



USER MANUAL

## **Gocator Line Profile Sensors**

Gocator 2100, 2300, 2400 Series; Gocator 2880

Firmware version: 4.6.x.xx

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# Introduction

Gocator laser profile sensors are designed for 3D measurement and control applications. Gocator sensors are configured using a web browser and can be connected to a variety of input and output devices.

This documentation describes how to connect, configure, and use a Gocator. It also contains reference information on the device's protocols and job files. The documentation applies to the following sensors:

- Gocator 2100 series
- Gocator 2300 series
- Gocator 2400 series
- Gocator 2880



B revision Gocator sensors are only supported by firmware version 4.3 or later. These sensors are compatible with SDK applications built with version 4.x of the SDK. The sensors are also compatible with jobs created on sensors running firmware 4.3.



C revision Gocator sensors are only supported by firmware version 4.5 SR1 or later. These sensors are compatible with SDK applications built with version 4.x of the SDK. The sensors are also compatible with jobs created on sensors running firmware 4.x.

## Notational Conventions

This documentation uses the following notational conventions:



Follow these safety guidelines to avoid potential injury or property damage.



Consider this information in order to make best use of the product.

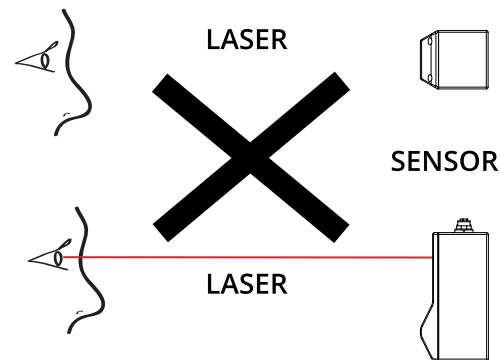
# Safety and Maintenance

The following sections describe the safe use and maintenance of Gocator sensors.

## Laser Safety

Gocator sensors contain semiconductor lasers that emit visible or invisible light and are designated as Class 2M, Class 3R, or Class 3B, depending on the chosen laser option. See *Laser Classes* on the next page for more information on the laser classes used in Gocator sensors.

Gocator sensors are referred to as *components*, indicating that they are sold only to qualified customers for incorporation into their own equipment. These sensors do not incorporate safety items that the customer may be required to provide in their own equipment (e.g., remote interlocks, key control; refer to the references below for detailed information). As such, these sensors do not fully comply with the standards relating to laser products specified in IEC 60825-1 and FDA CFR Title 21 Part 1040.



**WARNING: DO NOT LOOK DIRECTLY INTO THE LASER BEAM**

 Use of controls or adjustments or performance of procedures other than those specified herein may result in hazardous radiation exposure.

### References

1. *International standard IEC 60825-1 (2001-08) consolidated edition*, Safety of laser products – Part 1: Equipment classification, requirements and user's guide.
2. *Technical report 60825-10*, Safety of laser products – Part 10. Application guidelines and explanatory notes to IEC 60825-1.
3. *Laser Notice No. 50*, FDA and CDRH (<https://www.fda.gov/Radiation-EmittingProducts/ElectronicProductRadiationControlProgram/default.htm>)

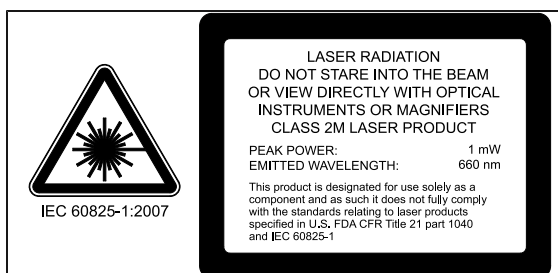


## Laser Classes

### Class 2M laser components

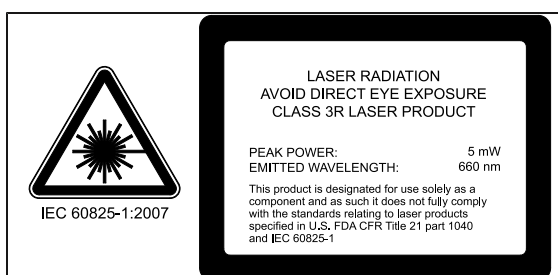
Class 2M laser components should not cause permanent damage to the eye under reasonably foreseeable conditions of operation, provided that:

- No optical aids are used (these could focus the beam).
- The user's blink reflex can terminate exposure (in under 0.25 seconds).
- Users do not need to look repeatedly at the beam or reflected light.
- Exposure is only accidental.



### Class 3R laser components

Class 3R laser products emit radiation where direct intrabeam viewing is potentially hazardous, but the risk is lower with 3R lasers than for 3B lasers. Fewer manufacturing requirements and control measures for 3R laser users apply than for 3B lasers. Eye protection and protective clothing are not required. The laser beam must be terminated at the end of an appropriate path. Avoid unintentional reflections. Personnel must be trained in working with laser equipment.



### Class 3B laser components

Class 3B components are unsafe for eye exposure. Usually only eye protection is required. Protective gloves may also be used. Diffuse reflections are safe if viewed for less than 10 seconds at a minimum distance of 13 cm. There is a risk of fire if the beam encounters flammable materials. The laser area must be clearly identified. Use a key switch or other mechanism to prevent unauthorized use. Use a clearly visible indicator to show that a laser is in use, such as "Laser in operation." Restrict the laser beam to the working area. Ensure that there are no reflective surfaces in this area.



Labels reprinted here are examples only. For accurate specifications, refer to the label on your sensor.

For more information, see *Precautions and Responsibilities* below.

## Precautions and Responsibilities

Precautions specified in IEC 60825-1 and FDA CFR Title 21 Part 1040 are as follows:

| Requirement          | Class 2M     | Class 3R                                        | Class 3B                                        |
|----------------------|--------------|-------------------------------------------------|-------------------------------------------------|
| Remote interlock     | Not required | Not required                                    | Required*                                       |
| Key control          | Not required | Not required                                    | Required – cannot remove key when in use*       |
| Power-on delays      | Not required | Not required                                    | Required*                                       |
| Beam attenuator      | Not required | Not required                                    | Required*                                       |
| Emission indicator   | Not required | Not required                                    | Required*                                       |
| Warning signs        | Not required | Not required                                    | Required*                                       |
| Beam path            | Not required | Terminate beam at useful length                 | Terminate beam at useful length                 |
| Specular reflection  | Not required | Prevent unintentional reflections               | Prevent unintentional reflections               |
| Eye protection       | Not required | Not required                                    | Required under special conditions               |
| Laser safety officer | Not required | Not required                                    | Required                                        |
| Training             | Not required | Required for operator and maintenance personnel | Required for operator and maintenance personnel |

*\*LMI Class 3B laser components do not incorporate these laser safety items. These items must be added and completed by customers in their system design. For more information, see Class 3B Responsibilities below.*

## Class 3B Responsibilities

LMI Technologies has filed reports with the FDA to assist customers in achieving certification of laser products. These reports can be referenced by an accession number, provided upon request. Detailed descriptions of the safety items that must be added to the system design are listed below.

### Remote Interlock

A remote interlock connection must be present in Class 3B laser systems. This permits remote switches to be attached in serial with the keylock switch on the controls. The deactivation of any remote switches must prevent power from being supplied to any lasers.

### Key Control

A key operated master control to the lasers is required that prevents any power from being supplied to the lasers while in the OFF position. The key can be removed in the OFF position but the switch must not allow the key to be removed from the lock while in the ON position.

## Power-On Delays

A delay circuit is required that illuminates warning indicators for a short period of time before supplying power to the lasers.

## Beam Attenuators

A permanently attached method of preventing human access to laser radiation other than switches, power connectors or key control must be employed.

## Emission Indicator

It is required that the controls that operate the sensors incorporate a visible or audible indicator when power is applied and the lasers are operating. If the distance between the sensor and controls is more than 2 meters, or mounting of sensors intervenes with observation of these indicators, then a second power-on indicator should be mounted at some readily-observable position. When mounting the warning indicators, it is important not to mount them in a location that would require human exposure to the laser emissions. User must ensure that the emission indicator, if supplied by OEM, is visible when viewed through protective eyewear.

## Warning Signs

Laser warning signs must be located in the vicinity of the sensor such that they will be readily observed.

Examples of laser warning signs are as follows:



*FDA warning sign example*



*IEC warning sign example*

## Nominal Ocular Hazard Distance (NOHD)

Nominal Ocular Hazard Distance (NOHD) is the distance from the source at which the intensity or the energy per surface unit becomes lower than the Maximum Permissible Exposure (MPE) on the cornea and on the skin.



The laser beam is considered dangerous if the operator is closer to the source than the NOHD.

The following table shows example calculations of the NOHD values for each Gocator model and laser class, assuming continuous operation of the laser. As a configurable device the Gocator, lets you set the laser exposure (laser on-time) independently of the frame period (total cycle time for data acquisition). Continuous operation of the laser means that the laser exposure is configured to be identical to the frame period, which is also referred to as 100% duty cycle. However, in many applications the laser exposure can be smaller than the frame period (less than 100% duty cycle) thereby reducing the NOHD. The table therefore shows the worst-case NOHD.

| Model | Laser Class | Model Constant | Class I MPE (mW) | Class II MPE (mw) | Class I NOHD (mm) | Class II NOHD (mm) |
|-------|-------------|----------------|------------------|-------------------|-------------------|--------------------|
| 2x20  | 2M          | 101            | 0.39             | 0.98              | 259               | 103                |
| 2x30  | 2M          | 101            | 0.39             | 0.98              | 259               | 103                |
|       | 3R          | 351            | 0.39             | 0.98              | 900               | 358                |
|       | 3B          | 2246           | 0.39             | 0.98              | 5759              | 2292               |
| 2x40  | 2M          | 101            | 0.39             | 0.98              | 259               | 103                |
|       | 3R          | 351            | 0.39             | 0.98              | 900               | 358                |
|       | 3B          | 2246           | 0.39             | 0.98              | 5759              | 2292               |
| 2x50  | 2M          | 101            | 0.39             | 0.98              | 259               | 103                |
|       | 3R          | 351            | 0.39             | 0.98              | 900               | 358                |
|       | 3B          | 2246           | 0.39             | 0.98              | 5759              | 2292               |
| 2x70  | 2M          | 98             | 0.39             | 0.98              | 251               | 100                |
|       | 3R          | 341            | 0.39             | 0.98              | 875               | 348                |
|       | 3B          | 1422           | 0.39             | 0.98              | 3645              | 1451               |
| 2x75  | 3B-N        | 8817           | 0.64             |                   | 13777             |                    |
| 2x80  | 2M          | 95             | 0.39             | 0.98              | 245               | 97                 |
|       | 3R          | 335            | 0.39             | 0.98              | 859               | 342                |
|       | 3B          | 1031           | 0.39             | 0.98              | 2645              | 1052               |

To calculate the NOHD value for a specific laser class, use the following formula:

$$NOHD = Model\ Constant / MPE$$

Model Constant includes a consideration of the fan angle for the individual models.

## Systems Sold or Used in the USA

Systems that incorporate laser components or laser products manufactured by LMI Technologies require certification by the FDA.

Customers are responsible for achieving and maintaining this certification.

Customers are advised to obtain the information booklet *Regulations for the Administration and Enforcement of the Radiation Control for Health and Safety Act of 1968: HHS Publication FDA 88-8035*.

This publication, containing the full details of laser safety requirements, can be obtained directly from the FDA, or downloaded from their web site at <https://www.fda.gov/Radiation-EmittingProducts/ElectronicProductRadiationControlProgram/default.htm>.

## Electrical Safety



Failure to follow the guidelines described in this section may result in electrical shock or equipment damage.

### **Sensors should be connected to earth ground**

All sensors should be connected to earth ground through their housing. All sensors should be mounted on an earth grounded frame using electrically conductive hardware to ensure the housing of the sensor is connected to earth ground. Use a multi-meter to check the continuity between the sensor connector and earth ground to ensure a proper connection.

### **Minimize voltage potential between system ground and sensor ground**

Care should be taken to minimize the voltage potential between system ground (ground reference for I/O signals) and sensor ground. This voltage potential can be determined by measuring the voltage between Analog\_out- and system ground. The maximum permissible voltage potential is 12 V but should be kept below 10 V to avoid damage to the serial and encoder connections.

See *Gocator I/O Connector* on page 560 for a description of the connector pins.

### **Use a suitable power supply**

The +24 to +48 VDC power supply used with Gocator sensors should be an isolated supply with inrush current protection or be able to handle a high capacitive load.

### **Use care when handling powered devices**

Wires connecting to the sensor should not be handled while the sensor is powered. Doing so may cause electrical shock to the user or damage to the equipment.

## **Handling, Cleaning, and Maintenance**



Dirty or damaged sensor windows (emitter or camera) can affect accuracy. Use caution when handling the sensor or cleaning the sensor's windows.

### **Keep sensor windows clean**

Use dry, clean air to remove dust or other dirt particles. If dirt remains, clean the windows carefully with a soft, lint-free cloth and non-streaking glass cleaner or isopropyl alcohol. Ensure that no residue is left on the windows after cleaning.

### **Turn off lasers when not in use**

LMI Technologies uses semiconductor lasers in Gocator sensors. To maximize the lifespan of the sensor, turn off the laser when not in use.

### **Avoid excessive modifications to files stored on the sensor**

Settings for Gocator sensors are stored in flash memory inside the sensor. Flash memory has an expected lifetime of 100,000 writes. To maximize lifetime, avoid frequent or unnecessary file save operations.

## **Environment and Lighting**

### **Avoid strong ambient light sources**

The imager used in this product is highly sensitive to ambient light hence stray light may have adverse effects on measurement. Do not operate this device near windows or lighting fixtures that could influence measurement. If the unit must be installed in an environment with high ambient light levels, a lighting shield or similar device may need to be installed to prevent light from affecting measurement.

### **Avoid installing sensors in hazardous environments**

To ensure reliable operation and to prevent damage to Gocator sensors, avoid installing the sensor in locations

- that are humid, dusty, or poorly ventilated;
- with a high temperature, such as places exposed to direct sunlight;
- where there are flammable or corrosive gases;
- where the unit may be directly subjected to harsh vibration or impact;
- where water, oil, or chemicals may splash onto the unit;
- where static electricity is easily generated.

### **Ensure that ambient conditions are within specifications**

Gocator sensors are suitable for operation between 0–50° C and 25–85% relative humidity (non-condensing). Measurement error due to temperature is limited to 0.015% of full scale per degree C.

The Master 400/800/1200/2400 is similarly rated for operation between 0–50° C.

The storage temperature is -30–70° C.



The sensor must be heat-sunk through the frame it is mounted to. When a sensor is properly heat sunk, the difference between ambient temperature and the temperature reported in the sensor's health channel is less than 15° C.



Gocator sensors are high-accuracy devices, and the temperature of all of its components must therefore be in equilibrium. When the sensor is powered up, a warm-up time of at least one hour is required to reach a consistent spread of temperature in the sensor.

# Getting Started

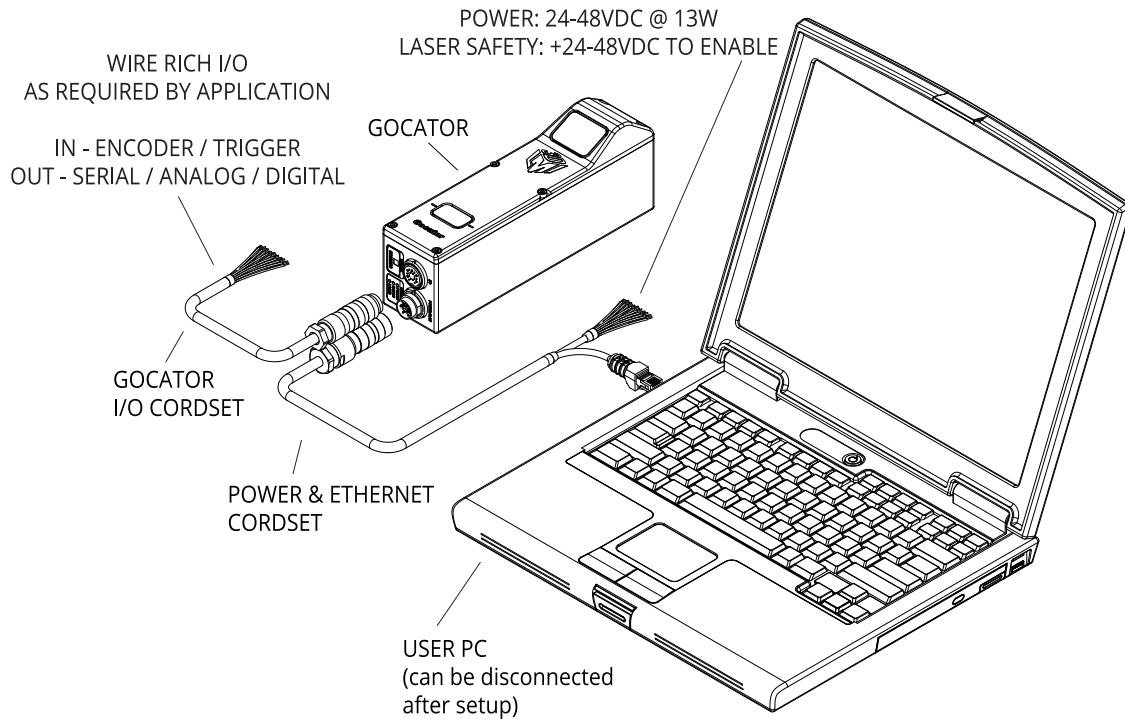
The following sections provide system and hardware overviews, in addition to installation and setup procedures.

## System Overview

Gocator sensors can be installed and used in a variety of scenarios. Sensors can be connected as standalone devices, dual-sensor systems, or multi-sensor systems.

### Standalone System

Standalone systems are typically used when only a single Gocator sensor is required. The sensor can be connected to a computer's Ethernet port for setup and can also be connected to devices such as encoders, photocells, or PLCs.



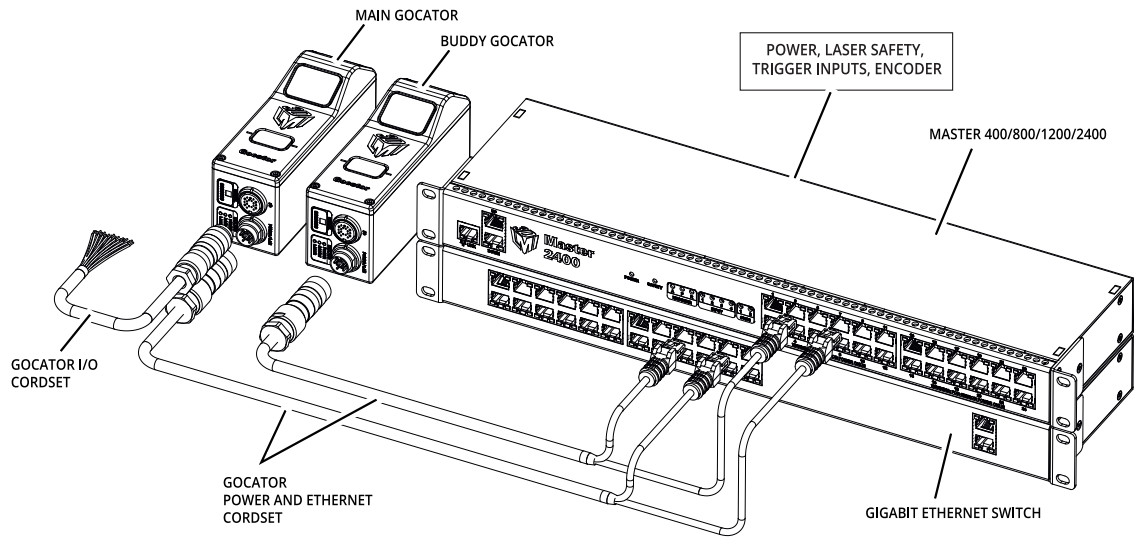
## Dual-Sensor System

In a dual-sensor system, two Gocator sensors work together to perform profiling and output the combined results. The controlling sensor is referred to as the *Main* sensor, and the other sensor is referred to as the *Buddy* sensor. Gocator's software recognizes three installation orientations: *Opposite*, *Wide*, and *Reverse*.

A [Master network controller](#) (excluding Master 100) must be used to connect two sensors in a dual-sensor system. Gocator Power and Ethernet to Master cordsets are used to connect sensors to the Master.



## GOCATOR 2300 SERIES

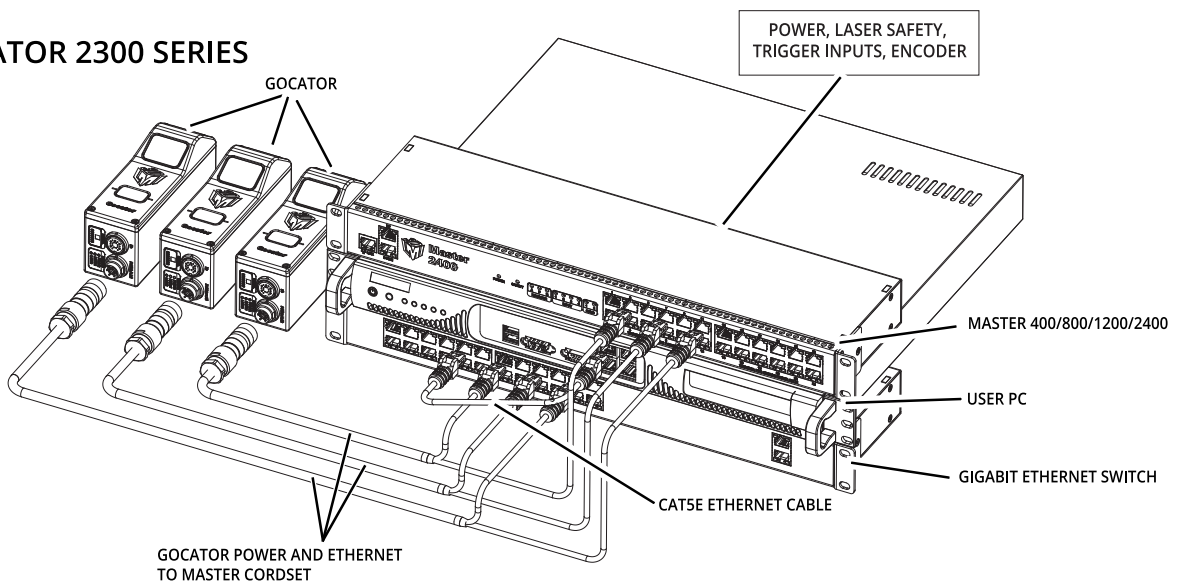


## Multi-Sensor System

A [Master network controller](#) (excluding Master 100) can be used to connect two or more sensors into a multi-sensor system. Gocator Master cordsets are used to connect the sensors to a Master. The Master provides a single point of connection for power, safety, encoder, and digital inputs. A Master 400/800/1200/2400 can be used to ensure that the scan timing is precisely synchronized across sensors. Sensors and client computers communicate via an Ethernet switch (1 Gigabit/s recommended).

Master networking hardware does not support digital, serial, or analog output.

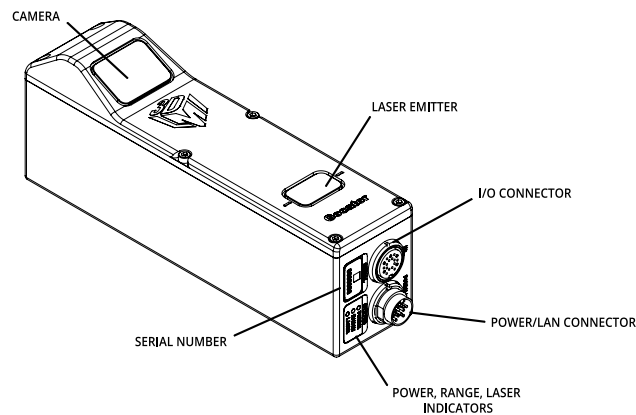
## GOCATOR 2300 SERIES



# Hardware Overview

The following sections describe Gocator and its associated hardware.

## Gocator Sensor



*Gocator 2140 / 2340*

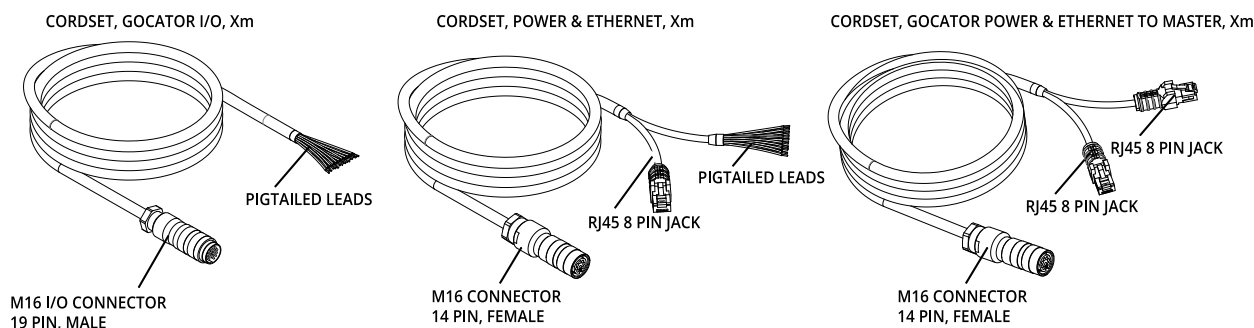
| Item                  | Description                                                                          |
|-----------------------|--------------------------------------------------------------------------------------|
| Camera                | Observes laser light reflected from target surfaces.                                 |
| Laser Emitter         | Emits structured light for laser profiling.                                          |
| I/O Connector         | Accepts input and output signals.                                                    |
| Power / LAN Connector | Accepts power and laser safety signals and connects to 1000 Mbit/s Ethernet network. |
| Power Indicator       | Illuminates when power is applied (blue).                                            |
| Range Indicator       | Illuminates when camera detects laser light and is within the target range (green).  |
| Laser Indicator       | Illuminates when laser safety input is active (amber).                               |
| Serial Number         | Unique sensor serial number.                                                         |

## Gocator Cordsets

Gocator sensors use two types of cordsets.

The Power & Ethernet cordset provides power, laser safety interlock to the sensor. It is also used for sensor communication via 1000 Mbit/s Ethernet with a standard RJ45 connector. The Master version of the Power & Ethernet cordset provides direct connection between the sensor and a [Master network controller](#) (excluding Master 100).

The Gocator I/O cordset provides digital I/O connections, an encoder interface, RS-485 serial connection, and an analog output.



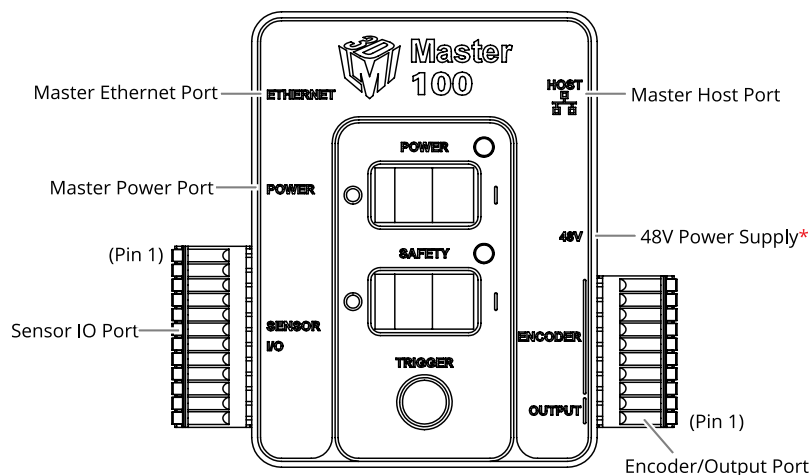
The maximum cordset length is 60 m.

See *Gocator I/O Connector* on page 560 and *Gocator Power/LAN Connector* on page 558 for pinout details.

See *Accessories* on page 581 for cordset lengths and part numbers. Contact LMI for information on creating cordsets with customized lengths and connector orientations.

## Master 100

The Master 100 is used by Gocator sensors for standalone system setup (that is, a single sensor).



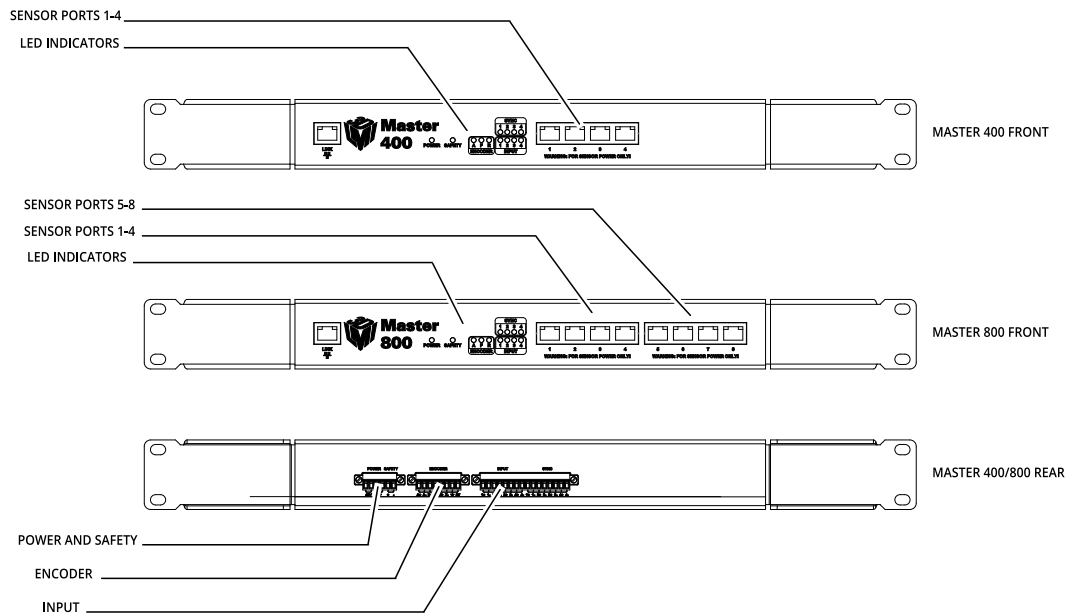
| Item                 | Description                                                                                                                           |
|----------------------|---------------------------------------------------------------------------------------------------------------------------------------|
| Master Ethernet Port | Connects to the RJ45 connector labeled Ethernet on the Power/LAN to Master cordset.                                                   |
| Master Power Port    | Connects to the RJ45 connector labeled Power/Sync on the Power/LAN to Master cordset. Provides power and laser safety to the Gocator. |
| Sensor I/O Port      | Connects to the Gocator I/O cordset.                                                                                                  |
| Master Host Port     | Connects to the host PC's Ethernet port.                                                                                              |
| Power                | Accepts power (+48 V).                                                                                                                |
| Power Switch         | Toggles sensor power.                                                                                                                 |
| Laser Safety Switch  | Toggles laser safety signal provided to the sensors [O= laser off, I= laser on].                                                      |
| Trigger              | Signals a digital input trigger to the Gocator.                                                                                       |
| Encoder              | Accepts encoder A, B and Z signals.                                                                                                   |
| Digital Output       | Provides digital output.                                                                                                              |

See *Master 100* on page 564 for pinout details.

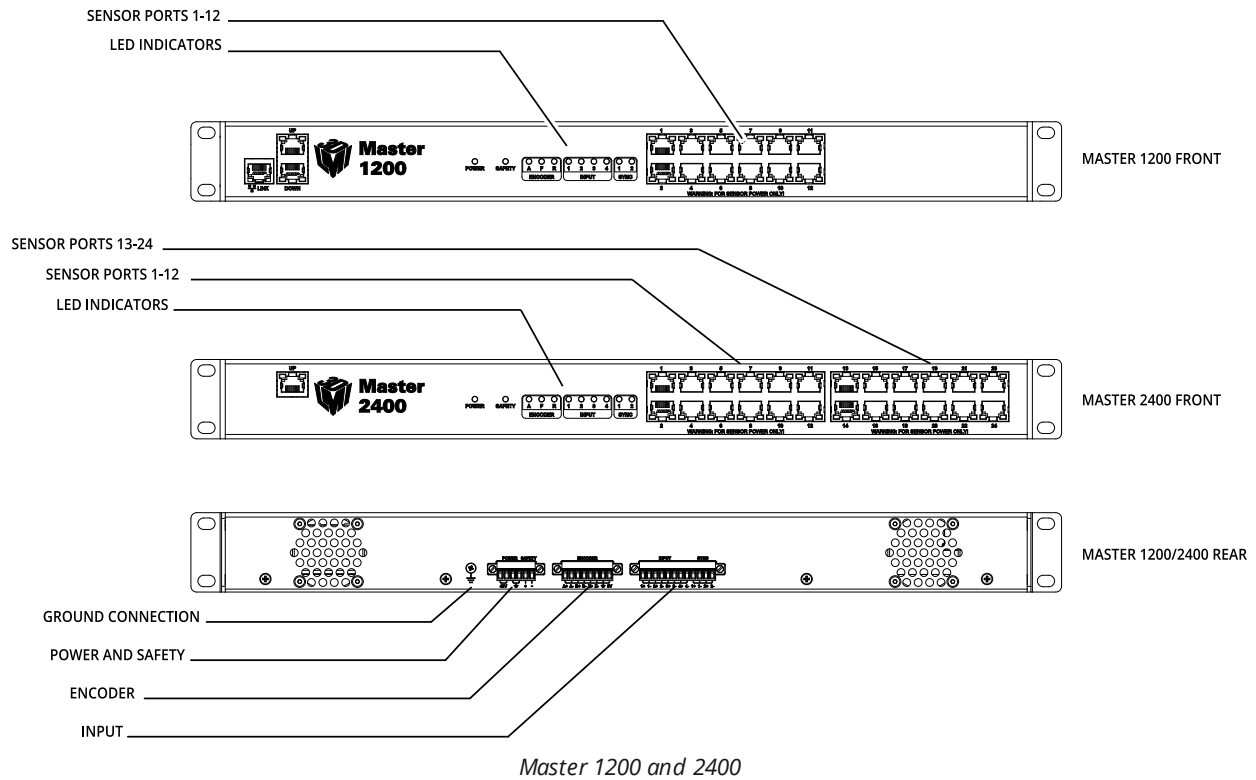
## Master 400 / 800 / 1200 / 2400

The Master 400, 800, 1200, and 2400 network controllers let you connect more than two sensors:

- Master 400: accepts four sensors
- Master 800 accepts eight sensors
- Master 1200: accepts twelve sensors
- Master 2400: accepts twenty-four sensors



*Master 400 and 800*



| Item              | Description                                                         |
|-------------------|---------------------------------------------------------------------|
| Sensor Ports      | Master connection for Gocator sensors (no specific order required). |
| Ground Connection | Earth ground connection point.                                      |
| Power and Safety  | Power and laser safety connection.                                  |
| Encoder           | Accepts encoder signal.                                             |
| Input             | Accepts digital input.                                              |

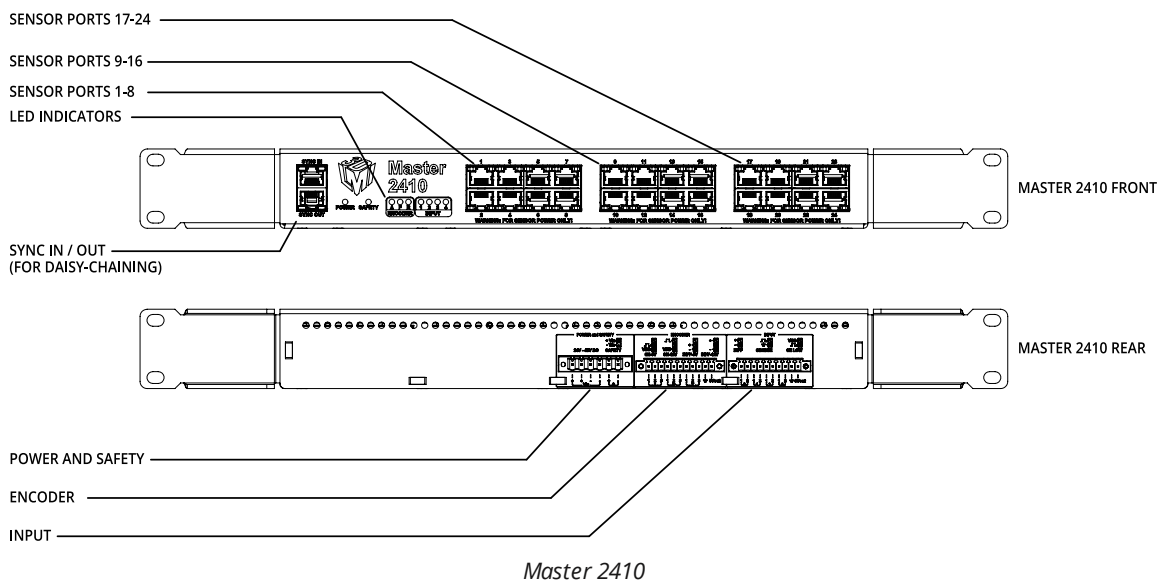
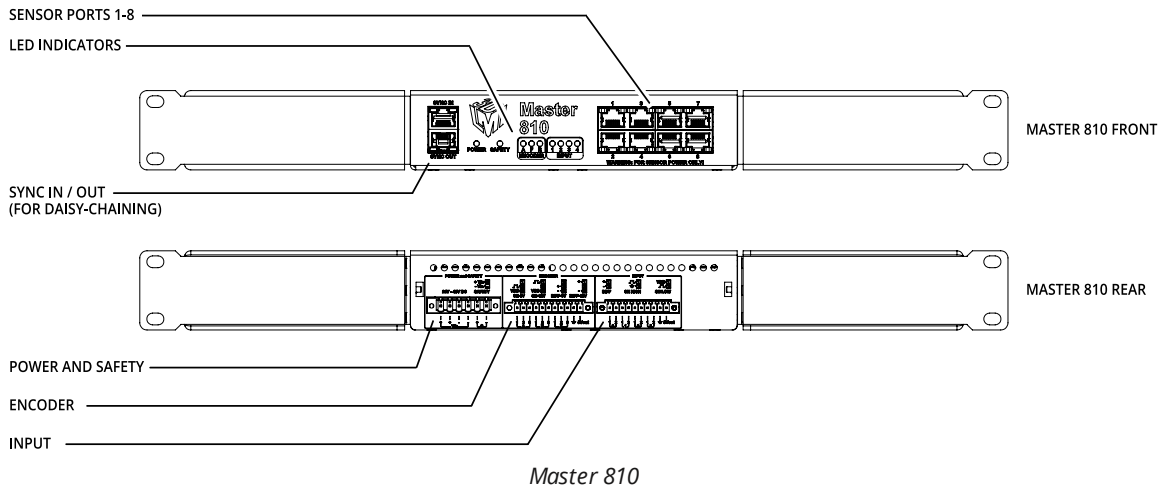
For pinout details for Master 400 or 800, see *Master 400/800* on page 566.

For pinout details for Master 1200 or 2400, see *Master 1200/2400* on page 578.

## Master 810 / 2410

The Master 810 and 2410 network controllers let you connect more than two sensors:

- Master 810 accepts eight sensors
- Master 2410: accepts twenty-four sensors



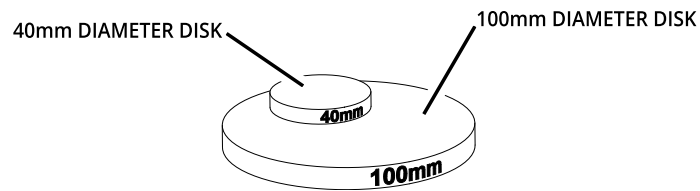
| Item             | Description                                                         |
|------------------|---------------------------------------------------------------------|
| Sensor Ports     | Master connection for Gocator sensors (no specific order required). |
| Power and Safety | Power and laser safety connection.                                  |
| Encoder          | Accepts encoder signal.                                             |
| Input            | Accepts digital input.                                              |

For pinout details, see *Master 810/2410* on page 570.

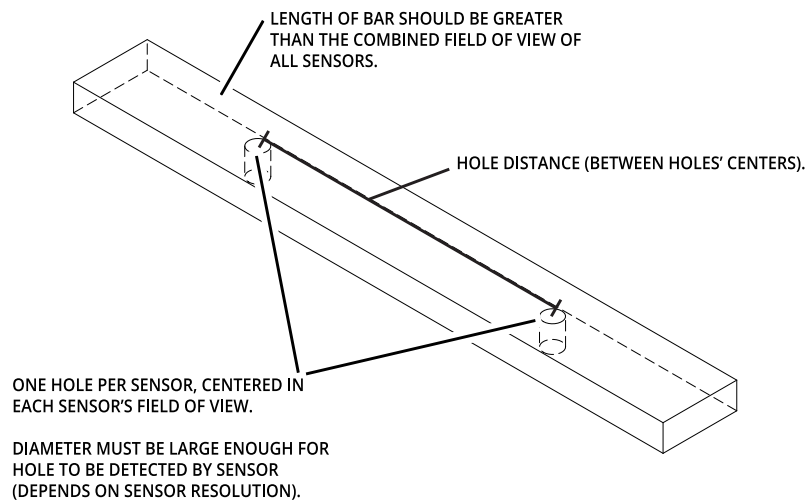
## Calibration Targets

Targets are used for alignment and calibrating encoder systems.

Disks are typically used with systems containing a single sensor and can be ordered from LMI Technologies. When choosing a disk for your application, select the largest disk that fits entirely within the required field of view. See *Accessories* on page 581 for disk part numbers.



For dual- and multi-sensor systems, bars are required to match the length of the system by following the guidelines illustrated below. (LMI Technologies does not manufacture or sell bars.)



See *Aligning Sensors* on page 113 for more information on alignment.

# Installation

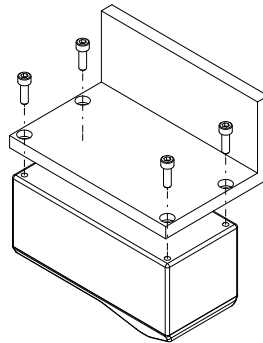
The following sections provide grounding, mounting, and orientation information.

## Mounting

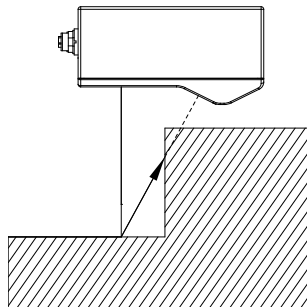
Sensors should be mounted using a model-dependent number of screws. Some models also provide the option to mount using bolts in through-body holes. Refer to the Dimension drawings of the sensors in *Specifications* on page 523 for the appropriate screw diameter, pitch, and length, and bolt hole diameter.



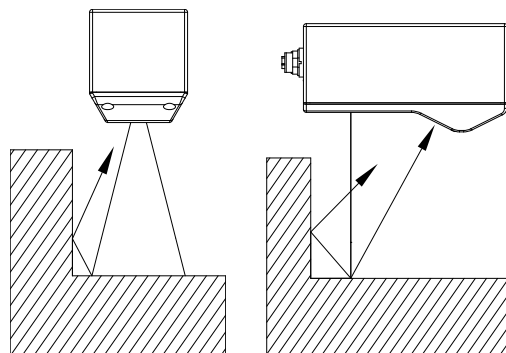
Proper care should be taken in order to ensure that the internal threads are not damaged from cross-threading or improper insertion of screws.



With the exception of Gocator 2880, sensors should not be installed near objects that might occlude a camera's view of the laser. (Gocator 2880 is specifically designed to compensate for occlusions.)



Sensors should not be installed near surfaces that might create unanticipated laser reflections.







The sensor must be heat sunk through the frame it is mounted to. When a sensor is properly heat sunk, the difference between ambient temperature and the temperature reported in the sensor's health channel is less than 15° C.



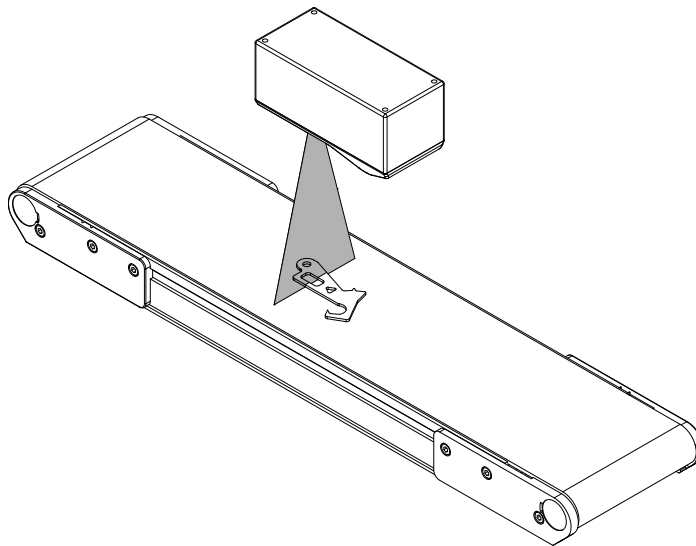
Gocator sensors are high-accuracy devices. The temperature of all of its components must be in equilibrium. When the sensor is powered up, a warm-up time of at least one hour is required to reach a consistent spread of temperature within the sensor.

## Orientations

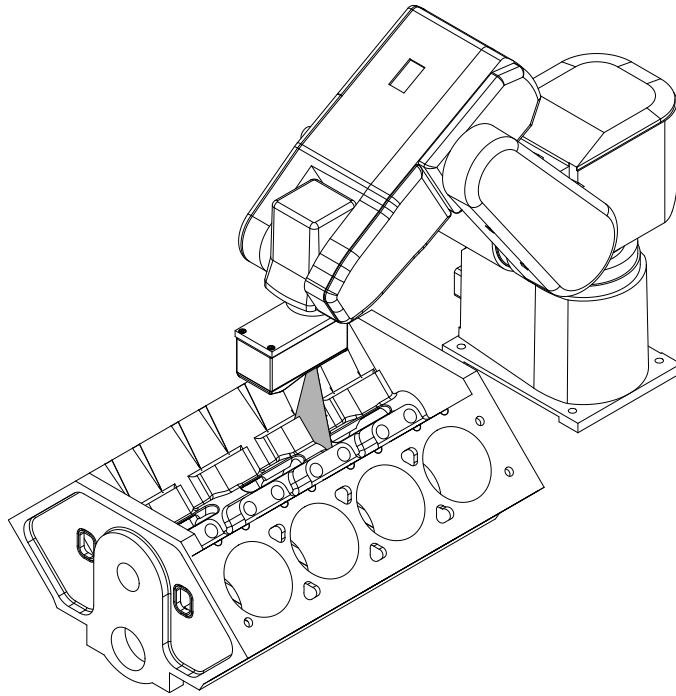
The examples below illustrate the possible mounting orientations for standalone and dual-sensor systems.

See *Layout* on page 73 for more information on orientations.

### Standalone Orientations

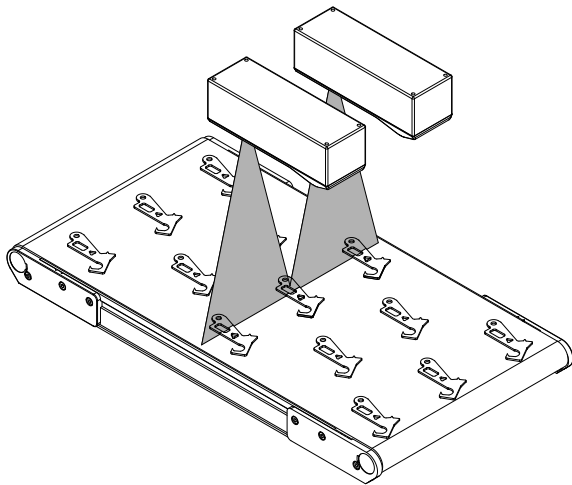


*Single sensor above conveyor*

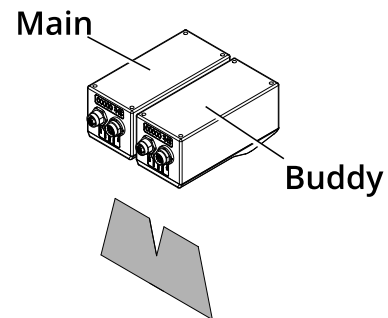


*Single sensor on robot arm*

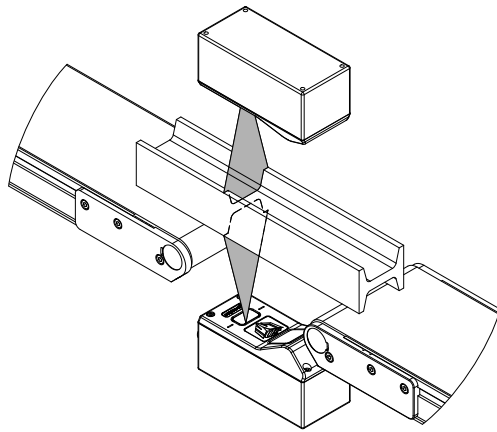
### **Dual-Sensor System Orientations:**



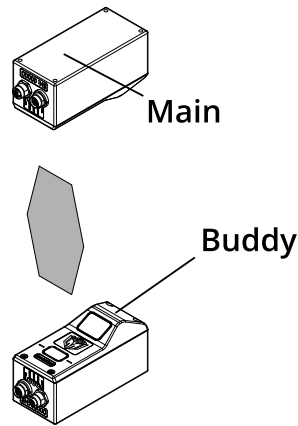
*Side-by-side for wide-area measurement (Wide)*



*Main must be on the left side (when looking into the connector) of the Buddy (Wide)*



*Above/below for two-sided measurement (Opposite)*



*Main must be on the top  
with Buddy on the bottom (Opposite)*

For more information on setting up a dual-sensor system, see

[http://lmi3d.com/sites/default/files/APPNOTE\\_Gocator\\_2300\\_Gocator\\_4.x\\_Dual\\_Sensor\\_Setup\\_Guide.pdf](http://lmi3d.com/sites/default/files/APPNOTE_Gocator_2300_Gocator_4.x_Dual_Sensor_Setup_Guide.pdf).

## Grounding: Gocator

Gocators should be grounded to the earth/chassis through their housings and through the grounding shield of the Power I/O cordset. Gocator sensors have been designed to provide adequate grounding through the use of M5 x 0.8 pitch mounting screws. Always check grounding with a multi-meter to ensure electrical continuity between the mounting frame and the Gocator's connectors.

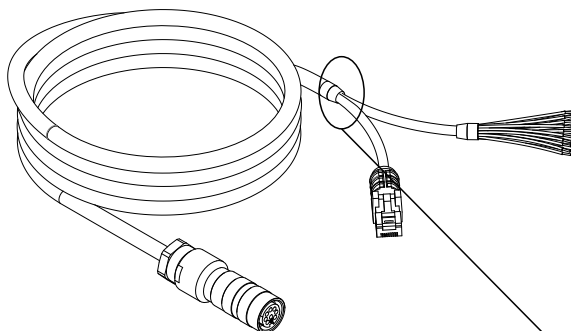


The frame or electrical cabinet that the Gocator is mounted to must be connected to earth ground.

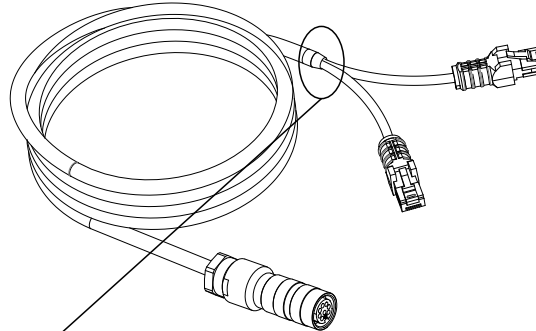
## Grounding: Recommended Practices for Cordsets

If you need to minimize interference with other equipment, you can ground the Power & Ethernet or the Power & Ethernet to Master cordset (depending on which cordset you are using) by terminating the shield of the cordset before the split. The most effective grounding method is to use a 360-degree clamp.

**CORDSET, POWER & ETHERNET, Xm**



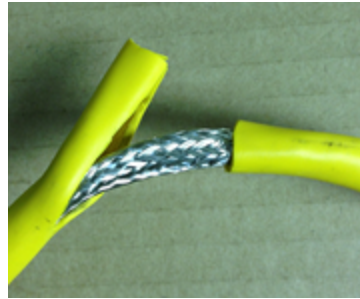
**CORDSET, GOCATOR POWER & ETHERNET TO MASTER, Xm**



**Attach the 360-degree clamp before the split**

*To terminate the cordset's shield:*

1. Expose the cordset's braided shield by cutting the plastic jacket before the point where the cordset splits.



2. Install a 360-degree ground clamp.



## Installing DIN Rail Clips: Master 810 or 2410

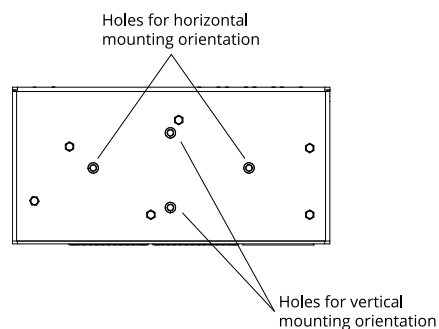
You can mount the Master 810 and 2410 using the included DIN rail mounting clips with M4x8 flat socket cap screws. The following DIN rail clips ([DINM12-RC](#)) are included:



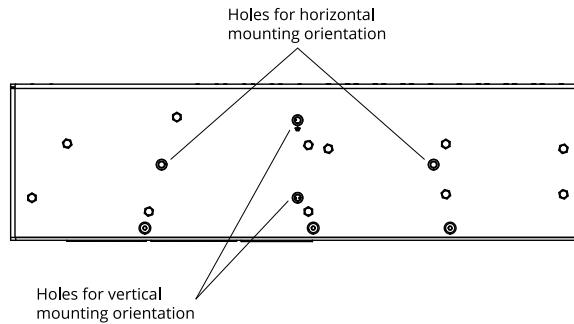
*To install the DIN rail clips:*

1. Remove the 1U rack mount brackets.
2. Locate the DIN rail mounting holes on the back of the Master (see below).

Master 810:

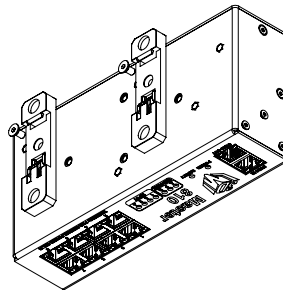


Master 2410:



3. Attach each of the two DIN rail mount clips to the back of the Master using an M4x8 flat socket cap screw for each one.

The following illustration shows the installation of clips on a Master 810 for horizontal mounting:



Ensure that there is enough clearance around the Master for cabling.

## Grounding: Master Network Controllers

The rack mount brackets provided with all Masters are designed to provide adequate grounding through the use of star washers. Always check grounding with a multi-meter by ensuring electrical continuity between the mounting frame and RJ45 connectors on the front.



When using the rack mount brackets, you *must* connect the frame or electrical cabinet to which the Master is mounted to earth ground.

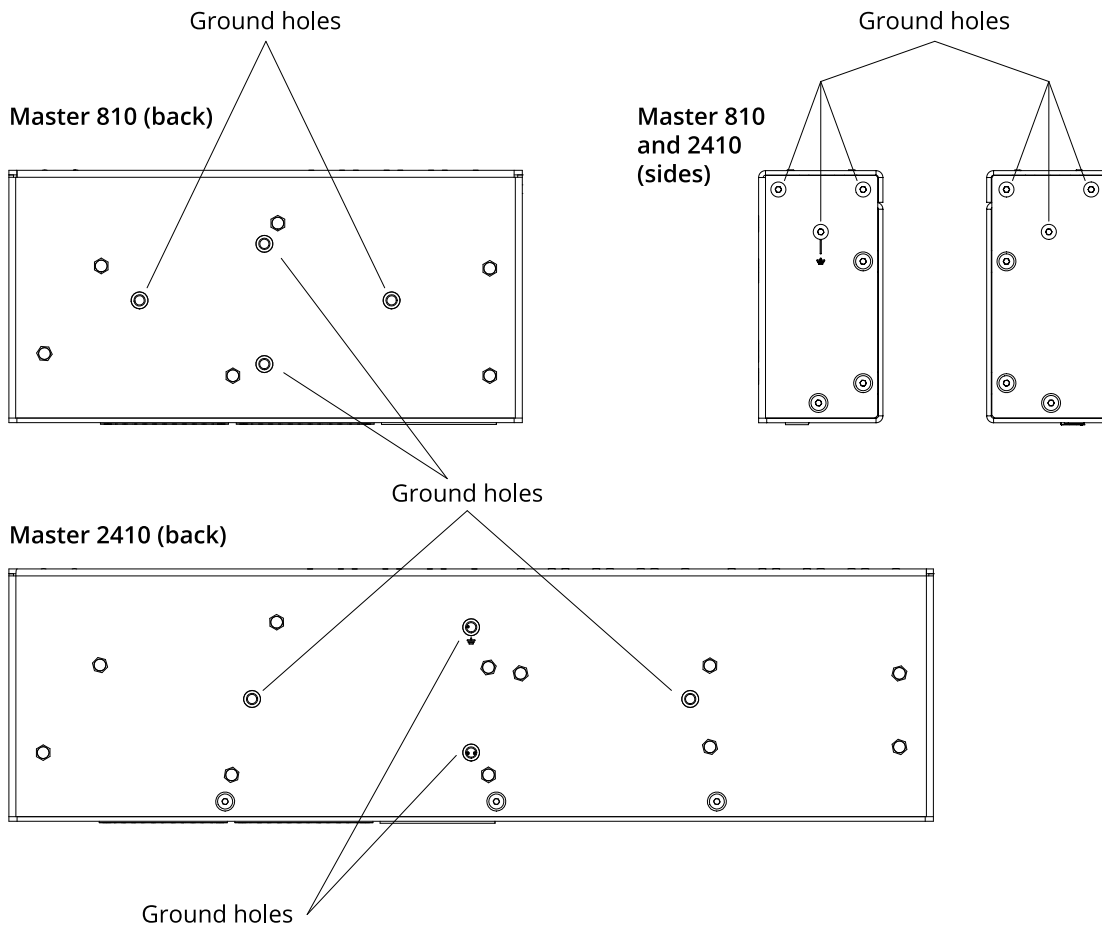


You *must* check electrical continuity between the mounting frame and RJ45 connectors on the front using a multi-meter.

If you are mounting Master 810 or 2410 using the provided DIN rail mount adapters, you must ground the Master directly; for more information, see *Grounding When Using a DIN Rail (Master 810/2410)* below.

### Grounding When Using a DIN Rail (Master 810/2410)

If you are using DIN rail adapters instead of the rack mount brackets, you must ensure that the Master is properly grounded by connecting a ground cable to one of the holes indicated below. The holes accept M4x5 screws.

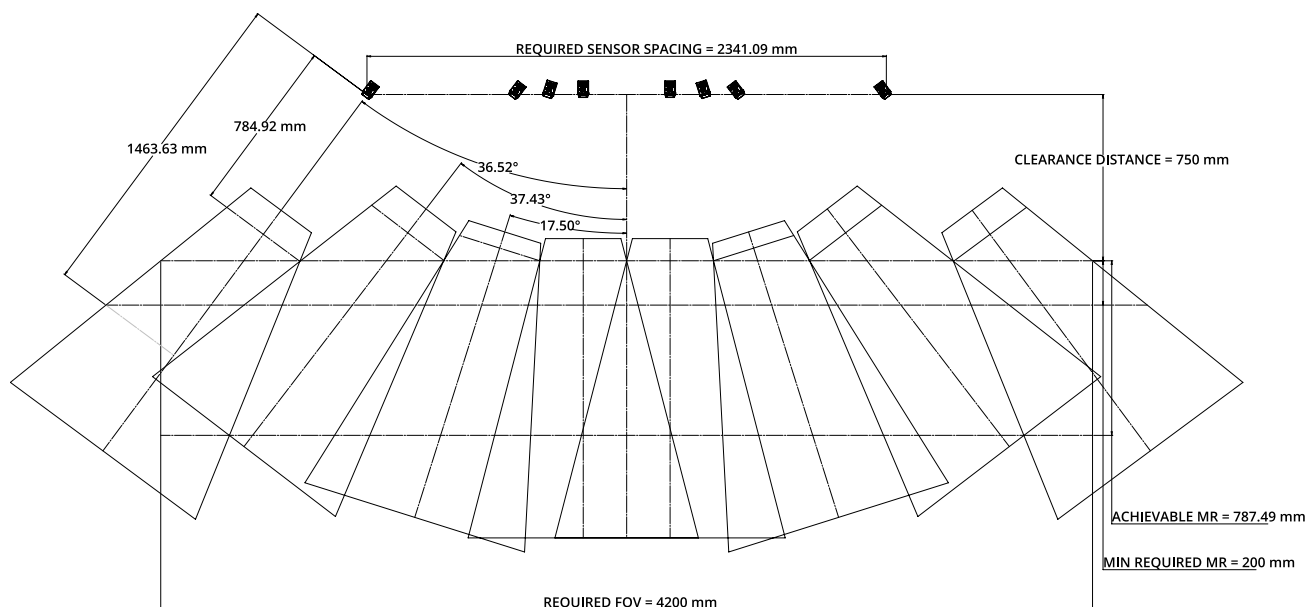


## Rut-Scanning System Setup

The following sections describe how to set up a Gocator 2375 rut-scanning system.

### Layout

The Gocator 2375 sensor is designed to cover a scan width of up to 4.2 m by using 8 sensors mounted in parallel.

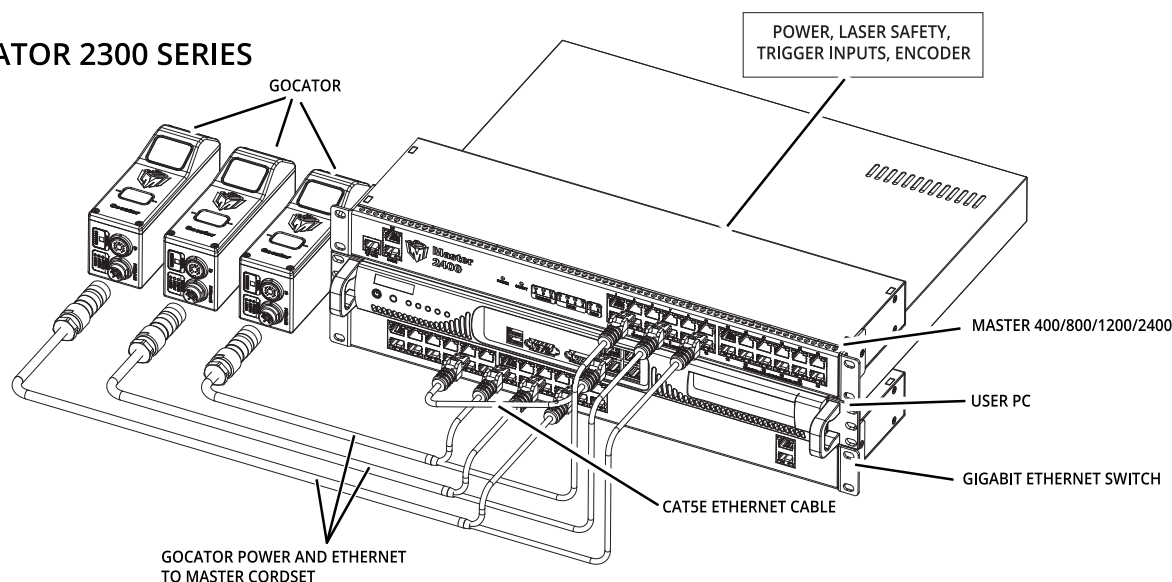


The diagram above shows the clearance distance and measurement range required in a typical setup. Use the specification estimator (Gocator-2375\_Specification\_Estimator.xlsx) to calculate the X and Z resolution of the sensors with different combinations of clearance distance and measurement range.

## System Setup

A typical Gocator 2375 system is set up as a multi-sensor system. The sensors are powered using a [Master network controller](#) (excluding Master 100).

### GOCATOR 2300 SERIES



To connect a Gocator 2375:

1. Connect the Power and Ethernet to Master cordset to the Power/LAN connector on the sensor.

2. Connect the RJ45 jack labeled Power to an unused port on the Master.
3. Connect the RJ45 jack labeled Ethernet to an unused port on the Master.
4. Repeat the steps above for each sensor.

See *Master 400/800* on page 566 and *Master 1200/2400* on page 578 for more information on how to install a Master.

## Software Configuration

Each sensor is shipped with a default IP address of 192.168.1.10. Before you add a sensor to a multi-sensor system, its firmware version must match that of the other sensors, and its IP address must be unique.

*To configure a Gocator 2375 for the first time:*

1. Set up the sensor's IP address.
  - a. Follow the steps in *Running a Standalone Sensor System* on page 39.
  - b. Make sure that there is no other sensor in the network with the IP address 192.168.1.10.
2. Upgrade the firmware.
  - a. Follow the steps in *Firmware Upgrade* on page 87.
3. Set up profiling parameters.
  - a. Follow the steps in *Scan Setup and Alignment* on page 91 to set up profiling parameters. Typically, trigger, active area, and exposure will need to be adjusted.

## System Operation

An isolated layout should be used. Under this layout, each sensor can be independently controlled by the SDK. The following application notes explain how to operate a multi-sensor system using the SDK.

### **APPNOTE\_Gocator\_4.x\_Multi\_Sensor\_Guide.zip**

Explains how to use the SDK to create a multi-sensor system, and multiplex their timing.

### **Gocator-2000-2300\_appnote\_multi-sensor-alignment-calibration.zip**

Explains how to use the SDK to perform alignment calibration of a multi-sensor system.

You can find the app notes under the How-to category in LMI's online [Gocator resources](#).

Example code is included with both of the application notes above.



# Network Setup

The following sections provide procedures for client PC and Gocator network setup.



DHCP is not recommended for Gocator sensors. If you choose to use DHCP, the DHCP server should try to preserve IP addresses. Ideally, you should use static IP address assignment (by MAC address) to do this.

## Client Setup

Sensors are shipped with the following default network configuration:

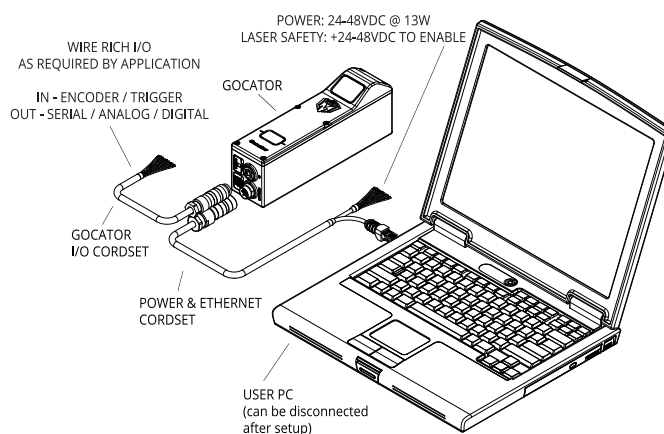
| Setting     | Default       |
|-------------|---------------|
| DHCP        | Disabled      |
| IP Address  | 192.168.1.10  |
| Subnet Mask | 255.255.255.0 |
| Gateway     | 0.0.0.0       |



All Gocator sensors are configured to 192.168.1.10 as the default IP address. For a dual-sensor system, the Main and Buddy sensors must be assigned unique addresses before they can be used on the same network. Before proceeding, connect the Main and Buddy sensors one at a time (to avoid an address conflict) and use the steps in See *Running a Dual-Sensor System* on page 40 to assign each sensor a unique address.

*To connect to a sensor for the first time:*

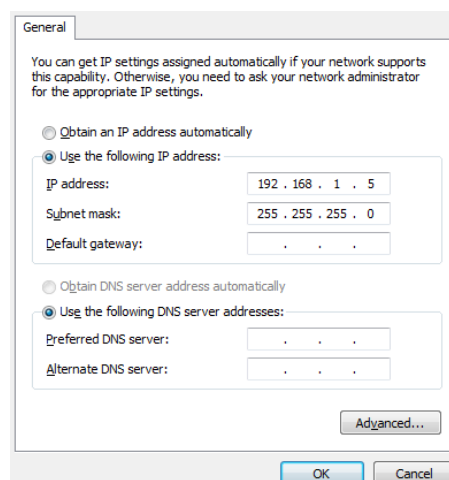
1. Connect cables and apply power.  
Sensor cabling is illustrated in *System Overview* on page 19.



2. Change the client PC's network settings.

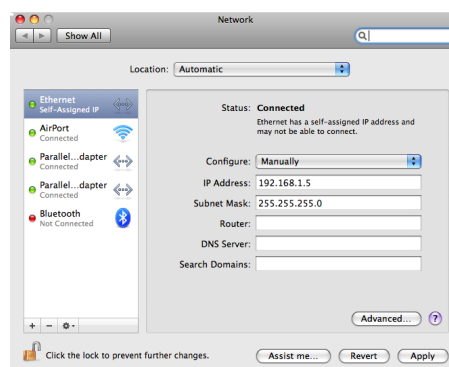
#### Windows 7

- a. Open the Control Panel, select **Network and Sharing Center**, and then click **Change Adapter Settings**.
- b. Right-click the network connection you want to modify, and then click **Properties**.
- c. On the **Networking** tab, click **Internet Protocol Version 4 (TCP/IPv4)**, and then click **Properties**.
- d. Select the **Use the following IP address** option.
- e. Enter IP Address "192.168.1.5" and Subnet Mask "255.255.255.0", then click **OK**.



#### Mac OS X v10.6

- a. Open the Network pane in **System Preferences** and select **Ethernet**.
- b. Set **Configure** to **Manually**.
- c. Enter IP Address "192.168.1.5" and Subnet Mask "255.255.255.0", then click **Apply**.



See *Troubleshooting* on page 521 if you experience any problems while attempting to establish a connection to the sensor.

## Gocator Setup

The Gocator is shipped with a default configuration that will produce laser profiles for most targets.

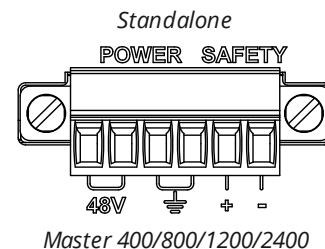
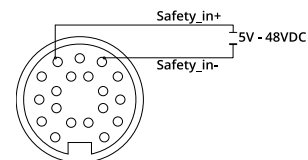
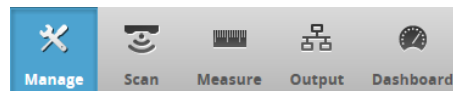
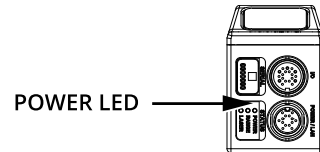
The following sections describe how to set up a standalone sensor system and a dual-sensor system for operations. After you have completed the setup, you can perform laser profiling to verify basic sensor operation.

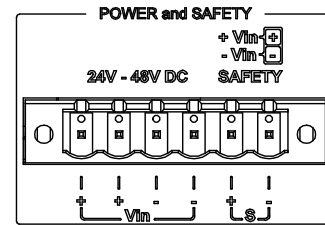
### Running a Standalone Sensor System

*To configure a standalone sensor system:*

1. Power up the sensor.  
The power indicator (blue) should turn on immediately.
2. Enter the sensor's IP address (192.168.1.10) in a web browser.  
The Gocator interface loads.  
If a password has been set, you will be prompted to provide it and then log in.
3. Go to the **Manage** page.
4. Ensure that Replay mode is off (the slider is set to the left).  

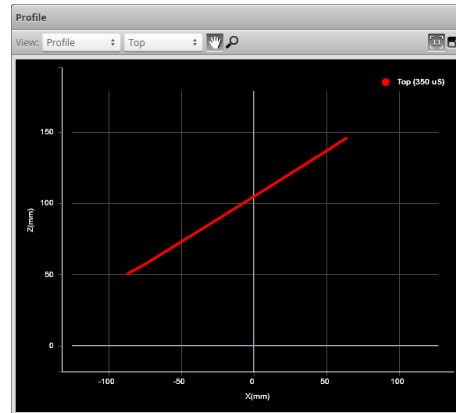
 Replay mode disables measurements.
5. Ensure that the Laser Safety Switch is enabled or the Laser Safety input is high.
6. Go to the **Scan** page.
7. Observe the profile in the data viewer
8. Press the **Start** button or the **Snapshot** on the **Toolbar** to start the sensor.  
The **Start** button is used to run sensors continuously.  
The **Snapshot** button is used to trigger the capture of a single profile.





Master 810/2410

9. Move a target into the laser plane.  
If a target object is within the sensor's measurement range, the data viewer will display the shape of the target, and the sensor's range indicator will illuminate. If you cannot see the laser, or if a profile is not displayed in the Data Viewer, see *Troubleshooting* on page 521.



10. Press the **Stop** button.  
The laser should turn off.

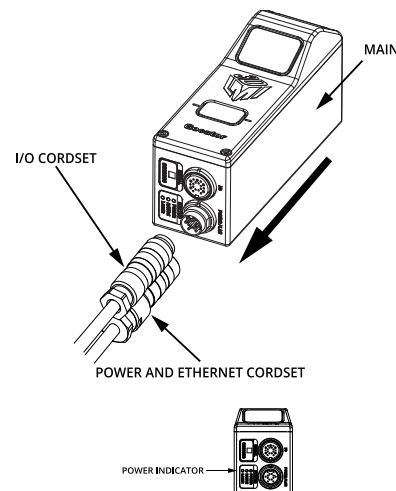


## Running a Dual-Sensor System

All sensors are shipped with a default IP address of 192.168.1.10. Ethernet networks require a unique IP address for each device, so you must set up a unique address for each sensor.

*To configure a dual-sensor system:*

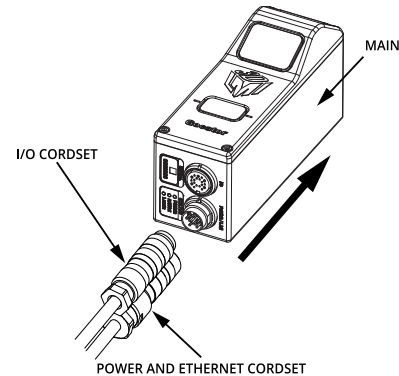
1. Turn off the sensors and unplug the Ethernet network connection of the Main sensor.  
All sensors are shipped with a default IP address of 192.168.1.10. Ethernet networks require a unique IP address for each device. Skip step 1 to 3 if the Buddy sensor's IP address is already set up with a unique address.
2. Power up the Buddy sensor.  
The power LED (blue) of the Buddy sensor should turn on immediately.
3. Enter the sensor's IP address 192.168.1.10 in a web browser.



The Gocator interface loads.

4. Go to the **Manage** Page.
5. Modify the IP address to 192.168.1.11 in the **Networking** category and click the **Save** button.  
When you click the **Save** button, you will be prompted to confirm your selection.
6. Turn off the sensors, re-connect the Main sensor's Ethernet connection and power-cycle the sensors.  
After changing network configuration, the sensors must be reset or power-cycled before the change will take effect.

The screenshot shows the 'Networking' configuration window in the Gocator software. The 'Type' is set to 'Manual'. The 'IP' field is set to '192.168.1.11', the 'Subnet Mask' is '255.255.255.0', and the 'Gateway' is '0.0.0.0'. A 'Save' button is located at the bottom right of the configuration area.



A screenshot of a web browser's address bar. It contains the URL 'http://192.168.1.10' and navigation buttons (back, forward, refresh, home, and a play button).

7. Enter the sensor's IP address 192.168.1.10 in a web browser.  
The Gocator interface loads.

8. Select the **Manage** page.
9. Go to **Manage** page, **Sensor System** panel, and select the **Visible Sensors** panel.  
The serial number of the Buddy sensor is listed in the Available Sensors panel.

The screenshot shows the 'Buddy' sensor information panel. It displays 'Status: N/A', 'Model:', 'Version:', and 'Master: N/A'. There is a 'Remove' button. Below this is the 'Visible Sensors' section, which contains a table with the following data:

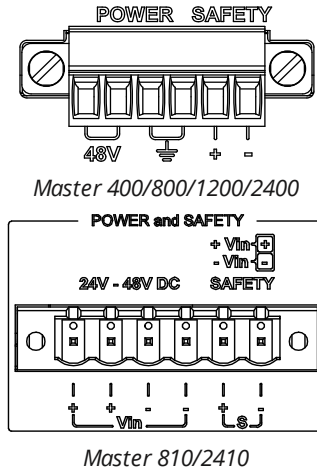
| Serial | Model        | Version  | State |
|--------|--------------|----------|-------|
| 17355  | Gocator 2330 | 4.0.9.84 | Ready |

At the bottom of the 'Visible Sensors' section is an 'Assign' button.

10. Select the Buddy sensor and click the **Assign** button.  
The Buddy sensor will be assigned to the Main sensor

and its status will be updated in the System panel.  
The firmware on Main and Buddy sensors must be the same for Buddy assignment to be successful. If the firmware is different, connect the Main and Buddy sensor one at a time and follow the steps in *Firmware Upgrade* on page 87 to upgrade the sensors.

11. Ensure that the Laser Safety Switch is enabled or the Laser Safety input is high.



12. Ensure that **Replay** mode is off (the slider is set to the left).

13. Go to the the **Scan** page.

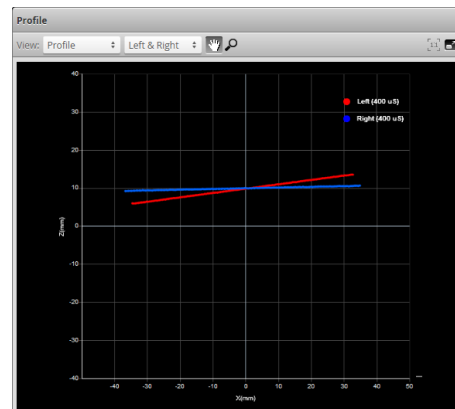
14. Press the **Start** or the **Snapshot** button on the **Toolbar** to start the sensors.

The **Start** button is used to run sensors continuously, while the **Snapshot** button is used to trigger a single profile.



15. Move a target into the laser plane.

If a target object is within the sensor's measurement range, the data viewer will display the shape of the target, and the sensor's range indicator will illuminate. If you cannot see the laser, or if a profile is not displayed in the Data Viewer, see *Troubleshooting* on page 521.



16. Press the **Stop** button if you used the **Start** button to start the sensors.

The laser should turn off.



# Next Steps

After you complete the steps in this section, the Gocator measurement system is ready to be configured for an application using the software interface. The interface is explained in the following sections:

## **Management and Maintenance (page 70)**

Contains settings for sensor system layout, network, motion and alignment, handling jobs, and sensor maintenance.

## **Scan Setup and Alignment (page 91)**

Contains settings for scan mode, trigger source, detailed sensor configuration, and performing alignment.

## **Models (page 140)**

Contains settings for creating part matching models and sections.

## **Measurement (page 161)**

Contains built-in measurement tools and their settings.

## **Output (page 283)**

Contains settings for configuring output protocols used to communicate measurements to external devices.

## **Dashboard (page 295)**

Provides monitoring of measurement statistics and sensor health.

## **Toolbar (page 59)**

Controls sensor operation, manages jobs, and replays recorded measurement data.

# How Gocator Works

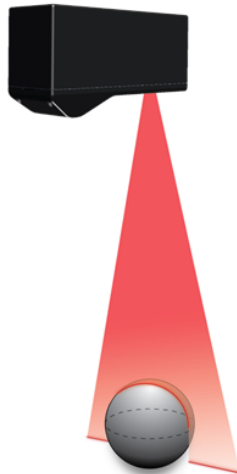
The following sections provide an overview of how Gocator acquires and produces data, detects and measures parts, and controls devices such as PLCs. Some of these concepts are important for understanding how you should mount sensors and configure settings such as active area.



You can use the Gocator Accelerator to speed up processing of data. For more information, see *Gocator Accelerator* on page 313.

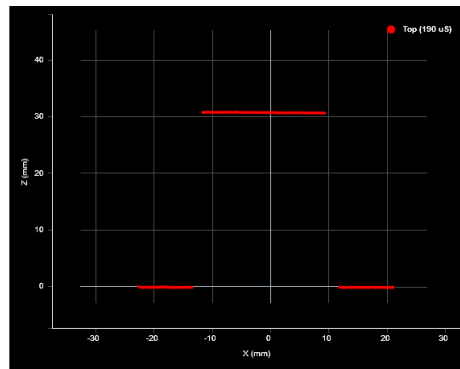
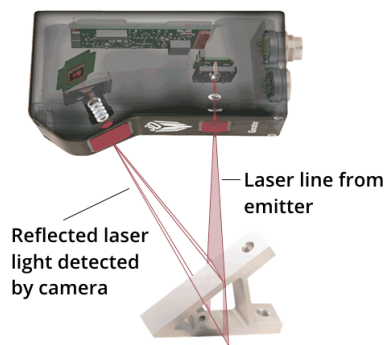
## 3D Acquisition

After a Gocator system has been set up and is running, it is ready to start capturing 3D data.



The sensor's camera views the laser line on the target from an angle and captures the reflection of the laser light off the target. The camera captures a single 3D profile—a slice, in a sense—for each camera exposure. The reflected laser light falls on the camera at different positions, depending on the distance of the target from the sensor. The sensor's laser emitter, its camera, and the target form a triangle. Gocator uses the known distance between the laser emitter and the camera, and two known angles—one of which depends on the position of the laser light on the camera—to calculate the distance from the sensor to the target. This translates to the height of the target. This method of calculating distance is called *laser triangulation*.





Resulting laser profile

Target objects are typically moved under the sensor on a transportation mechanism, such as a conveyor belt. Sensors can also be mounted on robot arms and moved over the target. In both cases, the sensor captures a series of 3D profiles, building up a full scan of the object. Sensor speed and required exposure time to measure the target are typically critical factors in applications with line profiler sensors.



Gocator sensors are always pre-calibrated to deliver 3D data in engineering units throughout their measurement range.

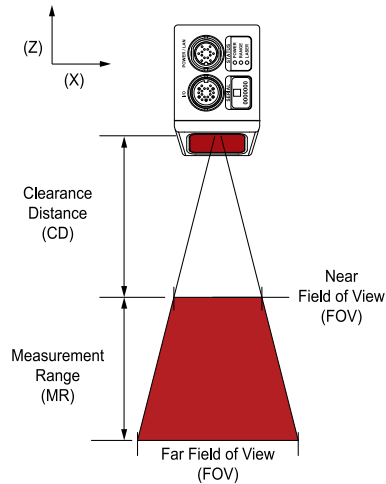
## Clearance Distance, Field of View and Measurement Range

Clearance distance (CD), field of view (FOV), and measurement range (MR) are important concepts for understanding the setup of a Gocator sensor and for understanding results.

**Clearance distance** – The minimum distance from the sensor that a target can be scanned and measured. A target closer than this distance will result in invalid data.

**Measurement range** – The vertical distance, starting at the end of the clearance distance, in which targets can be scanned and measured. Targets beyond the measurement range will result in invalid data.

**Field of view** – The width on the X axis along the measurement range. At the far end of the measurement range, the field of view is wider, but the [X resolution](#) and [Z resolution](#) is lower. At the near end, the field of view is narrower, but the X resolution is higher. When resolution is critical, if possible, place the target closer to the near end.



## Resolution and Accuracy

The following sections describe X Resolution, Z Resolution, and Z Linearity. These terms are used in the Gocator datasheets to describe the measurement capabilities of the sensors.

### X Resolution

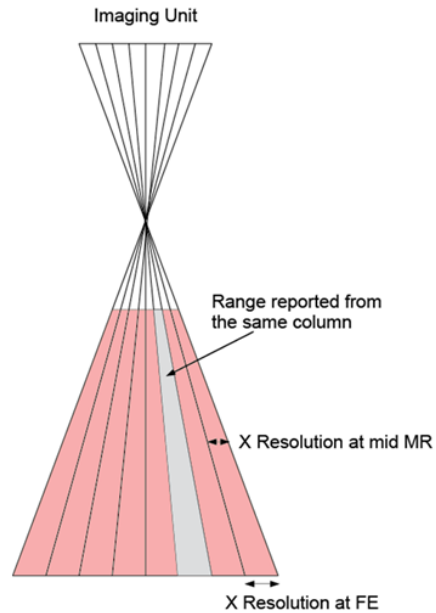
X resolution is the horizontal distance between each measurement point along the laser line. This specification is based on the number of camera columns used to cover the field of view (FOV) at a particular measurement range.

Because the FOV is trapezoidal (shown in red, below), the distance between points is closer at the near range than at the far range. This is reflected in the Gocator data sheet as the two numbers quoted for X resolution.

X Resolution is important for understanding how accurately width on a target can be measured.

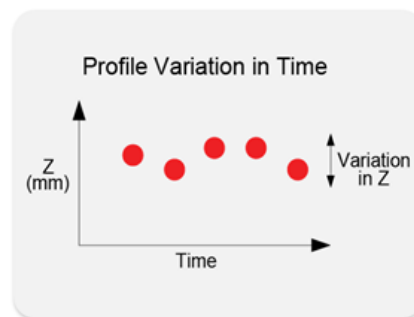


When the Gocator runs in Profile mode and **Uniform Spacing** is enabled, the 3D data is resampled to an X interval that is different from the raw camera resolution. For more information, see *Uniform Spacing (Data Resampling)* on page 53.



## Z Resolution

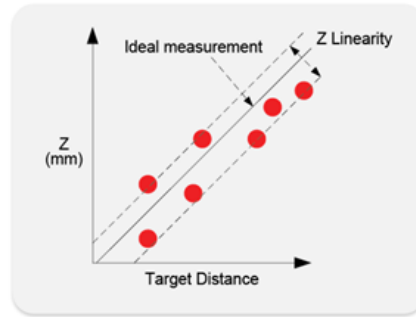
Z Resolution gives an indication of the smallest detectable height difference at each point, or how accurately height on a target can be measured. Variability of height measurements at any given moment, in each individual 3D point, with the target at a fixed position, limits Z resolution. This variability is caused by camera and sensor electronics.



Like X resolution, Z resolution is better closer to the sensor. This is reflected in the Gocator data sheet as the two numbers quoted for Z resolution.

## Z Linearity

Z linearity is the difference between the actual distance to the target and the measured distance to the target, throughout the measurement range. Z linearity gives an indication of the sensor's ability to measure absolute distance.



Z linearity is expressed in the Gocator data sheet as a percentage of the total measurement range.

# Profile Output

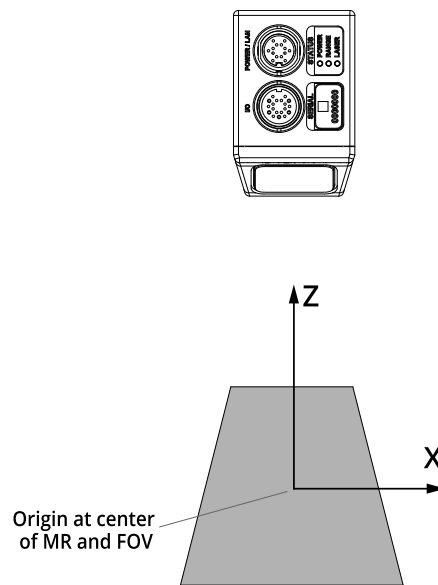
Gocator represents a profile as a series of ranges, with each range representing the distance from the origin. Each range contains a height (on the Z axis) and a position (on the X axis) in the sensor's field of view.

## Coordinate Systems

Range data is reported in sensor or system coordinates depending on the alignment state. The coordinate systems are described below.

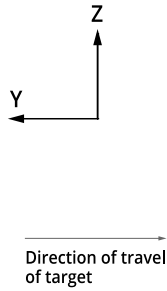
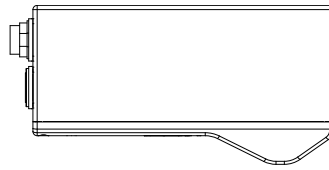
### Sensor Coordinates

Unaligned sensors use the coordinate system shown below.



The measurement range (MR) is along the Z axis. Values increase toward the sensor. The sensor's field of view (FOV) is along the X axis. The origin is at the center of the MR and FOV.

In Surface data, the Y axis represents the relative position of the part in the direction of travel. Y position increases as the object moves forward (increasing encoder position). The image below represents a left-handed coordinate system.

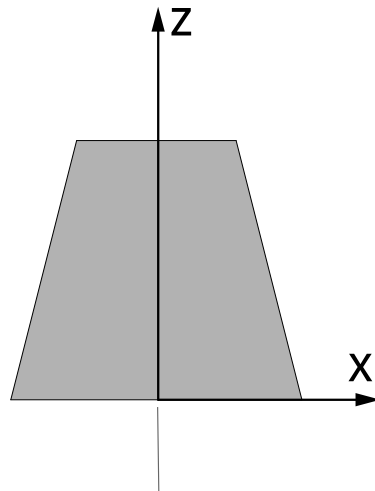
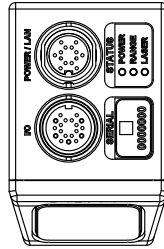


The mounting direction, relative to the direction of travel, can be set in Gocator using either the Normal or Reverse layout. For more information, see *Layout* on page 73.

## System Coordinates

Aligning sensors adjusts the coordinate system in relation to sensor coordinates.

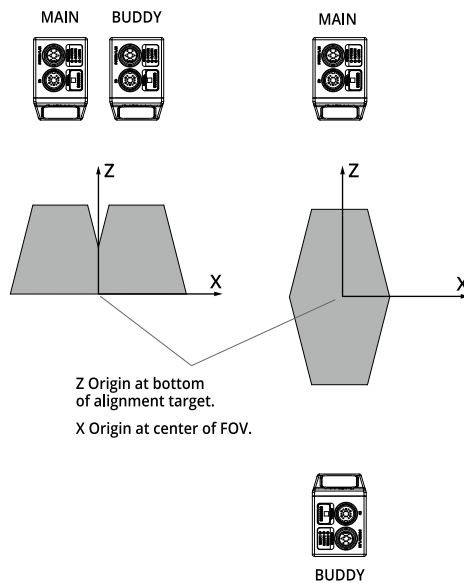
Alignment is used with a single sensor to compensate for mounting misalignment and to set a zero reference, such as a conveyor belt surface.



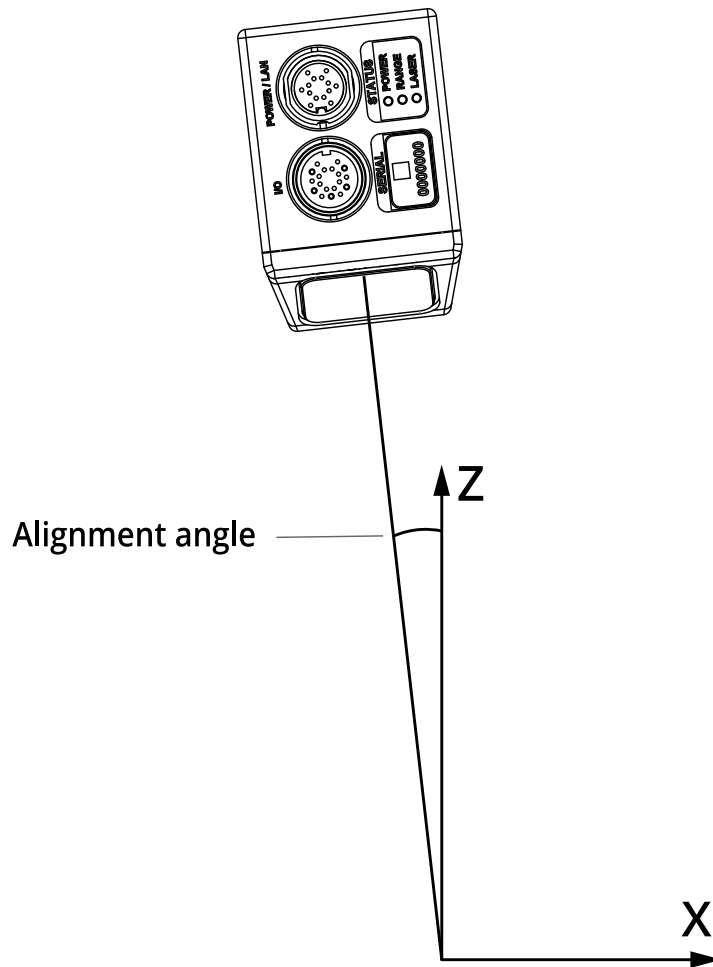
Z Origin at bottom  
of alignment target.

X Origin at center of FOV.

Alignment is also used to set a common coordinate system for dual-sensor systems. That is, profiles and measurements from the sensors are expressed in a unified coordinate system.



In both cases, alignment determines the offsets in X and Z. Alignment also determines the tilt (angle on the X-Z plane, around the Y axis) needed to align sensor data.



The adjustments resulting from alignment are called *transformations* and are displayed in **Sensor** panel on the **Scan** page.

System coordinates are aligned so that the system X axis is parallel to the alignment target surface. The system Z origin is set to the base of the alignment target object. The tilt angle is positive when rotating from the X to the Z axis.

As with sensor coordinates, Y position increases as the object moves forward (increasing encoder position). The orientation of the Y axis is unaffected by alignment.

For more information on aligning sensors, see *Alignment* on page 111.

## Part and Section Coordinates

When you work with [parts](#) or [sections](#) extracted from scan data, a different coordinate system is available.

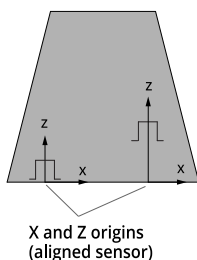
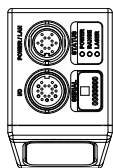
Part data can be expressed in aligned [system coordinates](#) or unaligned [sensor coordinates](#), depending on the alignment state of the sensor. Part data can *also* be represented in part coordinates, in which the



data and measurement results are in a coordinate system that places the X and Y origins at the center of the part. The Z origin is at the bottom of the alignment target (or in the center of the measurement range if the sensor is unaligned).



The **Frame of Reference** setting, in the **Part Detection** panel on the **Scan** page, controls whether part data is recorded using sensor/system coordinates or part coordinates.



## Switching between Coordinate Systems

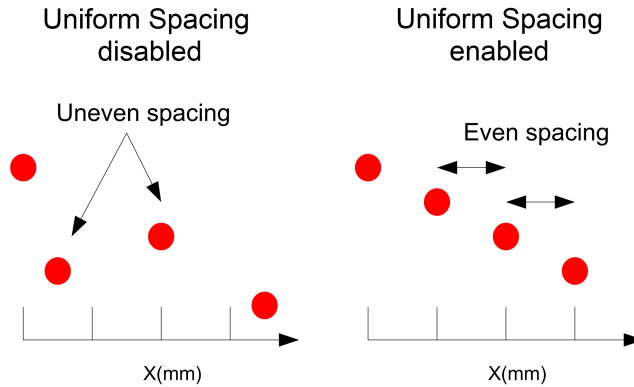
In many situations, when working with section data or part data that has been recorded with **Frame of Reference** set to **Part**, it is useful to have access to the "real-world" coordinates, rather than part- or section-relative coordinates. Gocator provides special "global" measurements, in the Bounding Box tools, that you can use in Gocator scripts to convert from part or section coordinates to sensor/system coordinates.

For more information, see the [Profile Bounding Box tool](#) or the [Surface Bounding Box tool](#), and the [Script tool](#).

## Uniform Spacing (Data Resampling)

Data produced in Profile mode is available in two formats: with and without uniform spacing. Uniform spacing is enabled in the **Scan Mode** panel, on the **Scan** page.

When uniform spacing is enabled, the ranges that make up a profile are resampled so that the spacing is uniform along the laser line (X axis). The resampling divides the X axis into fixed size "bins." Profile points that fall into the same bin are combined into a single range value (Z). The size of the spacing interval can be set under the **Spacing** tab in the **Sensor** panel on **Scan** page.



Resampling to uniform spacing reduces the complexity for downstream algorithms to process the profile data from the Gocator, but places a higher processing load on the sensor's CPU.

When uniform spacing is not enabled, no processing is required on the sensor. This frees up processing resources in the Gocator, but usually requires more complicated processing on the client side. Ranges in this case are reported in (X, Z) coordinate pairs.

Most built-in measurement tools in the Gocator in Profile mode operate on profiles with uniform spacing. A limited number of tools can operate on profiles without uniform spacing. For more information on the profile tools, see *Profile Measurement* on page 183.



When uniform spacing is enabled, in the Ethernet output, only the range values (Z) are reported and the X positions can be reconstructed through the array index at the receiving end (the client). For more information on Ethernet output, see *Ethernet Output* on page 284.

For information on enabling uniform spacing, see *Scan Modes* on page 92.

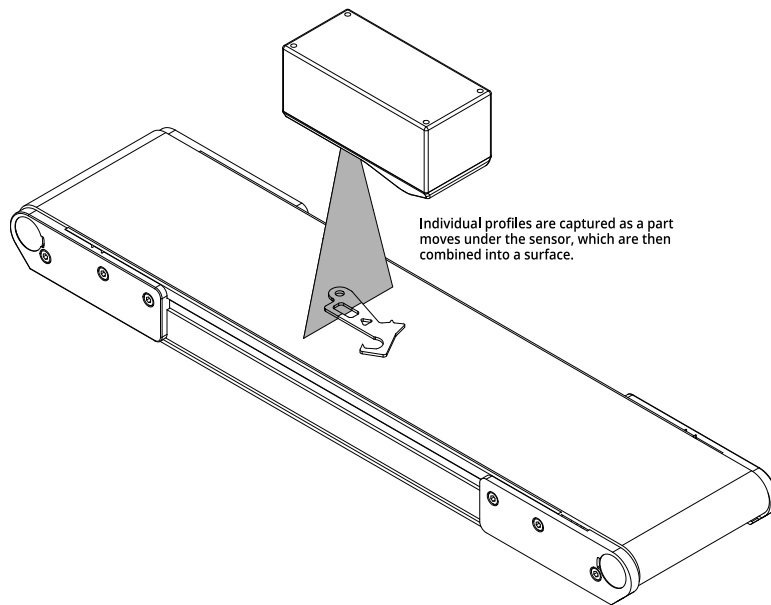
## Data Generation and Processing

After scanning a target, Gocator can process the scan data to allow the use of more sophisticated measurement tools. This section describes the following concepts:

- Surface generation
- Part detection
- Sectioning

### Surface Generation

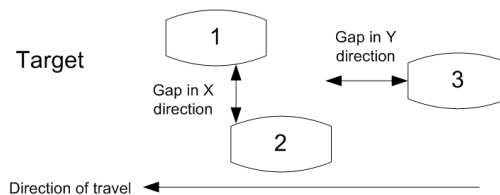
Gocator laser profile sensors create a single profile with each exposure. These sensors can combine a series of profiles gathered as a target moves under the sensor to generate a height map, or surface, of the entire target.



For more information, see *Surface Generation* on page 119.

## Part Detection

After Gocator has generated a surface by combining single exposures into larger pieces of data, the firmware can isolate discrete parts on a generated surface into separate scans representing parts. Gocator can then perform measurements on these isolated parts.

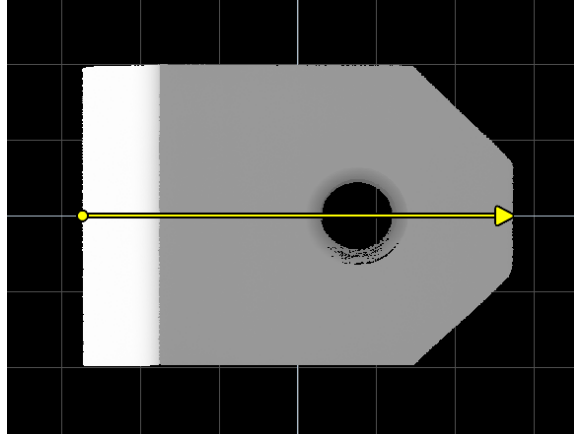


Part detection is useful when measurements on individual parts are needed and for robotic pick and place applications.

For more information on part detection, see *Part Detection* on page 123.

## Sectioning

In Surface mode, Gocator can also extract a profile from a surface or part using a line you define on that surface or part. The resulting profile is called a “section.” A section can have any orientation on the surface, but its profile is parallel to the Z axis.

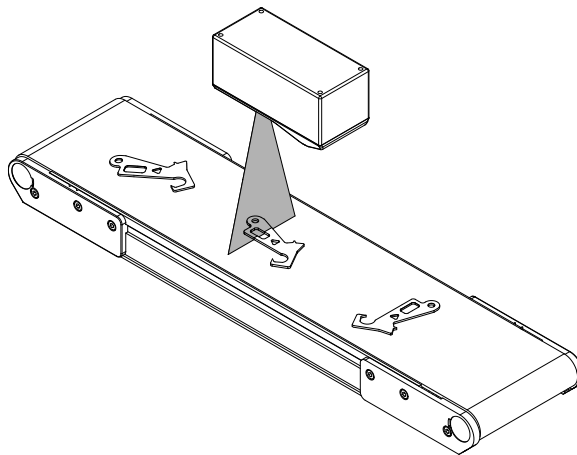


You can use most of Gocator's profile measurement tools on a section, letting you perform measurements that are not possible with surface measurement tools.

For more information on sections, see *Sections* on page 155.

## Part Matching

Gocator can match scanned parts to the edges of a model based on a previously scanned part (see *Using Edge Detection* on page 142) or to the dimensions of a fitted bounding box or ellipse that encapsulate the model (see *Using Bounding Box and Ellipse* on page 151). When parts match, Gocator can rotate scans so that they are all oriented in the same way. This allows measurement tools to be applied consistently to parts, regardless of the orientation of the part you are trying to match.



## Measurement and Anchoring

After a target has been scanned and, optionally, the data has been [further processed](#), Gocator is ready to take measurements on the scan data.

Gocator provides several measurement tools, each of which provides a set of individual measurements, giving you dozens of measurements ideal for a wide variety of applications to choose from. The configured measurements start returning pass/fail decisions, as well as the actual measured values, which are then sent over the enabled [output](#) channels to control devices such as PLCs, which can in turn control ejection or sorting mechanisms. (For more information on measurements and configuring measurements, see *Measurement* on page 161.)



You can create custom measurement tools that run your own algorithms. For more information, see *GDK* on page 497.

A part's position can vary on a transport system. To compensate for this variation, Gocator can anchor a measurement to the positional measurement (X, Y, or Z) of an easily detectable feature, such as the edge of a part. The calculated offset between the two ensures that the anchored measurement will always be properly positioned on different parts.

If combined with the matching and rotation capabilities of [part matching](#), anchoring accounts for most sources of variation in part position and orientation and, consequently, avoids many measurement errors. For more information on anchoring, see *Measurement Anchoring* on page 175.

## Output and Digital Tracking

After Gocator has scanned and measured parts, the last step in the operation flow is to output the results and/or measurements.

One of the main functions of Gocator sensors is to produce pass/fail decisions, and then control something based on that decision. Typically, this involves rejecting a part through an eject gate, but it can also involve making decisions on good, but different, parts. This is described as “output” in Gocator. Gocator supports the following output types:

- Ethernet (which provides industry-standard protocols such as Modbus, EtherNet/IP, and ASCII, in addition to the Gocator protocol)
- Digital
- Analog
- Serial interfaces

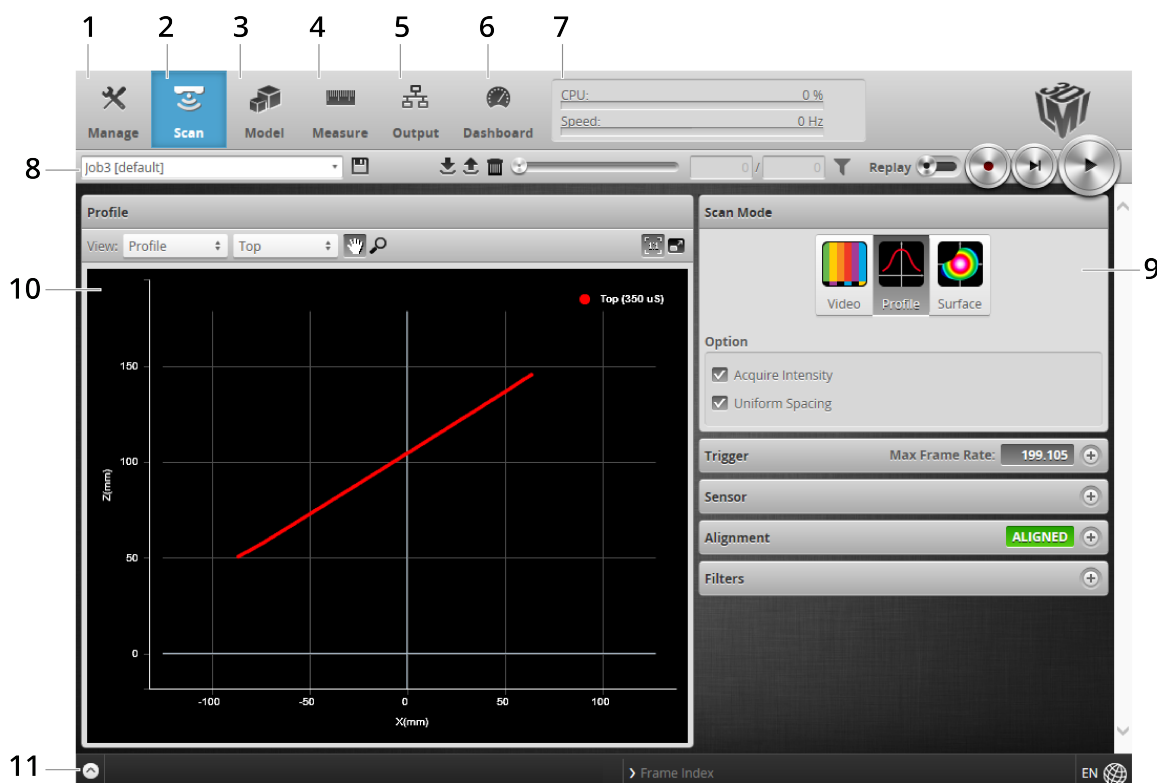
An important concept is digital output tracking. Different production lines can place an ejection or sorting mechanism at different distances from where the sensor scans the target. For this reason, Gocator lets you schedule a delayed decision over the digital interfaces. Because the conveyor system on a typical production line will use an encoder or have a known, constant speed, targets can effectively be “tracked” or “tagged.” Gocator will know when a defective part has traveled far enough and trigger a PLC to activate an ejection/sorting mechanism at the correct moment. For more information on digital output tracking, see *Digital Output* on page 288.

# Gocator Web Interface

The following sections describe the Gocator web interface.

## User Interface Overview

Gocator sensors are configured by connecting to a *Main* sensor with a web browser. The Gocator web interface is illustrated below.

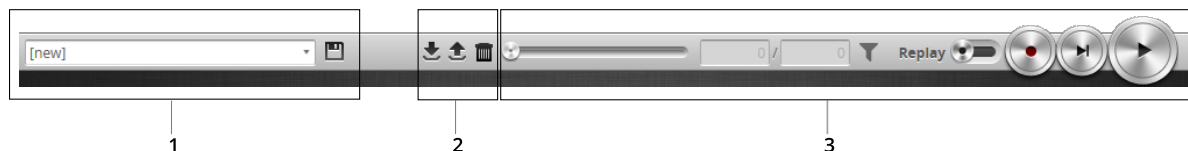


| Element | Description                                                                                                                                                                        |
|---------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 1       | Manage page<br>Contains settings for sensor system layout, network, motion and alignment, handling jobs, and sensor maintenance. See <i>Management and Maintenance</i> on page 70. |
| 2       | Scan page<br>Contains settings for scan mode, trigger source, detailed sensor configuration, and performing alignment. See <i>Scan Setup and Alignment</i> on page 91.             |
| 3       | Model page<br>Lets you set up part matching. See <i>Models</i> on page 140                                                                                                         |

| Element              | Description                                                                                                                                                                                                                |
|----------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 4 Measure page       | Contains built-in measurement tools and their settings. See <i>Measurement</i> on page 161.                                                                                                                                |
| 5 Output page        | Contains settings for configuring output protocols used to communicate measurements to external devices. See <i>Output</i> on page 283.                                                                                    |
| 6 Dashboard page     | Provides monitoring of measurement statistics and sensor health. See <i>Dashboard</i> on page 295.                                                                                                                         |
| 7 CPU Load and Speed | Provides important sensor performance metrics. See <i>Metrics Area</i> on page 67.                                                                                                                                         |
| 8 Toolbar            | Controls sensor operation, manages jobs, and filters and replays recorded measurement data. See <i>Toolbar</i> below.                                                                                                      |
| 9 Configuration area | Provides controls to configure scan and measurement tool settings.                                                                                                                                                         |
| 10 Data viewer       | Displays sensor data, tool setup controls, and measurements. See <i>Data Viewer</i> on page 127 for its use when the <b>Scan</b> page is active and on page 162 for its use when the <b>Measure</b> page is active.        |
| 11 Status bar        | Displays <a href="#">log messages</a> from the sensor (errors, warnings, and other information) and <a href="#">frame information</a> , and lets you switch the <a href="#">interface language</a> . For more information, |

## Toolbar

The toolbar is used for performing operations such as managing jobs, working with replay data, and starting and stopping the sensor.



| Element                             | Description                                                                                                 |
|-------------------------------------|-------------------------------------------------------------------------------------------------------------|
| 1 Job controls                      | For saving and loading jobs.                                                                                |
| 2 Replay data controls              | For downloading, uploading, and exporting recorded data.                                                    |
| 3 Sensor operation / replay control | Use the sensor operation controls to start sensors, enable and filter recording, and control recorded data. |

## Creating, Saving and Loading Jobs (Settings)

A Gocator can store several hundred jobs. Being able to switch between jobs is useful when a Gocator is used with different constraints during separate production runs. For example, width decision minimum and maximum values might allow greater variation during one production run of a part, but might allow less variation during another production run, depending on the desired grade of the part.

Most of the settings that can be changed in the Gocator's web interface, such as the ones in the **Manage**, **Measure**, and **Output** pages, are temporary until saved in a job file. Each sensor can have

multiple job files. If there is a job file that is designated as the default, it will be loaded automatically when the sensor is reset.

When you change sensor settings using the Gocator web interface in the emulator, some changes are saved automatically, while other changes are temporary until you save them manually. The following table lists the types of information that can be saved in a sensor.

| Setting Type    | Behavior                                                                                                                                                                                                                                                                                                                                                                                                             |
|-----------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Job             | Most of the settings that can be changed in the Gocator's web interface, such as the ones in the <b>Manage</b> , <b>Measure</b> , and <b>Output</b> pages, are temporary until saved in a job file. Each sensor can have multiple job files. If there is a job file that is designated as the default, it will be loaded automatically when the sensor is reset.                                                     |
| Alignment       | Alignment can either be fixed or dynamic, as controlled by the <b>Alignment Reference</b> setting in <b>Motion and Alignment</b> in the <b>Manage</b> page.<br>Alignment is saved automatically at the end of the alignment procedure when <b>Alignment Reference</b> is set to <b>Fixed</b> . When <b>Alignment Reference</b> is set to <b>Dynamic</b> , however, you must manually save the job to save alignment. |
| Network Address | Network address changes are saved when you click the <b>Save</b> button in <b>Networking</b> on the <b>Manage</b> page. The sensor must be reset before changes take effect.                                                                                                                                                                                                                                         |

The job drop-down list in the toolbar shows the jobs stored in the sensor. The job that is currently active is listed at the top. The job name will be marked with "[unsaved]" to indicate any unsaved changes.



#### *To create a job:*

1. Choose **[New]** in the job drop-down list and type a name for the job.
2. Click the **Save** button  or press **Enter** to save the job.  
The job is saved to sensor storage using the name you provided. Saving a job automatically sets it as the default, that is, the job loaded when the sensor is restarted.

#### *To save a job:*

- Click the **Save** button .
- The job is saved to sensor storage. Saving a job automatically sets it as the default, that is, the job loaded when the sensor is restarted.

#### *To load (switch) jobs:*

- Select an existing file name in the job drop-down list.
- The job is activated. If there are any unsaved changes in the current job, you will be asked whether you want to discard those changes.



You can perform other job management tasks—such as downloading job files from a sensor to a computer, uploading job files to a sensor from a computer, and so on—in the **Jobs** panel in the **Manage** page. See *Jobs* on page 83 for more information.

## Recording, Playback, and Measurement Simulation

Gocator sensors can record and replay recorded scan data, and also simulate measurement tools on recorded data. This feature is most often used for troubleshooting and fine-tuning measurements, but can also be helpful during setup.

Recording and playback are controlled using the toolbar controls.



*Recording and playback controls when replay is off*

*To record live data:*

1. Toggle **Replay** mode off by setting the slider to the left in the **Toolbar**.

 Replay mode disables measurements.

2. (Optional) Configure recording filtering.  
For more information on recording filtering, see *Recording Filtering* on page 63.
3. Click the **Record** button to enable recording.

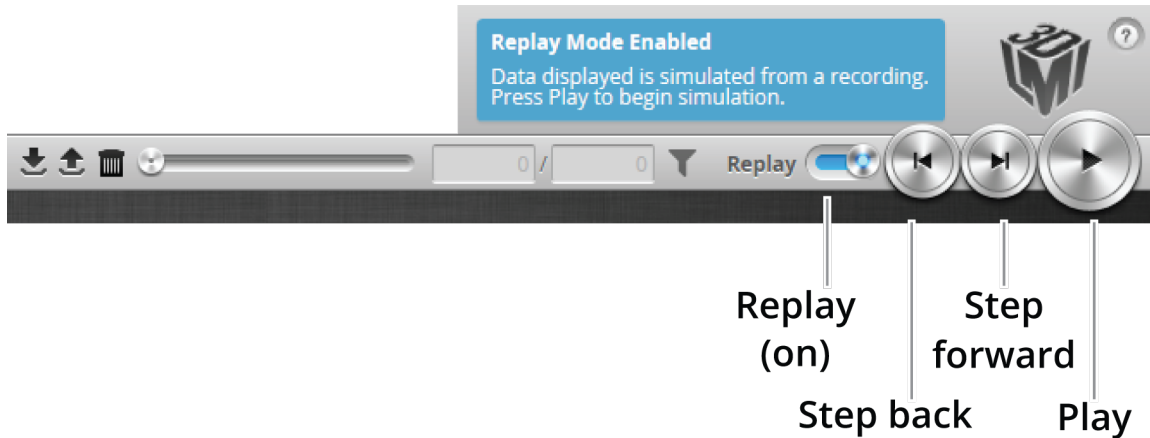


The center of the Record button turns red.

When recording is enabled (and replay is off), the sensor will store the most recent data as it runs. Remember to disable recording if you no longer want to record live data. (Press the **Record** button again to disable recording).

4. Press the **Snapshot** button or **Start** button.  
The **Snapshot** button records a single frame. The **Start** button will run the sensor continuously and all frames will be recorded, up to available memory. When the memory limit is reached, the oldest data will be discarded.

 Newly recorded data is appended to existing replay data unless the sensor job has been modified.



*Playback controls when replay is on*

*To replay data:*

1. Toggle **Replay** mode on by setting the slider to the right in the **Toolbar**.  
The slider's background turns blue and a Replay Mode Enabled message is displayed.
2. Use the **Replay** slider or the **Step Forward**, **Step Back**, or **Play** buttons to review data.  
The **Step Forward** and **Step Back** buttons move and the current replay location backward and forward by a single frame, respectively.  
The **Play** button advances the replay location continuously, animating the playback until the end of the replay data.  
The **Stop** button (replaces the **Play** button while playing) can be used to pause the replay at a particular location.  
The **Replay** slider (or **Replay Position** box) can be used to go to a specific replay frame.

*To simulate measurements on replay data:*

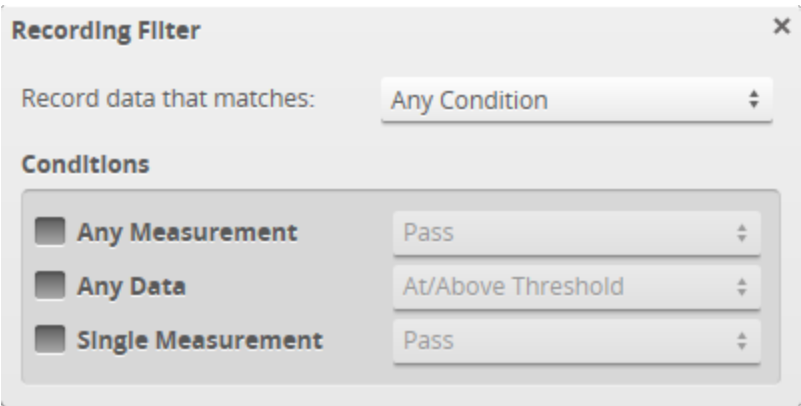
1. Toggle **Replay** mode on by setting the slider to the right in the **Toolbar**.  
The slider's background turns blue and a Replay Mode Enabled message is displayed.  
To change the mode, **Replay Protection** must be unchecked.
2. Go to the **Measure** page.  
Modify settings for existing measurements, add new measurement tools, or delete measurement tools as desired. For information on adding and configuring measurements, see *Measurement* on page 161.
3. Use the **Replay Slider**, **Step Forward**, **Step Back**, or **Play** button to simulate measurements.  
Step or play through recorded data to execute the measurement tools on the recording.  
Individual measurement values can be viewed directly in the data viewer. Statistics on the measurements that have been simulated can be viewed in the **Dashboard** page; for more information on the dashboard, see *Dashboard* on page 295.

*To clear replay data:*

1. Stop the sensor if it is running by clicking the **Stop** button.
2. Click the **Clear Replay Data** button .

Recording Filtering

Replay data is often used for troubleshooting. But replay data can contain thousands of frames, which makes finding a specific frame to troubleshoot difficult. Recording filtering lets you choose which frames Gocator records, based on one or more conditions, which makes it easier to find problems.



How Gocator treats conditions

| Setting        | Description                                              |
|----------------|----------------------------------------------------------|
| Any Condition  | Gocator records a frame when any condition is true.      |
| All Conditions | Gocator only records a frame if all conditions are true. |

Conditions

| Setting            | Description                                                                                                                                                                                                                                                                                                                                                                                                                           |
|--------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Any Measurement    | Gocator records a frame when <i>any</i> measurement is in the state you select.<br>The following states are supported: <ul style="list-style-type: none"><li>• pass</li><li>• fail or invalid</li><li>• fail and valid</li><li>• valid</li><li>• invalid</li></ul>                                                                                                                                                                    |
| Single Measurement | Gocator records a frame if the measurement with the ID you specify in <b>ID</b> is in the state you select. This setting supports the same states as the <b>Any Measurement</b> setting (see above).                                                                                                                                                                                                                                  |
| Any Data           | <b>At/Above Threshold:</b> Gocator records a frame if the number of valid points in the frame is above the value you specify in <b>Range Count Threshold</b> .<br><b>Below Threshold:</b> Gocator records a frame if the number of valid points is below the threshold you specify.<br>In Surface mode, the number of valid points in the surface is compared to the threshold, not any <a href="#">sections</a> that may be defined. |

To set recording filtering:

1. Make sure recording is enabled by clicking the Record button.



2. Click the Recording Filtering button .
3. In the Recording Filtering dialog, choose how Gocator treats conditions:  
For information on the available setting, see *How Gocator treats conditions* on the previous page.
4. Configure the conditions that will cause Gocator to record a frame:  
For information on the available setting, see *Conditions* on the previous page.
5. Click the "x" button or outside of the Recording Filtering dialog to close the dialog.  
The recording filter icon turns green to show that recording filters have been set.  
When you run the sensor, Gocator only records the frames that satisfy the conditions you have set.

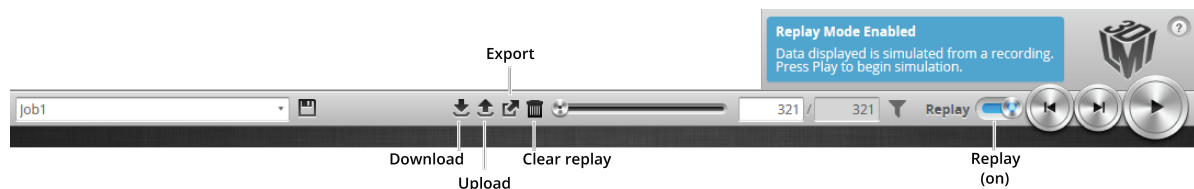
## Downloading, Uploading, and Exporting Replay Data

Replay data (recorded scan data) can be downloaded from a Gocator to a client computer, or uploaded from a client computer to a Gocator.

Data can also be exported from a Gocator to a client computer in order to process the data using third-party tools.



You can only upload replay data to the same sensor model that was used to create the data.



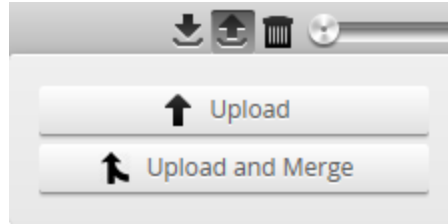
Replay data is not loaded or saved when you load or save jobs.

*To download replay data:*

1. Click the Download button .
2. In the **File Download** dialog, click **Save**.
3. In the **Save As...** dialog, choose a location, optionally change the name (keeping the .rec extension), and click **Save**.

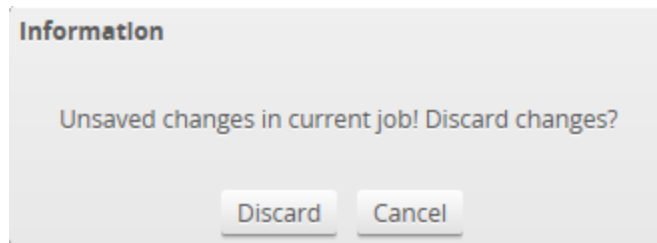
*To upload replay data:*

1. Click the Upload button .
- The Upload menu appears.



2. In the Upload menu, choose one of the following:
  - **Upload:** Unloads the current job and creates a new unsaved and untitled job from the content of the replay data file.
  - **Upload and merge:** Uploads the replay data and merges the data's associated job with the current job. Specifically, the settings on the **Scan** page are overwritten, but all other settings of the current job are preserved, including any measurements or models.

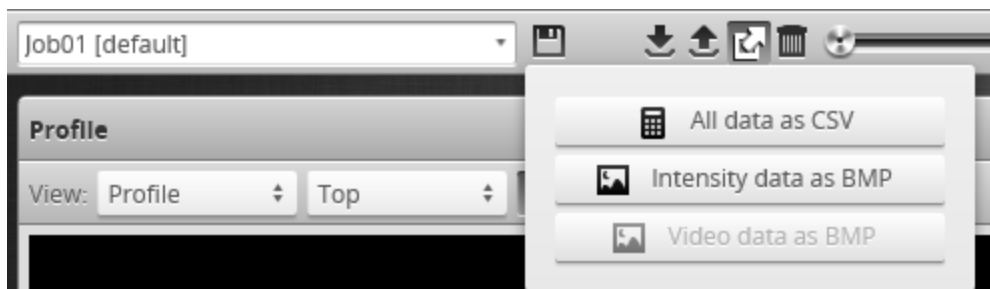
If you have unsaved changes in the current job, the firmware asks whether you want to discard the changes.



3. Do one of the following:
  - Click **Discard** to discard any unsaved changes.
  - Click **Cancel** to return to the main window to save your changes.
4. If you clicked **Discard**, navigate to the replay data to upload from the client computer and click **OK**. The replay data is loaded, and a new unsaved, untitled job is created.

Replay data can be exported using the CSV format. If you have enabled **Acquire Intensity** in the **Scan Mode** panel on the **Scan** page, the exported CSV file includes intensity data.

 *Surface* intensity data cannot be exported to the CSV format. It can only be [exported separately as a bitmap](#).



*To export replay data in the CSV format:*

1. In the **Scan Mode** panel, switch to Profile or Surface.  
In Profile mode, all data in the record buffer is exported. In Surface mode, only data at the current replay location is exported.  
Use the playback control buttons to move to a different replay location; for information on playback, see *To replay data in Recording, Playback, and Measurement Simulation* on page 61.
2. Click the Export button  and select **All Data as CSV**.  
In Profile mode, all data in the record buffer is exported. In Surface mode, only data at the current replay location is exported.  
Use the playback control buttons to move to a different replay location; for information on playback, see *To replay data in Recording, Playback, and Measurement Simulation* on page 61.
3. Optionally, convert exported data to another format using the CSV Converter Tool. For information on this tool, see *CSV Converter Tool* on page 519.



The decision values in the exported data depend on the *current* state of the job, not the state during recording. For example, if you record data when a measurement returns a *pass* decision, change the measurement's settings so that a *fail* decision is returned, and then export to CSV, you will see a *fail* decision in the exported data.

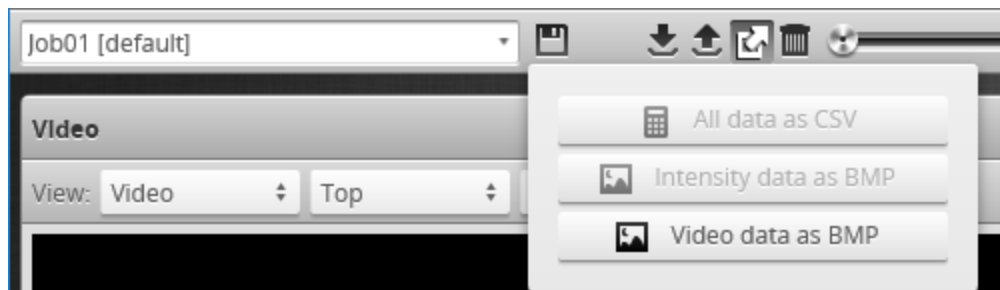
Recorded intensity data can be exported to a bitmap (.BMP format). **Acquire Intensity** must be checked in the **Scan Mode** panel while data was being recorded in order to export intensity data.

*To export recorded intensity data to the BMP format:*

- Click the **Export** button  and select **Intensity data as BMP**.

Only the intensity data in the current replay location is exported.

Use the playback control buttons to move to a different replay location; for information on playback, see *To replay data in Recording, Playback, and Measurement Simulation* on page 61.



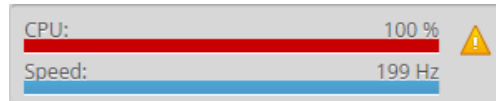
*To export video data to a BMP file:*

1. In the **Scan Mode** panel, switch to Video mode.  
Use the playback control buttons to move to a different replay location; for information on playback, see *To replay data in Recording, Playback, and Measurement Simulation* on page 61.
2. Click the Export button  and select **Video data as BMP**.

## Metrics Area

The **Metrics** area displays two important sensor performance metrics: CPU load and speed (current frame rate).

The **CPU** bar in the **Metrics** panel (at the top of the interface) displays how much of the CPU is being utilized. A warning symbol (⚠) will appear next to the **CPU** bar if the sensor drops profiles because the CPU is over-loaded.



*CPU at 100%*

The **Speed** bar displays the frame rate of the sensor. A warning symbol (⚠) will appear next to it if triggers (external input or encoder) are dropped because the external rate exceeds the maximum frame rate.

Open the log for details on the warning. For more information on logs, see *Log* on the next page.

When a sensor is [accelerated](#) a "rocket" icon appears in the metrics area.



## Data Viewer

The data viewer is displayed in both the **Scan** and the **Measure** pages, but displays different information depending on which page is active.

When the **Scan** page is active, the data viewer displays sensor data and can be used to adjust the active area and other settings. Depending on the selected operation mode (page 92), the data viewer can display video images, profiles, sections, or surfaces. For details, see *Data Viewer* on page 127.

When the **Measure** page is active, the data viewer displays sensor data onto which representations of measurement tools and their measurements are superimposed. For details, see *Data Viewer* on page 162.

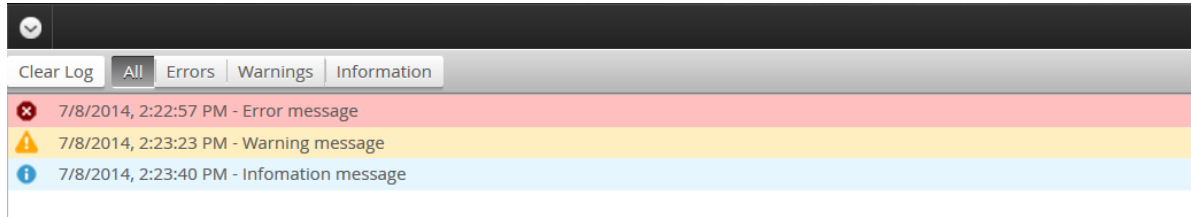
## Status Bar

The status bar lets you do the following:

- See sensor messages in the [log](#).
- See [frame information](#).
- Change the [interface language](#).

## Log

The log, located at the bottom of the web interface, is a centralized location for all messages that the Gocator displays, including warnings and errors.



A number indicates the number of unread messages:



*To use the log:*

1. Click on the Log open button  at the bottom of the web interface.
2. Click on the appropriate tab for the information you need.

## Frame Information

The area to the right of the status bar displays useful frame information, both when the sensor is running and when viewing recorded data.



This information is especially useful when you have enabled [recording filtering](#). If you look at a recording playback, when you have enabled recording filtering, some frames can be excluded, resulting in variable "gaps" in the data.

The following information is available:

**Frame Index:** Displays the index in the data buffer of the current frame. The value resets to 0 when the sensor is restarted or when recording is enabled.

**Master Time:** Displays the recording time of the current frame, with respect to when the sensor was started.

**Encoder Index:** Displays the encoder index of the current frame.

**Timestamp:** Displays the timestamp the current frame, in microseconds from when the sensor was started.

*To switch between types of frame information:*

- Click the frame information area to switch to the next available type of information.



## Interface Language

The language button on the right side of the status bar lets you change the language of the Gocator interface.



*To use the log:*

1. Click the language button at the bottom of the web interface.



2. Choose a language from the list.



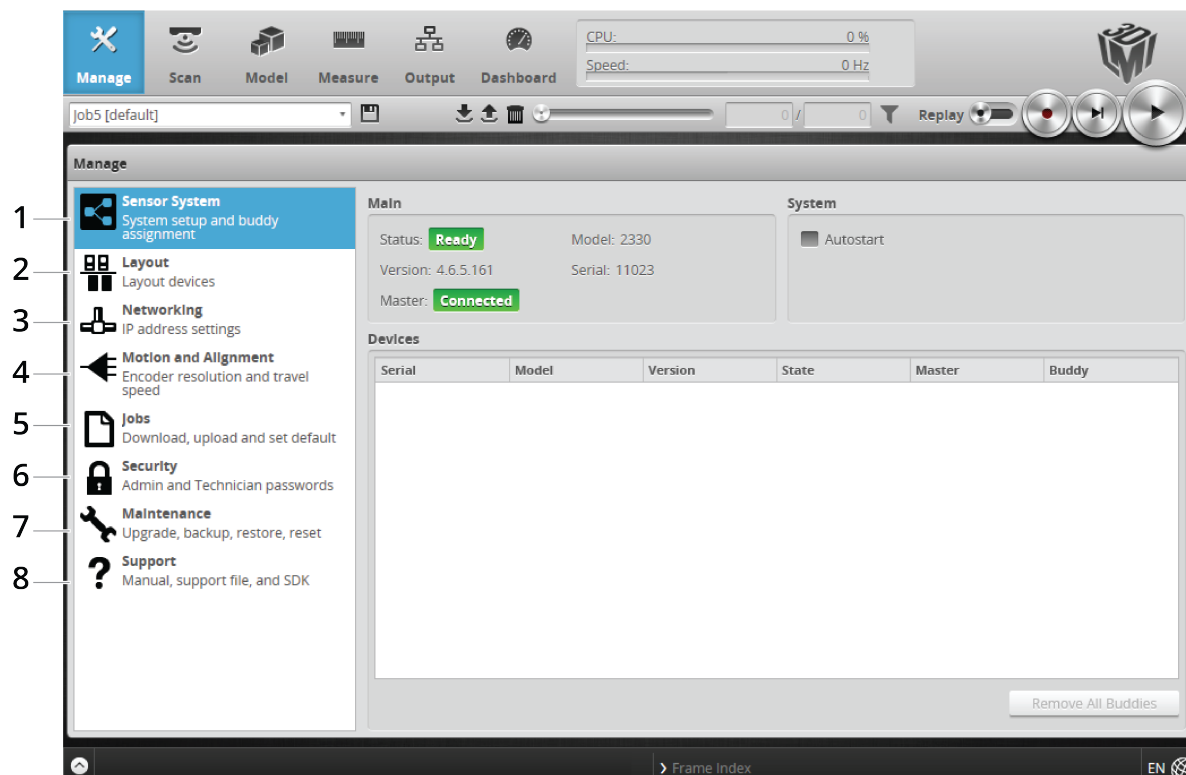
The Gocator interface reloads on the page you were working in, displaying the page using the language you chose. The sensor state is preserved.

# Management and Maintenance

The following sections describe how to set up the sensor connections and networking, how to calibrate encoders and choose the alignment reference, and how to perform maintenance tasks.

## Manage Page Overview

Gocator's system and maintenance tasks are performed on the **Manage** page.

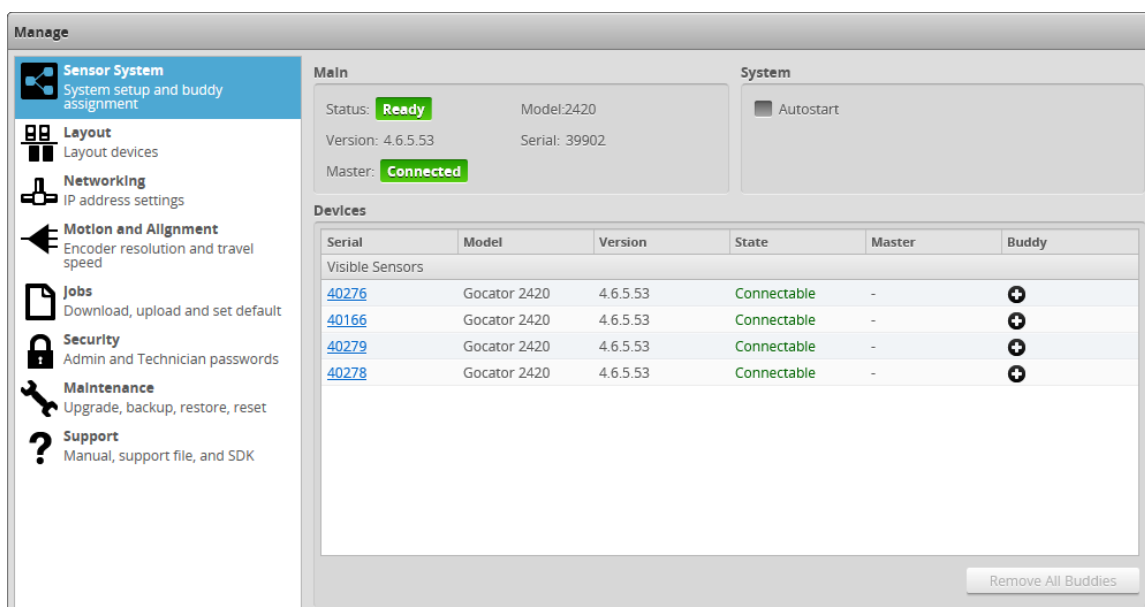


| Element                | Description                                                                                                          |
|------------------------|----------------------------------------------------------------------------------------------------------------------|
| 1 Sensor System        | Contains sensor information, buddy assignment, and the autostart setting. See <i>Sensor System</i> on the next page. |
| 2 Layout               | Contains settings for configuring dual- and multi-sensor system layouts.                                             |
| 3 Networking           | Contains settings for configuring the network. See <i>Networking</i> on page 80.                                     |
| 4 Motion and Alignment | Contains settings to configure the encoder. See <i>Motion and Alignment</i> on page 81.                              |
| 5 Jobs                 | Lets you manage jobs stored on the sensor. See <i>Jobs</i> on page 83.                                               |
| 6 Security             | Lets you change passwords. See <i>Security</i> on page 84.                                                           |
| 7 Maintenance          | Lets you upgrade firmware, create/restore backups, and reset sensors. See <i>Maintenance</i> on page 85.             |

| Element   | Description                                                                                                                                                                      |
|-----------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 8 Support | Lets you open an HTML version or download a PDF version of the manual, download the SDK, or save a support file. Also provides device information. See <i>Support</i> on page 88 |

## Sensor System

The following sections describe the **Sensor System** category on the **Manage** page. This category provides sensor information and the autostart setting. It also lets you choose which sensors to add to a dual- or multi-sensor system.



## Dual- and Multi-sensor Systems

Gocator supports dual- and multi-sensor systems. In these systems, data from each sensor is combined into a single profile or surface, effectively creating a wider field of view. Any [measurements](#) you configure work on the combined data.

Although some Gocator models have much wider fields of view, the trade-off is that their resolution is much lower: finer features on targets are below their resolution and therefore can't be measured. Models with smaller fields of view—which limit the maximum size of targets that can be scanned—have vastly finer resolutions. When you combine multiple sensors with a smaller field of view, you obtain a wider field of view with the finer resolution of those models.

Gocator lets you easily and quickly set up dual- and multi-sensor systems from the web interface. Setting up these systems involves two steps:

1. Assigning one or more additional sensors, called *Buddy* sensors, to the *Main* sensor. For more information, see *Buddy Assignment* on the next page.
2. Choosing the layout of the dual- or multi-sensor system. For more information, see *Layout* on page 73.

## Buddy Assignment

In a dual- or multi-sensor system, the *Main* sensor controls a second sensor, called the *Buddy* sensor, after the Buddy sensor is assigned to the Main sensor. You configure both sensors through the Main sensor's interface.



Main and Buddy sensors must be assigned unique IP addresses before they can be used on the same network. Before proceeding, connect the Main and Buddy sensors one at a time (to avoid an address conflict) and use the steps described in Running a Dual-Sensor System (page 30) to assign each sensor a unique address.



When a sensor is acting as a Buddy, it is not discoverable and its web interface is not accessible.

| Devices               |              |          |             |        |       |
|-----------------------|--------------|----------|-------------|--------|-------|
| Serial                | Model        | Version  | State       | Master | Buddy |
| Visible Sensors       |              |          |             |        |       |
| <a href="#">40276</a> | Gocator 2420 | 4.6.5.53 | Connectable | -      | +     |
| <a href="#">40166</a> | Gocator 2420 | 4.6.5.53 | Connectable | -      | +     |
| <a href="#">40279</a> | Gocator 2420 | 4.6.5.53 | Connectable | -      | +     |
| <a href="#">40278</a> | Gocator 2420 | 4.6.5.53 | Connectable | -      | +     |
| Remove All Buddies    |              |          |             |        |       |



A sensor can only be assigned as a Buddy if its firmware and model number match the firmware and model number of the Main sensor.

*To assign a Buddy sensor:*

1. Go to the **Manage** page and click on the **Sensor System** category.
2. In the **Visible Sensors** list, click the "plus" icon next to the sensor you want to add as a Buddy.  
The sensor you added to the system appears in a **Buddies** list.

| Devices               |              |          |             |           |       |
|-----------------------|--------------|----------|-------------|-----------|-------|
| Serial                | Model        | Version  | State       | Master    | Buddy |
| Buddies               |              |          |             |           |       |
| 40276                 | Gocator 2420 | 4.6.5.53 | Connected   | Connected | -     |
| Visible Sensors       |              |          |             |           |       |
| <a href="#">40166</a> | Gocator 2420 | 4.6.5.53 | Connectable | -         | +     |
| <a href="#">40279</a> | Gocator 2420 | 4.6.5.53 | Connectable | -         | +     |
| <a href="#">40278</a> | Gocator 2420 | 4.6.5.53 | Connectable | -         | +     |

3. Repeat the previous step to add more sensors to the system.

After you have assigned the desired number of Buddy sensors, you must specify system's layout. For more information, see *Layout* on the next page.

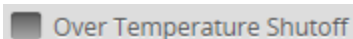
To remove a Buddy, click the "minus" icon next to the sensor you want to remove. To remove all Buddies, click **Remove All Buddies**.

## Over Temperature Protection

Sensors equipped with a 3B-N laser by default will turn off the laser if the temperature exceeds the safe operating range. You can override the setting by disabling the overheat protection.



Disabling the setting is not recommended. Disabling the overheat protection feature could lead to premature laser failure if the sensor operates outside the specified temperature range.

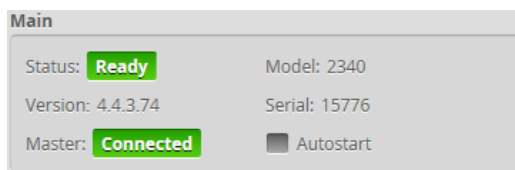


*To enable/disable overheat temperature protection:*

1. Check/uncheck the **Over Temperature Protection** option.
2. Save the job file.

## Sensor Autostart

With the **Autostart** setting enabled, laser ranging profiling and measurement functions will begin automatically when the sensor is powered on. Autostart must be enabled if the sensor will be used without being connected to a computer.

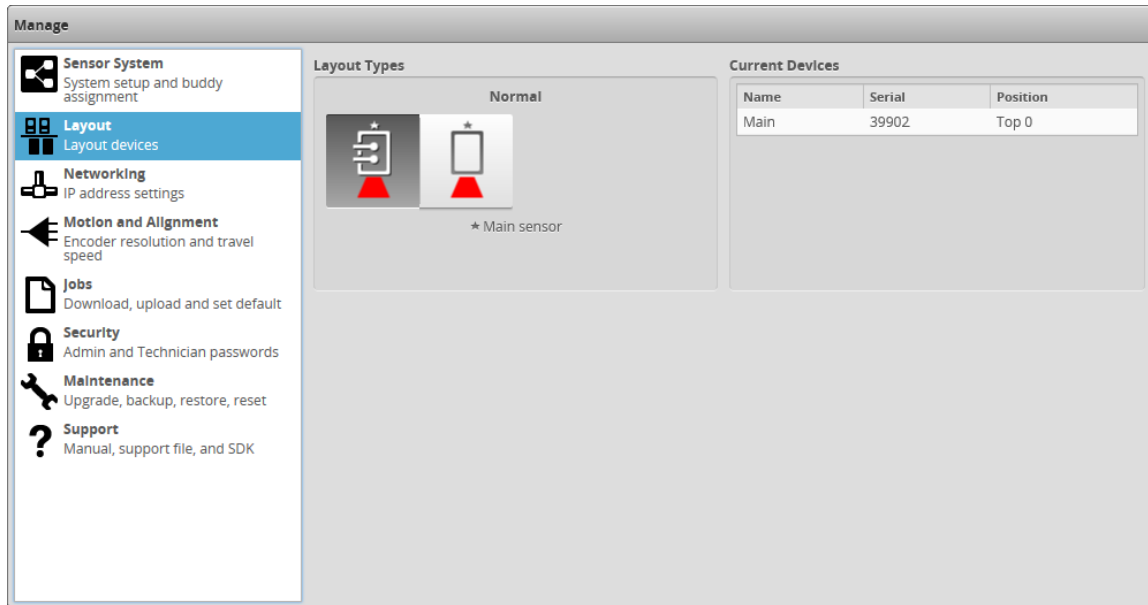


*To enable/disable Autostart:*

1. Go to the **Manage** page and click on the **Sensor System** category.
2. Check/uncheck the **Autostart** option in the **Main** section.

## Layout

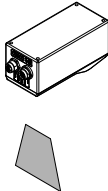
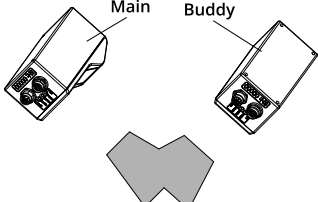
The following sections describe the **Layout** category on the **Manage** page. This category lets you configure dual- and multi-sensor systems.

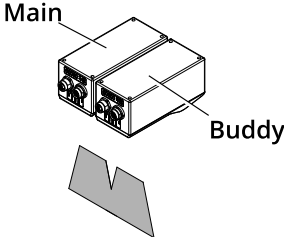
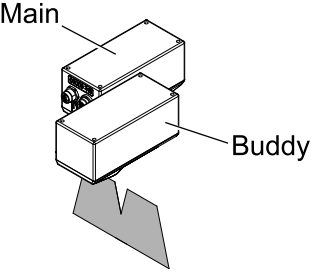
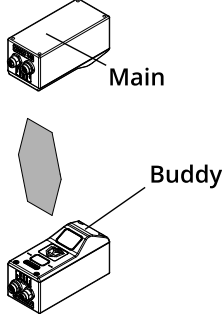
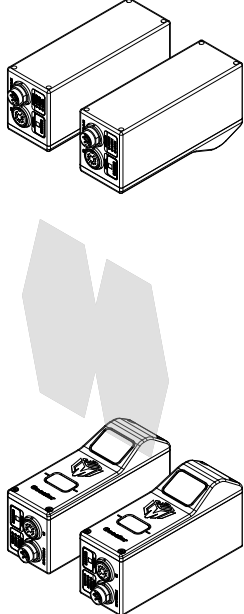


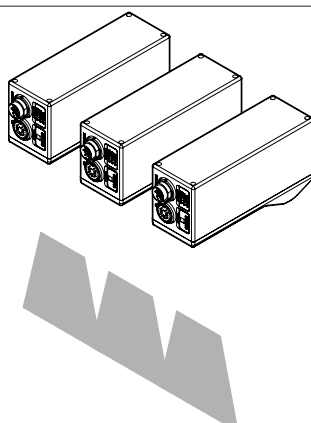
Mounting orientations must be specified for a dual- or multi-sensor system. This information allows the alignment procedure to determine the correct system-wide coordinates for laser profiling and measurements. For more information on sensor and system coordinates, see *Coordinate Systems* on page 49.

 Dual- and multi-sensor layouts are only displayed when a Buddy sensor has been assigned.

### Supported Layouts

| Layout Type                                                                                                                                                                                                                                                  | Example                                                                               |
|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---------------------------------------------------------------------------------------|
|  <p><b>Normal</b></p> <p>The sensor operates as an isolated device.</p>                                                                                                   |  |
|  <p><b>Reverse</b></p> <p>The sensor operates as an isolated device, but in a reverse orientation. You can use this layout to change the handedness of the data.</p>      |                                                                                       |
|  <p><b>Wide</b></p> <p>Sensors are mounted in Left (Main) and Right (Buddy) positions for a larger combined field of view. Sensors may be angled to avoid occlusions.</p> |   |

| Layout Type                                                                                                                                                                                                                                                                                                                                                                                      | Example                                                                               |
|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---------------------------------------------------------------------------------------|
|                                                                                                                                                                                                                                                                                                                                                                                                  |     |
|  <p><b>Reverse</b></p> <p>Sensors are mounted in a left-right layout as with the Wide layout, but the Buddy sensor is mounted such that it is rotated 180 degrees around the Z axis to prevent occlusion along the Y axis.</p> <p>Sensors should be shifted along the Y axis so that the laser lines align.</p> |     |
|  <p><b>Opposite</b></p> <p>Sensors are mounted in Top (Main) and Bottom (Buddy) positions for a larger combined measurement range and the ability to perform Top/Bottom differential measurements.</p>                                                                                                          |   |
|  <p><b>Grid</b></p> <p>For systems composed of three or more sensors. Sensors can be mounted in a 2-dimensional grid using the settings in the <b>Layout Grid</b> area below. Wide (side-by-side) and Opposite configurations are supported, as well as Reverse orientations.</p>                             |  |

| Layout Type | Example                                                                            |
|-------------|------------------------------------------------------------------------------------|
|             |  |

To specify a standalone layout:

- Go to the **Manage** page and click on the **Layout** category.
- Under **Layout Types**, choose Normal or Reverse layout by clicking one of the layout buttons.

Layout Types

Normal



\* Main sensor

Current Devices

| Name | Serial | Position |
|------|--------|----------|
| Main | 39902  | Top 0    |

See the table above for information on layouts.



Before you can select a dual-sensor layout, you must assign a second sensor as the Buddy sensor. For more information, see *Dual- and Multi-sensor Systems* on page 71.

To specify a dual-sensor layout:

- Go to the **Manage** page and click on the **Layout** category.
- Under **Layout Types**, choose a layout by clicking one of the layout buttons.

Layout Types

Wide



\* Main sensor

☐ Device Exposure Multiplexing

Current Devices

| Name    | Serial | Position |
|---------|--------|----------|
| Main    | 22282  | Top 0    |
| Buddy 0 | 22285  | Top 1    |

See the table above for information on layouts.





Before you can select a multi-sensor layout, you must assign two or more additional sensors as Buddy sensors. For more information, see *Dual- and Multi-sensor Systems* on page 71.

To specify a multi-sensor layout:

1. Go to the **Manage** page and click on the **Layout** category.
2. Under **Layout Grid**, click the "plus" icon to the right to add the desired number of columns in the grid.

| Name    | Serial | Position |
|---------|--------|----------|
| Main    | 39902  | Top 0    |
| Buddy 0 | 40276  | None     |
| Buddy 1 | 40278  | None     |
| Buddy 2 | 40166  | None     |

**Layout Grid** Columns: - 4 +

|        | 0                                              | 1       | 2       | 3       |
|--------|------------------------------------------------|---------|---------|---------|
| Top    | 39902* ▾<br>Reversed: <input type="checkbox"/> | Empty ▾ | Empty ▾ | Empty ▾ |
| Bottom | Empty ▾                                        | Empty ▾ | Empty ▾ | Empty ▾ |

The Main sensor is automatically assigned to the first cell. You can however assign the Main sensor to any cell.

3. Choose a sensor from the drop-down in each cell you want to populate.

**Layout Grid** Columns: - 4 +

|        | 0                                              | 1                                            | 2       | 3       |
|--------|------------------------------------------------|----------------------------------------------|---------|---------|
| Top    | 39902* ▾<br>Reversed: <input type="checkbox"/> | Empty ▾<br>39902*<br>40276<br>40278<br>40166 | Empty ▾ | Empty ▾ |
| Bottom | Empty ▾                                        | Empty ▾                                      | Empty ▾ | Empty ▾ |

The following shows the layout of a four-sensor Wide system:

**Layout Grid** Columns: - 4 +

|        | 0                                            | 1                                           | 2                                           | 3                                           |
|--------|----------------------------------------------|---------------------------------------------|---------------------------------------------|---------------------------------------------|
| Top    | 39902*<br>Reversed: <input type="checkbox"/> | 40276<br>Reversed: <input type="checkbox"/> | 40278<br>Reversed: <input type="checkbox"/> | 40166<br>Reversed: <input type="checkbox"/> |
| Bottom | Empty                                        | Empty                                       | Empty                                       | Empty                                       |

The following shows the layout of a four-sensor Opposite system:

**Layout Grid** Columns: - 4 +

|        | 0                                            | 1                                           | 2     | 3     |
|--------|----------------------------------------------|---------------------------------------------|-------|-------|
| Top    | 39902*<br>Reversed: <input type="checkbox"/> | 40276<br>Reversed: <input type="checkbox"/> | Empty | Empty |
| Bottom | 40278<br>Reversed: <input type="checkbox"/>  | 40166<br>Reversed: <input type="checkbox"/> | Empty | Empty |

See the table above for more information on layouts.

- (Optional) For each sensor mounted in a reversed orientation in relation to the Main sensor (rotated 180 degrees around the Z axis to avoid occlusions), check the **Reversed** option.

**Layout Grid** Columns: - 4 +

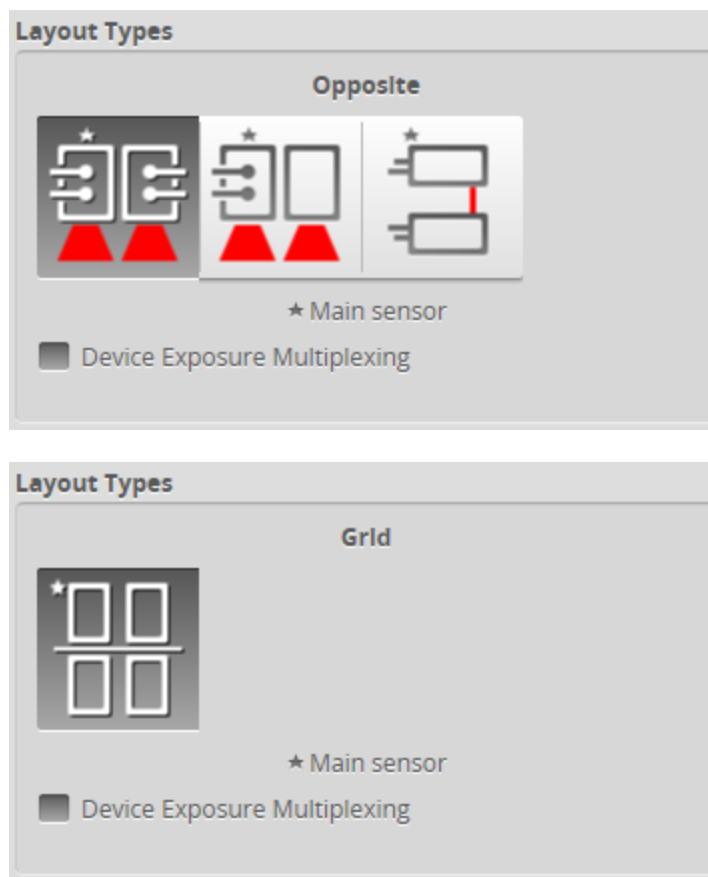
|        | 0                                            | 1                                                      | 2                                           | 3                                                      |
|--------|----------------------------------------------|--------------------------------------------------------|---------------------------------------------|--------------------------------------------------------|
| Top    | 39902*<br>Reversed: <input type="checkbox"/> | 40276<br>Reversed: <input checked="" type="checkbox"/> | 40278<br>Reversed: <input type="checkbox"/> | 40166<br>Reversed: <input checked="" type="checkbox"/> |
| Bottom | Empty                                        | Empty                                                  | Empty                                       | Empty                                                  |

You must assign all Buddy sensors to a cell in the layout grid. Otherwise, the system will not run.

You can configure dual- and multi-sensor systems so that there is a slight delay between the exposures of sensors or groups of sensors to eliminate laser interference. For more information, see *Device Exposure Multiplexing* below.

## Device Exposure Multiplexing

If the sensors in a dual- or multi-sensor system are mounted such that the camera from one sensor can detect the laser from the other sensor, the **Device Exposure Multiplexing** option can be used to eliminate laser interference. This setting creates a time offset for laser exposures and ensures that interfering lasers are not strobed at the same time. Using this setting may reduce the maximum frame rate.



*To enable/disable exposure multiplexing:*

1. Go to the **Manage** page and click on the **Sensor System** category.
2. In the Layout section, check/uncheck the **Device Exposure Multiplexing** option.  
This option is only displayed if a buddy is assigned.
3. (Optional) If the system contains more than two sensors, assign the sensors to different banks.

|        | 0                                                       | 1                                                      |
|--------|---------------------------------------------------------|--------------------------------------------------------|
| Top    | 42074*<br>Reversed: <input type="checkbox"/><br>Bank: 0 | 26296<br>Reversed: <input type="checkbox"/><br>Bank: 0 |
| Bottom | 26297<br>Reversed: <input type="checkbox"/><br>Bank: 1  | 13814<br>Reversed: <input type="checkbox"/><br>Bank: 1 |

## Networking

The **Networking** category on the **Manage** page provides network settings. Settings must be configured to match the network to which the Gocator sensors are connected.

Manage

Sensor System  
System setup and buddy assignment

Layout  
Layout devices

**Networking**  
IP address settings

Motion and Alignment  
Encoder resolution and travel speed

Jobs  
Download, upload and set default

Security  
Admin and Technician passwords

Maintenance  
Upgrade, backup, restore, reset

Support  
Manual, support file, and SDK

Networking

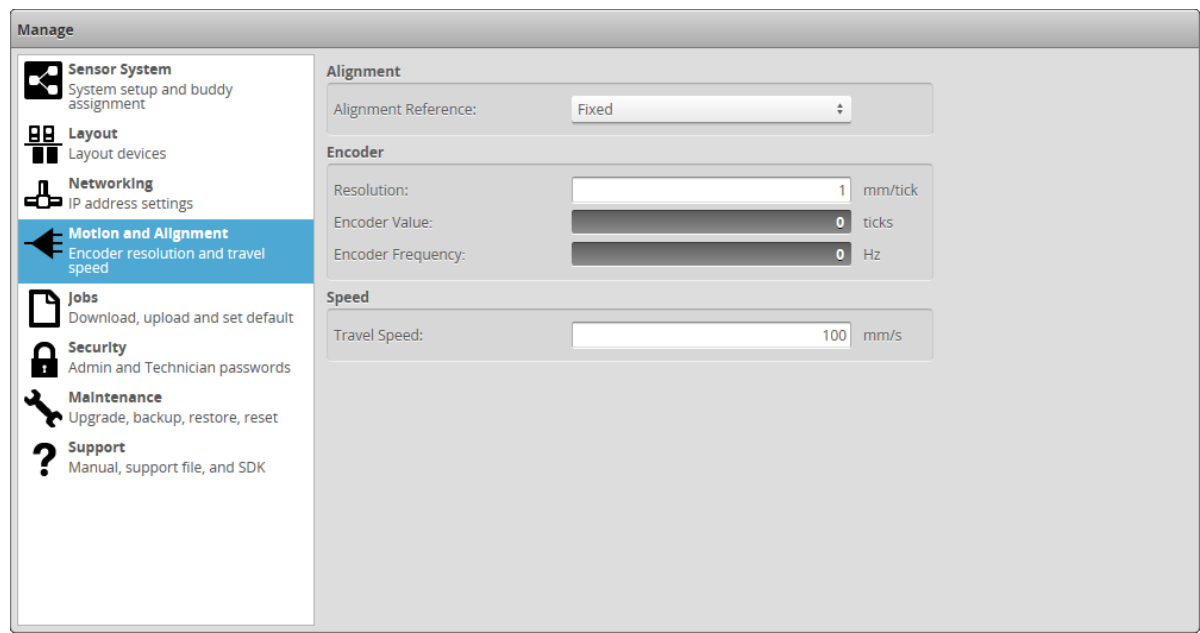
Type: Manual  
IP: 192.168.1.10  
Subnet Mask: 255.255.255.0  
Gateway: 0.0.0.0  
Save

*To configure the network settings:*

1. Go to the **Manage** page.
2. In the **Networking** category, specify the Type, IP, Subnet Mask, and Gateway settings.  
The Gocator sensor can be configured to use DHCP or assigned a static IP address.
3. Click on the **Save** button.  
You will be prompted to confirm your selection.

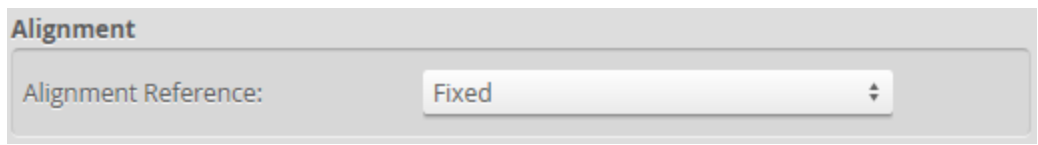
# Motion and Alignment

The **Motion and Alignment** category on the **Manage** page lets you configure alignment reference, encoder resolution, and travel speed, and confirm that encoder signals are being received by the sensor.



## Alignment Reference

The **Alignment Reference** setting can have one of two values: **Fixed** or **Dynamic**.



| Setting | Description                                                                                                                                                                                                                                    |
|---------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Fixed   | A single, global alignment is used for all jobs. This is typically used when the sensor mounting is constant over time and between scans, for example, when the sensor is mounted in a permanent position over a conveyor belt.                |
| Dynamic | A separate alignment is used for each job. This is typically used when the sensor's position relative to the object scanned is always changing, for example, when the sensor is mounted on a robot arm moving to different scanning locations. |

*To configure alignment reference:*

1. Go to the **Manage** page and click on the **Motion and Alignment** category.
2. In the Alignment section, choose **Fixed** or **Dynamic** in the **Alignment Reference** drop-down.

## Encoder Resolution

You can manually enter the encoder resolution in the **Resolution** setting, or it can be automatically set by performing an alignment with **Type** set to **Moving**. Establishing the correct encoder resolution is required for correct scaling of the scan of the target object in the direction of travel.



The image shows a configuration panel titled "Encoder". It contains three input fields: "Resolution:" with a value of "1" and unit "mm/tick", "Encoder Value:" with a value of "0" and unit "ticks", and "Encoder Frequency:" with a value of "0" and unit "Hz".

Encoder resolution is expressed in millimeters per tick, where one tick corresponds to *one* of the four encoder quadrature signals (A+ / A- / B+ / B-).



Encoders are normally specified in *pulses* per revolution, where each pulse is made up of the four quadrature *signals* (A+ / A- / B+ / B-). Because Gocator reads each of the four quadrature signals, you should choose an encoder accordingly, given the resolution required for your application.

*To configure encoder resolution:*

1. Go to the **Manage** page and click on the **Motion and Alignment** category.
2. In the **Encoder** section, enter a value in the **Resolution** field.

## Encoder Value and Frequency

The encoder value and frequency are used to confirm the encoder is correctly wired to the Gocator and to manually calibrate encoder resolution (that is, by moving the conveyor system a known distance and making a note of the encoder value at the start and end of movement).

## Travel Speed

The **Travel Speed** setting is used to correctly scale scans in the direction of travel in systems that lack an encoder but have a conveyor system that is controlled to move at constant speed. Establishing the correct travel speed is required for correct scaling of the scan in the direction of travel.



The image shows a configuration panel titled "Speed". It contains one input field: "Travel Speed:" with a value of "100" and unit "mm/s".

Travel speed is expressed in millimeters per second.

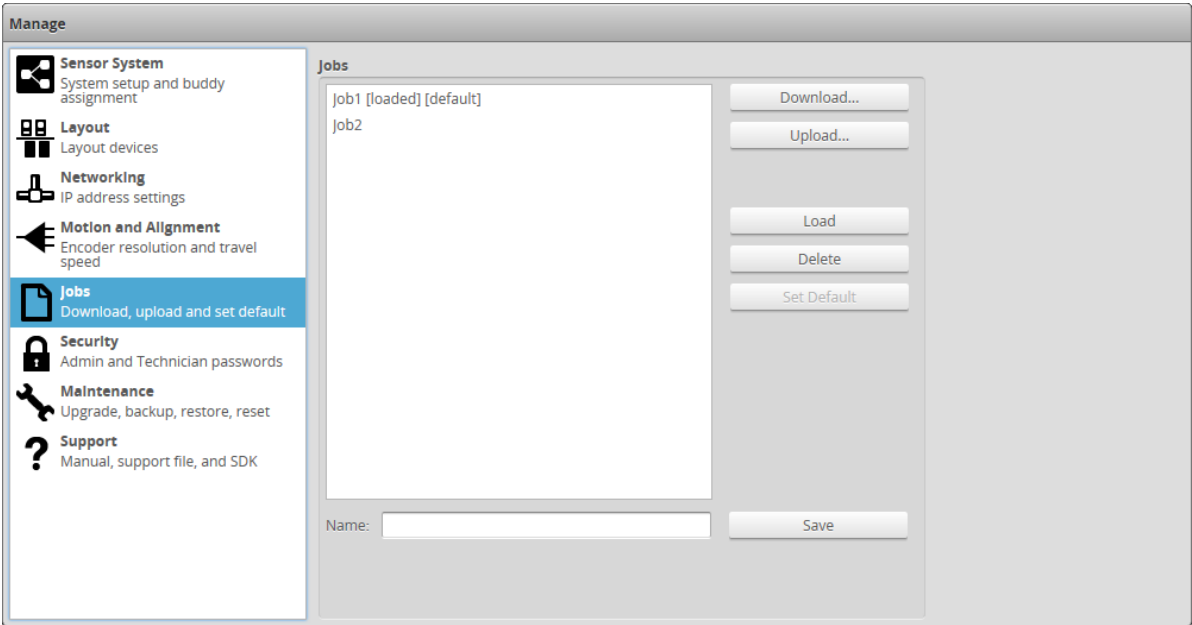
*To manually configure travel speed:*

1. Go to the **Manage** page and click on the **Motion and Alignment** category.
2. In the **Speed** section, enter a value in the **Travel Speed** field.

Travel speed can also be set automatically by performing an alignment with **Type** set to **Moving** (see *Aligning Sensors* on page 113).

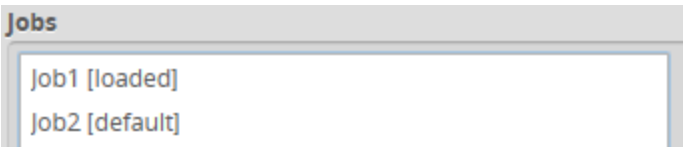
## Jobs

The **Jobs** category on the **Manage** page lets you manage the jobs stored on a sensor.

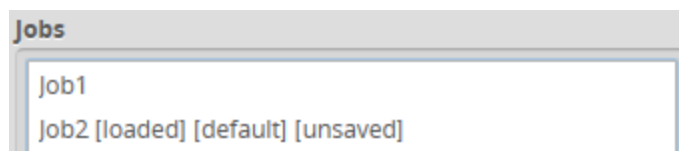


| Element               | Description                                                                                                                                           |
|-----------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------|
| Name field            | Used to provide a job name when saving files.                                                                                                         |
| Jobs list             | Displays the jobs that are currently saved in the sensor's flash storage.                                                                             |
| Save button           | Saves current settings to the job using the name in the <b>Name</b> field.                                                                            |
| Load button           | Loads the job that is selected in the job list. Reloading the current job discards any unsaved changes.                                               |
| Delete button         | Deletes the job that is selected in the job list.                                                                                                     |
| Set as Default button | Sets the selected job as the default to be loaded when the sensor starts. When the default job is selected, this button is used to clear the default. |
| Download... button    | Downloads the selected job to the client computer.                                                                                                    |
| Upload... button      | Uploads a job from the client computer.                                                                                                               |

Jobs can be loaded (currently activated in sensor memory) and set as default independently. For example, Job1 could be loaded, while Job2 is set as the default. Default jobs load automatically when a sensor is power cycled or reset.



Unsaved jobs are indicated by "[unsaved]".



*To save a job:*

1. Go to the **Manage** page and click on the **Jobs** category.
2. Provide a name in the **Name** field.  
To save an existing job under a different name, click on it in the **Jobs** list and then modify it in the **Name** field.
3. Click on the **Save** button or press **Enter**.  
Saving a job automatically sets it as the default, that is, the job loaded when then sensor is restarted.

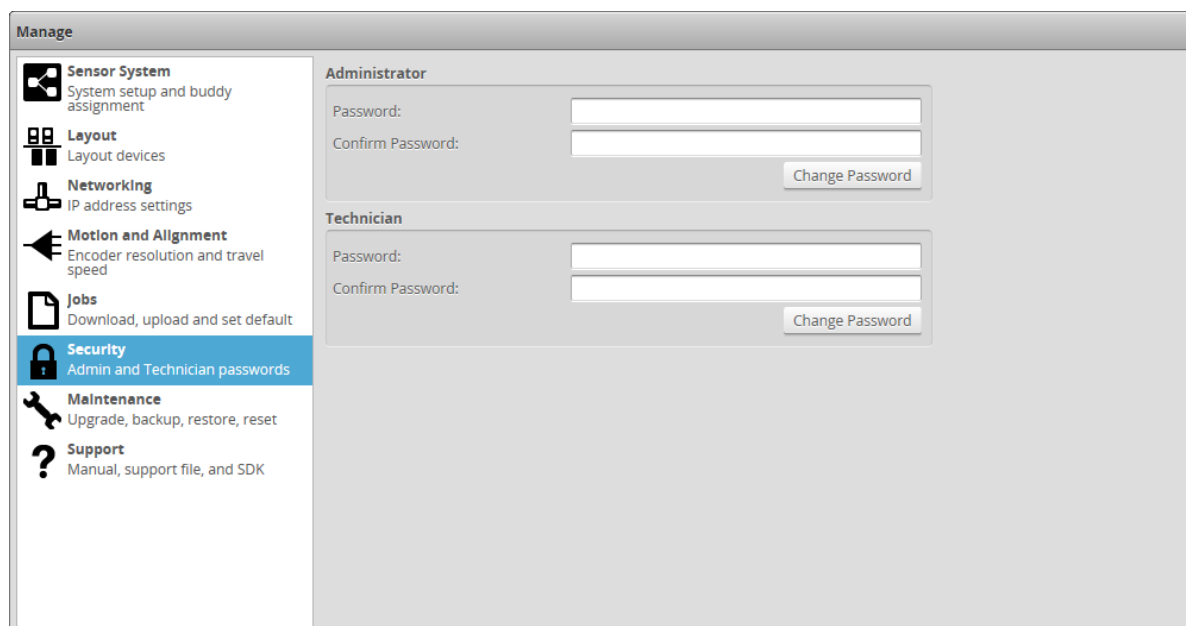
*To download, load, or delete a job, or to set one as a default, or clear a default:*

1. Go to the **Manage** page and click on the **Jobs** category.
2. Select a job in the **Jobs** list.
3. Click on the appropriate button for the operation.

## Security

You can prevent unauthorized access to a Gocator sensor by setting passwords. Each sensor has two accounts: Administrator and Technician.

By default, no passwords are set. When you start a sensor, you are prompted for a password only if a password has been set.





## Gocator Account Types

| Account       | Description                                                                                                                                                                                                                  |
|---------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Administrator | The Administrator account has privileges to use the toolbar (loading and saving jobs, recording and viewing replay data), to view all pages and edit all settings, and to perform setup procedures such as sensor alignment. |
| Technician    | The Technician account has privileges to use the toolbar (loading and saving jobs, recording and viewing replay data), to view the <b>Dashboard</b> page, and to start or stop the sensor.                                   |

The Administrator and Technician accounts can be assigned unique passwords.

### *To set or change the password for the Administrator account:*

1. Go to the **Manage** page and click on the **Security** category.
2. In the **Administrator** section, enter the Administrator account password and password confirmation.
3. Click **Change Password**.  
The new password will be required the next time that an administrator logs in to the sensor.

### *To set or change the password for the Technician account:*

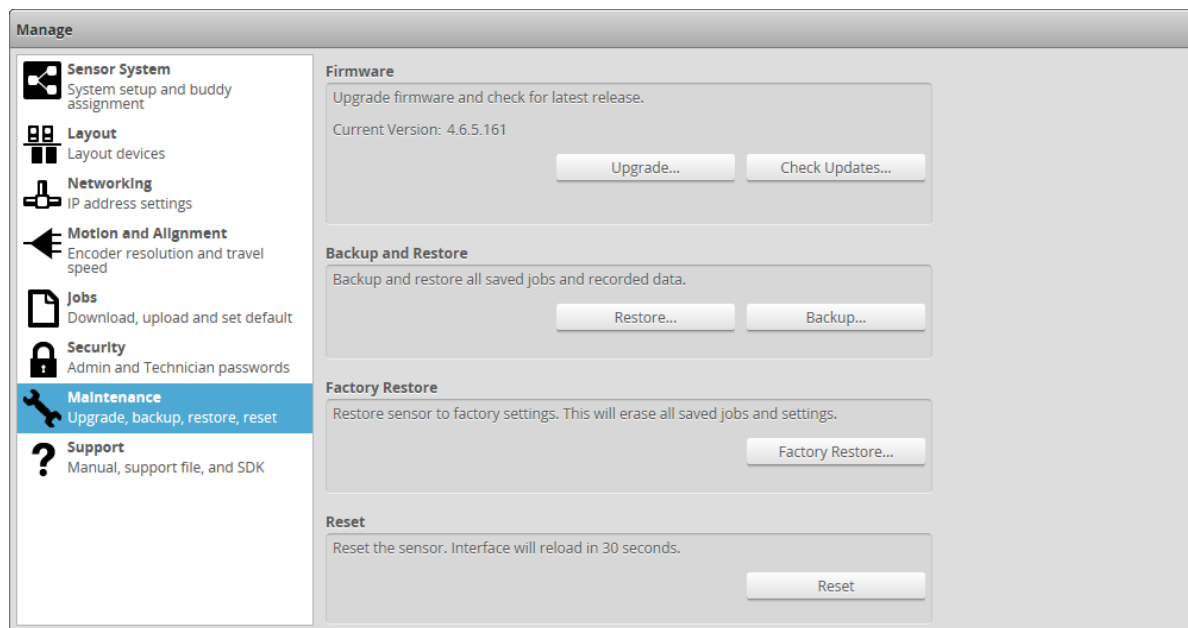
1. Go to the **Manage** page and click on the **Security** category.
2. In the **Technician** section, enter the Technician account password and password confirmation.
3. Click **Change Password**.  
The new password will be required the next time that a technician logs in to the sensor.

If the administrator or technician password is lost, the sensor can be recovered using a special software tool. See *Sensor Recovery Tool* on page 500 for more information.

## Maintenance

The **Maintenance** category in the **Manage** page is used to do the following:

- upgrade the firmware and check for firmware updates;
- back up and restore all saved jobs and recorded data;
- restore the sensor to factory defaults;
- reset the sensor.



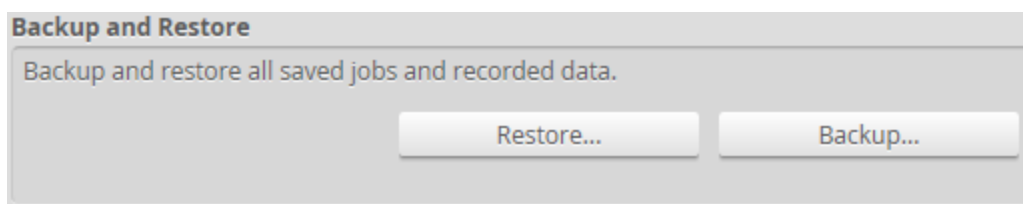
## Sensor Backups and Factory Reset

You can create sensor backups, restore from a backup, and restore to factory defaults in the **Maintenance** category.

Backup files contain all of the information stored on a sensor, including jobs and alignment.

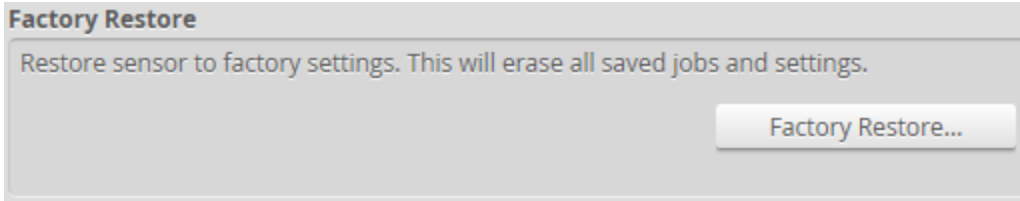


An Administrator should create a backup file in the unlikely event that a sensor fails and a replacement sensor is needed. If this happens, the new sensor can be restored with the backup file.



*To create a backup:*

1. Go to the **Manage** page and click on the **Maintenance** category.
2. Click the **Backup...** button under **Backup and Restore**.
3. When you are prompted, save the backup.  
Backups are saved as a single archive that contains all of the files from the sensor.



*To restore from a backup:*

1. Go to the **Manage** page and click on the **Maintenance** category.
2. Click the **Restore...** button under **Backup and Restore**.
3. When you are prompted, select a backup file to restore.  
The backup file is uploaded and then used to restore the sensor. Any files that were on the sensor before the restore operation will be lost.

*To restore a sensor to its factory default settings:*

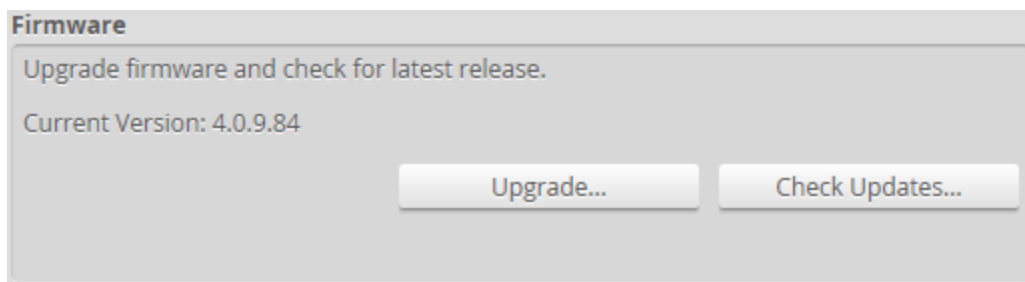
1. Go to the **Manage** page and click on **Maintenance**.
2. Consider making a backup.  
Before proceeding, you should perform a backup. Restoring to factory defaults cannot be undone.
3. Click the **Factory Restore...** button under **Factory Restore**.  
You will be prompted whether you want to proceed.

## Firmware Upgrade

LMI recommends routinely updating firmware to ensure that Gocator sensors always have the latest features and fixes.



In order for the Main and Buddy sensors to work together, they must be use the same firmware version. This can be achieved by upgrading through the Main sensor or by upgrading each sensor individually.



*To download the latest firmware:*

1. Go to the **Manage** page and click on the **Maintenance** category.
2. Click the **Check Updates...** button in the **Firmware** section.
3. Download the latest firmware.

If a new version of the firmware is available, follow the instructions to download it to the client computer.

If the client computer is not connected to the Internet, firmware can be downloaded and transferred to the client computer by using another computer to download the firmware from LMI's website:

<http://www.lmi3d.com/support/downloads>.

*To upgrade the firmware:*

1. Go to the **Manage** page and click on the **Maintenance** category.
2. Click the **Upgrade...** button in the **Firmware** section.
3. Locate the firmware file in the **File** dialog and then click open.
4. Wait for the upgrade to complete.

After the firmware upgrade is complete, the sensor will self-reset. If a buddy has been assigned, it will be upgraded and reset automatically.

## Support

The **Support** category in the **Manage** page is used to do the following:

- open an HTML version or download a PDF version of the manual
- download the SDK
- save a support file
- get device information

The screenshot shows the 'Manage' page of the Gocator Web Interface. The left sidebar contains a list of categories: Sensor System, Layout, Networking, Motion and Alignment, Jobs, Security, Maintenance, and Support. The 'Support' category is selected and highlighted in blue. The main content area is divided into three sections. The 'Device Information' section displays the Part Number (312330-2M-01), Serial (11023), and Version (4.6.5.161). The 'Support File' section includes a description, a text input field for the filename (containing 'support'), a description text area, and a 'Download' button. The 'User Manual' section has buttons for 'Open HTML' and 'Download PDF'. The 'Software Development Kit (SDK)' section has a 'Download' button.

## Support Files

You can download a support file from a sensor and save it on your computer. You can then use the support file to create a scenario in the Gocator emulator (for more information on the emulator, see *Gocator Emulator* on page 298). LMI's support staff may also request a support file to help in troubleshooting.

**Support File**

Download a support file which contains all jobs, data and current state of the sensor.

Filename:

Description:

Sensor running in surface mode. Contains Surface Stud and Countersunk Hole measurements, in addition to scan data from the current production run.

Download

*To download a support file:*

1. Go to the **Manage** page and click on the **Support** category.
2. In **Filename**, type the name you want to use for the support file.  
When you create a scenario from a support file in the emulator, the filename you provide here is displayed in the emulator's scenario list.  
Support files end with the .gs extension, but you do not need to type the extension in **Filename**.
3. (Optional) In **Description**, type a description of the support file.  
When you create a scenario from a support file in the emulator, the description is displayed below the emulator's scenario list.
4. Click **Download**, and then when prompted, click **Save**.



Downloading a support file stops the sensor.

## Manual Access

You can access the Gocator manuals from within the Web interface.

**User Manual:** [Open HTML](#) [Download PDF](#)



You may need to configure your browser to allow pop-ups to open or download the manual.

*To access the manuals:*

1. Go to the **Manage** page and click on the **Support** category
2. Next to **User Manual**, click one of the following:

- **Open HTML:** Opens the HTML version of the manual in your default browser.
- **Download PDF:** Downloads the PDF version of the manual to the client computer.

## Software Development Kit

You can download the Gocator SDK from within the Web interface.

**Software Development Kit (SDK):**

**Download**

*To download the SDK:*

1. Go to the **Manage** page and click on the **Support** category
2. Next to **Software Development Kit (SDK)**, click **Download**
3. Choose the location for the SDK on the client computer.



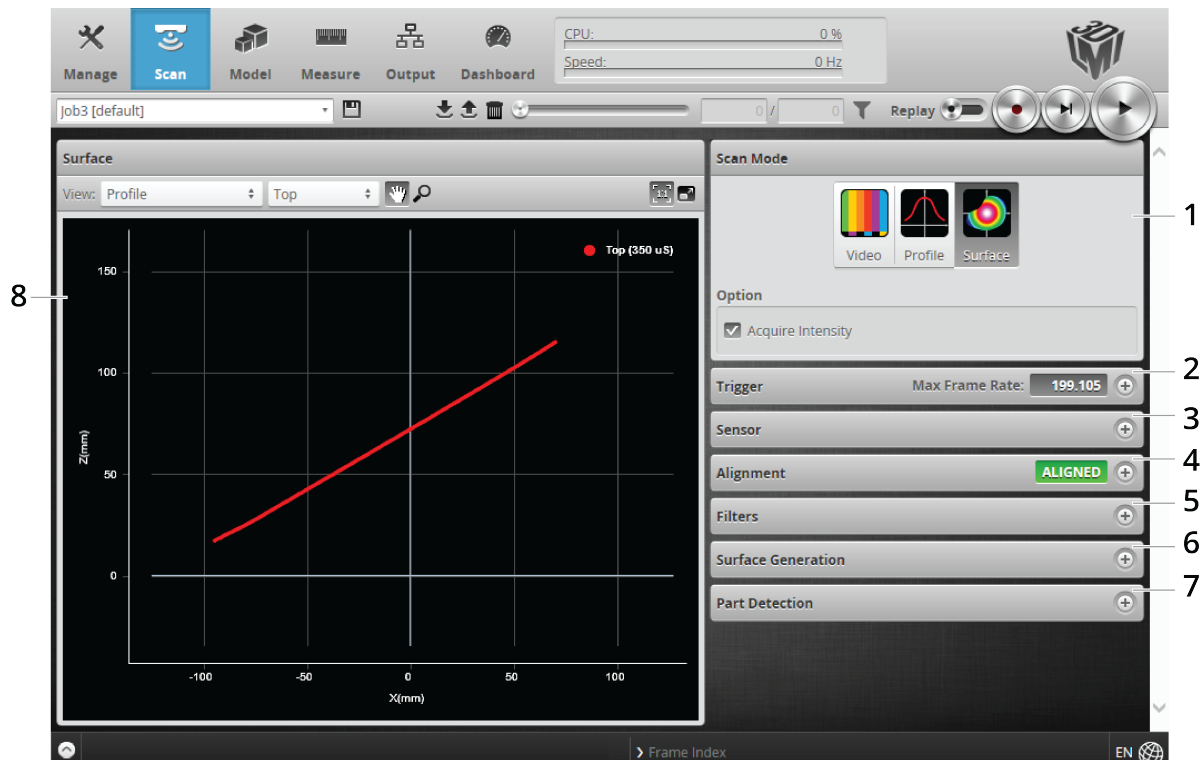
For more information on the SDK, see *SDK* on page 488.

# Scan Setup and Alignment

The following sections describe the steps to configure Gocator sensors for laser profiling using the **Scan** page. Setup and alignment should be performed before adding and configuring measurements or outputs.

## Scan Page Overview

The **Scan** page lets you configure sensors and perform alignment.



| Element                    | Description                                                                                                                         |
|----------------------------|-------------------------------------------------------------------------------------------------------------------------------------|
| 1 Scan Mode panel          | Contains settings for the current scan mode (Video, Profile, or Surface) and other options. See <i>Scan Modes</i> on the next page. |
| 2 Trigger panel            | Contains trigger source and trigger-related settings. See <i>Triggers</i> on page 93.                                               |
| 3 Sensor panel             | Contains settings for an individual sensor, such as active area or exposure. See <i>Sensor</i> on page 99.                          |
| 4 Alignment panel          | Used to perform alignment. See <i>Alignment</i> on page 111.                                                                        |
| 5 Filters panel            | Contains settings for post-processing of the profiles. See <i>Filters</i> on page 116.                                              |
| 6 Part Detection panel     | Used to set the part detection logic for sorting profiles into discrete objects. See <i>Part Detection</i> on page 123.             |
| 7 Surface Generation panel | Contains settings for surface generation. See <i>Surface Generation</i> on page 119.                                                |

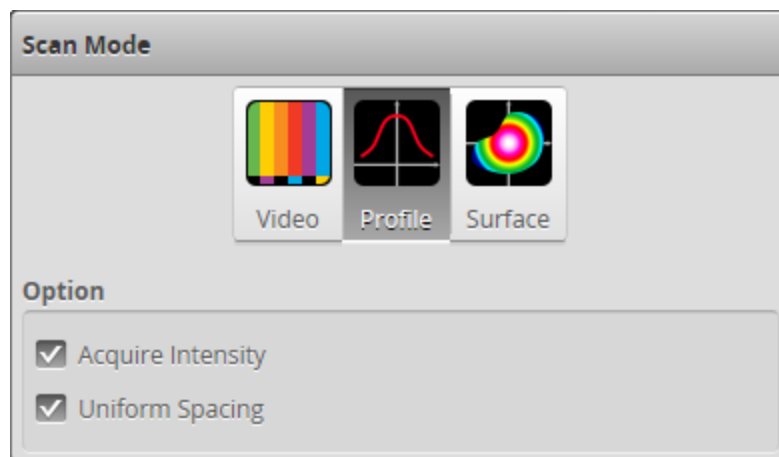
| Element       | Description                                                                                                                                                                                                     |
|---------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 8 Data Viewer | Displays sensor data and adjusts regions of interest. Depending on the current operation mode, the data viewer can display video images , profile plots, or surface views . See <i>Data Viewer</i> on page 127. |

The following table provides quick references for specific goals that you can achieve from the panels in the **Scan** page.

| Goal                                                                                                                                           | Reference                                                            |
|------------------------------------------------------------------------------------------------------------------------------------------------|----------------------------------------------------------------------|
| Select a trigger source that is appropriate for the application.                                                                               | Triggers (page 93)                                                   |
| Ensure that camera exposure is appropriate for laser profiling .                                                                               | Exposure (page 103)                                                  |
| Find the right balance between profile quality, speed, and CPU utilization.                                                                    | Active Area (page 99)<br>Exposure (page 103)<br>Job Files (page 319) |
| Specify mounting orientations.                                                                                                                 | Layout (page 73)                                                     |
| Calibrate the system so that laser profile data can be aligned to a common reference and values can be correctly scaled in the axis of motion. | Aligning Sensors (page 113)                                          |
| Set up the part detection logic to create discrete objects from surfaces or profiles.                                                          | Part Detection (page 123)                                            |
| Specify smoothing, gap-filling, and resampling parameters to remove effects of occlusions.                                                     | Filters (page 116)                                                   |

## Scan Modes

The Gocator web interface supports threescan modes: Video, Profile, and Surface. The scan mode can be selected in the **Scan Mode** panel.



| Mode and Option | Description                                                                                                                                         |
|-----------------|-----------------------------------------------------------------------------------------------------------------------------------------------------|
| Video           | Outputs video images from the Gocator. This mode is useful for configuring exposure time and troubleshooting stray light or ambient light problems. |
| Profile         | Outputs profiles and performs profile measurements.                                                                                                 |



| Mode and Option   | Description                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        |
|-------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
|                   | Video images are processed internally to produce laser profiles and cross-sectional measurements.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  |
| Surface           | Outputs 3D point clouds made up of many laser profiles combined together and performs surface measurements. The sensor uses various methods to generate a surface (see <i>Surface Generation</i> on page 119). Part detection can be enabled on a surface to identify discrete parts ( <i>Part Detection</i> on page 123).                                                                                                                                                                                                                                                                                                                                                         |
| Uniform Spacing   | <p>When this option is enabled, ranges are resampled to a uniform spacing along the X axis (<i>Uniform Spacing (Data Resampling)</i> on page 53 for more information). The size of the spacing can be set in the <b>Spacing</b> tab (see <i>Spacing Interval</i> on page 108).</p> <p>When the option is disabled, the Gocator outputs unprocessed range data. Ranges are reported in (x,z) coordinate pairs. Post-profiling processing is disabled. Only a subset of the measurement tools is available.</p> <p>Disable this option to extract ranges from the Gocator at the highest possible rate.</p> <p>When the sensor is in Surface mode, this option is not available.</p> |
| Acquire Intensity | When this option is enabled, an intensity value will be produced for each laser profile point.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     |

## Triggers

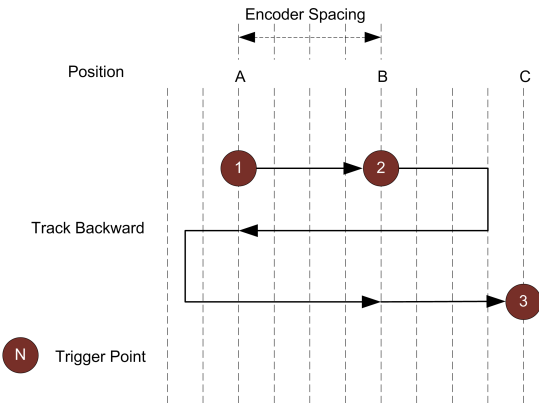
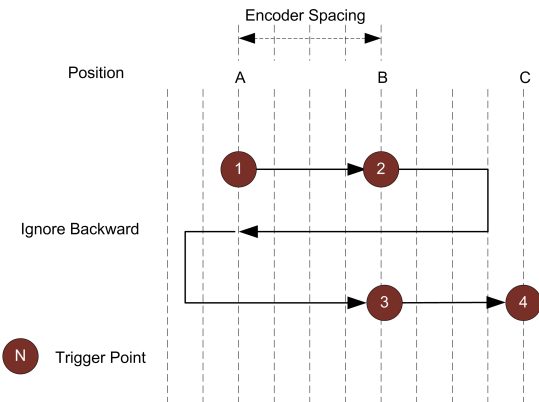
A trigger is an event that causes a Gocator sensor to take a single picture. Triggers are configured in the **Trigger** panel on the **Scan** page.

When a trigger is processed, the laser is strobed and the camera exposes to produce an image. The resulting image is processed inside the sensor to yield a profile (range/distance information), which can then be used for measurement.

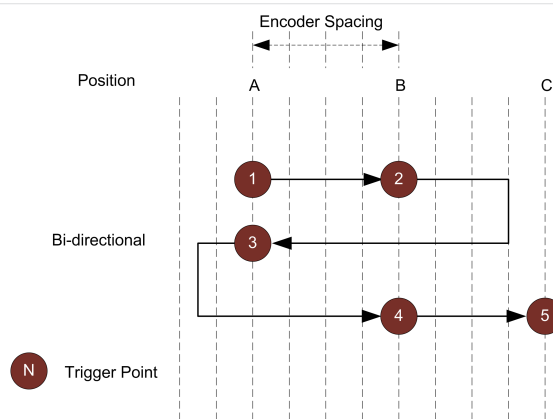
The sensor can be triggered by one of the sources described in the table below.

|                                                                                     |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             |
|-------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
|  | <p>If the sensor is connected to a Master 400 or higher, encoder and digital (external) input signals over the IO cordset are <i>ignored</i>. The sensor instead receives these signals from the Master; for encoder and digital input pinouts on Masters, see the section corresponding to your Master in <i>Master Network Controllers</i> on page 564.</p> <p>If the sensor is connected to a <a href="#">Master 100</a> (or no Master is used), the sensor receives signals over the IO cordset. For information on connecting encoder and digital input signals to a sensor in these cases, see <i>Encoder Input</i> on page 562 <i>Digital Input</i> on page 561 <i>Encoder Input</i> on page 562</p> |
|-------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|

| Trigger Source | Description                                                                                                                                                  |
|----------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Time           | Sensors have an internal clock that can be used to generate fixed-frequency triggers. The external input can be used to enable or disable the time triggers. |

| Trigger Source | Description                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         |
|----------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Encoder        | <p>An encoder can be connected to provide triggers in response to motion. Three encoder triggering behaviors are supported. These behaviors are set using the <b>Behavior</b> setting.</p> <p><b>Track Backward</b></p> <p>A scan is triggered when the target object moves forward. If the target object moves backward, it must move forward by at least the distance that the target travelled backward (this distance backward is "tracked"), plus one encoder spacing, to trigger the next scan.</p>  <p><b>Ignore Backward</b></p> <p>A scan is triggered only when the target object moves forward. If the target object moves backward, it must move forward by at least the distance of one encoder spacing to trigger the next scan.</p>  <p><b>Bi-directional</b></p> <p>A scan is triggered when the target object moves forward or backward.</p> |

| Trigger Source | Description |
|----------------|-------------|
|----------------|-------------|



When triggers are received at a frequency higher than the maximum frame rate, some triggers may not be accepted. The **Trigger Drops Indicator** in the **Dashboard** can be used to check for this condition.

The external input can be used to enable or disable the encoder triggers.

For information on the maximum encoder rate, see *Maximum Encoder Rate* on page 99.



To verify that the sensor is receiving encoder signals, check whether **Encoder Value** is changing in the [Motion and Alignment](#) category on the **Manage** page, or in the [dashboard](#).

|                |                                                                                                                                                                                                                                                                                                                                                                                                                                            |
|----------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| External Input | <p>A digital input can provide triggers in response to external events (e.g., photocell).</p> <p>When triggers are received at a frequency higher than the maximum frame rate, some triggers may not be accepted. The <b>Trigger Drops Indicator</b> in the <b>Dashboard</b> page can be used to check for this condition.</p> <p>For information on the maximum input trigger rate, see <i>Maximum Input Trigger Rate</i> on page 98.</p> |
| Software       | <p>A network command can be used to send a software trigger. See <i>Protocols</i> on page 404 for more information.</p>                                                                                                                                                                                                                                                                                                                    |

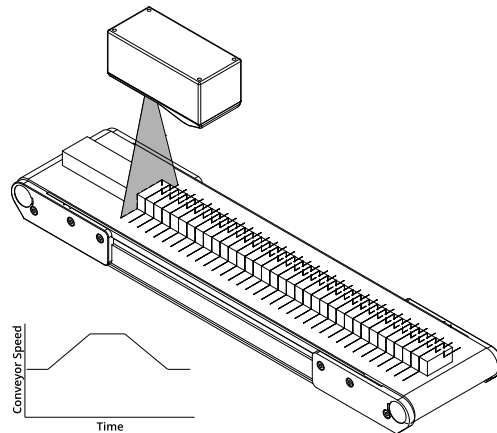
For examples of typical real-world scenarios, see *Trigger Examples* on the next page. For information on the settings used with each trigger source, see *Trigger Settings* on page 97

## Trigger Examples

### Example: Encoder + Conveyor

Encoder triggering is used to perform profile measurements at a uniform spacing.

The speed of the conveyor can vary while the object is being measured; an encoder ensures that the measurement spacing is consistent, independent of conveyor speed.

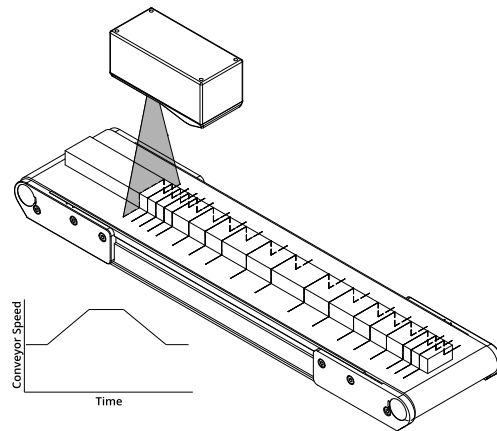


### Example: Time + Conveyor

Time triggering can be used instead of encoder triggering to perform profile measurements at a fixed frequency.

Measurement spacing will be non-uniform if the speed of the conveyor varies while the object is being measured.

It is strongly recommended to use an encoder with transport-based systems due to the difficulty in maintaining constant transport velocity.

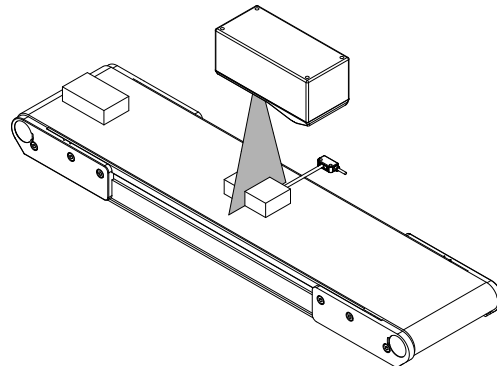


### Example: External Input + Conveyor

External input triggering can be used to produce a snapshot for profile measurement.

For example, a photocell can be connected as an external input to generate a trigger pulse when a target object has moved into position.

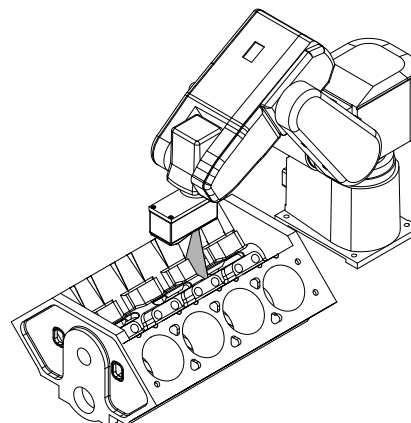
An external input can also be used to gate the trigger signals when time or encoder triggering is used. For example, a photocell could generate a series of trigger pulses as long as there is a target in position.



### Example: Software Trigger + Robot Arm

Software triggering can be used to produce a snapshot for profile measurement.

A software trigger can be used in systems that use external software to control the activities of system components.



## Trigger Settings

The trigger source is selected using the **Trigger** panel in the **Scan** page.

**Trigger** Max Frame Rate: 199.105

Source: Time

Frame Rate:  Max Speed Hz

☐ Gate on External Input

**Trigger** Max Frame Rate: 199.105

Source: Encoder

Spacing:  1 mm

Behavior: Bi-Directional

☐ Gate on External Input

**Trigger** Max Frame Rate: 199.105

Source: External Input

Units:  $\mu$ s (Time)

Trigger Delay:  0  $\mu$ s

**Trigger** Max Frame Rate: 199.105

Source: Software

Units:  $\mu$ s (Time)

☐ Gate on External Input

After specifying a trigger source, the **Trigger** panel shows the parameters that can be configured.

| Parameter              | Trigger Source | Description                                                                                                                                                                                                                                                                  |
|------------------------|----------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Source                 | All            | Selects the trigger source ( <b>Time</b> , <b>Encoder</b> , <b>External Input</b> , or <b>Software</b> ).                                                                                                                                                                    |
| Frame Rate             | Time           | Controls the frame rate. Select <b>Max Speed</b> from the drop-down to lock to the maximum frame rate. Fractional values are supported. For example, 0.1 can be entered to run at 1 frame every 10 seconds.                                                                  |
| Gate on External Input | Time, Encoder  | External input can be used to enable or disable profiling in a sensor. When this option is enabled, the sensor will respond to time or encoder triggers only when the external input is asserted.<br><br>This setting is not displayed when <b>Surface Generation</b> is set |

| Parameter     | Trigger Source           | Description                                                                                                                                                                                                                                                                                                                                                                             |
|---------------|--------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
|               |                          | to <b>Fixed Length</b> , <b>Variable Length</b> , or <b>Rotational</b> ( <i>Surface Generation</i> on page 119).<br>See <i>Digital Input</i> on page 561 for more information on connecting external input to Gocator sensors.                                                                                                                                                          |
| Behavior      | Encoder                  | Specifies how the Gocator sensor is triggered when the target moves. Can be Track Backward, Ignore Backward, or Bi-Directional. See <i>Triggers</i> on page 93 for more information on these behaviors.                                                                                                                                                                                 |
| Spacing       | Encoder                  | Specifies the distance between triggers (mm). Internally the Gocator sensor rounds the spacing to a multiple of the encoder resolution.                                                                                                                                                                                                                                                 |
| Units         | External Input, Software | Specifies whether the trigger delay, output delay, and output scheduled command operate in the time or the encoder domain. The unit is implicitly set to microseconds with Time trigger source, and millimeters with Encoder trigger source.                                                                                                                                            |
| Trigger Delay | External Input           | Controls the amount of time or the distance the sensor waits before producing a frame after the external input is activated. This is used to compensate for the positional difference between the source of the external input trigger (e.g., photocells) and the sensor.<br><br>Trigger delay is only supported in single exposure mode; for details, see <i>Exposure</i> on page 103. |



Depending on the surface generation settings, some trigger options may not be available.

To configure the trigger source:

1. Go to the **Scan** page.
2. Expand the **Trigger** panel by clicking on the panel header.
3. Select the trigger source from the drop-down.
4. Configure the settings.  
See the trigger parameters above for more information.
5. Save the job in the **Toolbar** by clicking the **Save** button .

## Maximum Input Trigger Rate



The maximum external input trigger rate in a system including Master 400 or higher is 20 kHz.

When using a standalone sensor or a sensor connected to a Master 100, the maximum trigger rate is 32 kHz. This rate is limited by the fall time of the signal, which depends on the Vin and duty cycles. To achieve the maximum trigger rate, the Vin and duty cycles must be adjusted as follows:

| Maximum Speed | Vin   | Maximum Duty Cycle |
|---------------|-------|--------------------|
| 32 kHz        | 3.3 V | 88%                |
| 32 kHz        | 5 V   | 56%                |
| 32 kHz        | 7 V   | 44%                |
| 32 kHz        | 10 V  | 34%                |

At 50% duty cycle, the maximum trigger rates are as follows:

| Vin   | Maximum Speed |
|-------|---------------|
| 3.3 V | 34 kHz        |
| 5 V   | 34 kHz        |
| 10 V  | 22 kHz        |

## Maximum Encoder Rate

On a standalone sensor, with the encoder directly wired into the I/O port or through a Master 100, the maximum encoder rate is about 1 MHz.

For sensors connected through a Master 400 or higher, with the encoder signal supplied to the Master, the maximum rate is about 300 kHz.

## Sensor

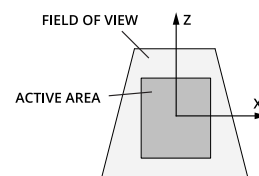
The following sections describe the settings that are configured in the **Sensor** panel on the **Scan** page.

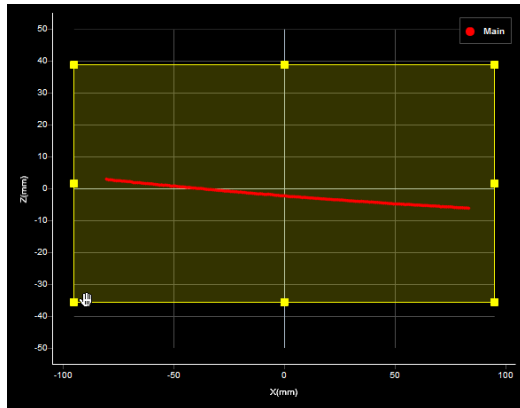
### Active Area

Active area refers to the region within the sensor's maximum field of view that is used for laser profiling.

By default, the active area covers the sensor's entire field of view. By reducing the active area, the sensor can operate at higher speeds.

Active area is specified in sensor coordinates, rather than in system coordinates. As a result, if the sensor is already alignment calibrated, press the **Acquire** button to display uncalibrated data before configuring the active area. See *Coordinate Systems* on page 49 for more information on sensor and system coordinates.





|                    | Min  | Value | Max     |
|--------------------|------|-------|---------|
| X Field of View:   | 0    | 250   | 250 mm  |
| Measurement Range: | 0    | 210   | 210 mm  |
| X Start:           | -125 | -125  | -125 mm |
| Z Start:           | -105 | -105  | -105 mm |

To set the active area:

1. Go to the **Scan** page.
2. Choose Profile or Surface mode in the **Scan Mode** panel, depending on the type of measurement whose decision you need to configure.  
If one of these modes is not selected, tools will not be available in the **Measure** panel.
3. Expand the **Sensor** panel by clicking on the panel header or the button.
4. Click the button corresponding to the sensor you want to configure.  
The button is labeled **Top**, **Bottom**, **Top-Left**, or **Top-Right**, depending on the system.  
Active area is specified separately for each sensor.
5. Click on the **Active Area** tab.
6. Click the **Select** button.
7. Click the **Acquire** button to see a scan while setting the active area.
8. Set the active area.  
Enter the active area values in the edit boxes or adjust the active area graphically in the data viewer.
9. Click the **Save** button in the **Sensor** panel.  
Click the **Cancel** button to cancel setting the active area.
10. Save the job in the **Toolbar** by clicking the **Save** button .



Laser profiling devices are usually more accurate at the near end of their measurement range. If your application requires a measurement range that is small compared to the maximum measurement range of the sensor, mount the sensor so that the active area can be defined at the near end of the measurement range.

## Tracking Window

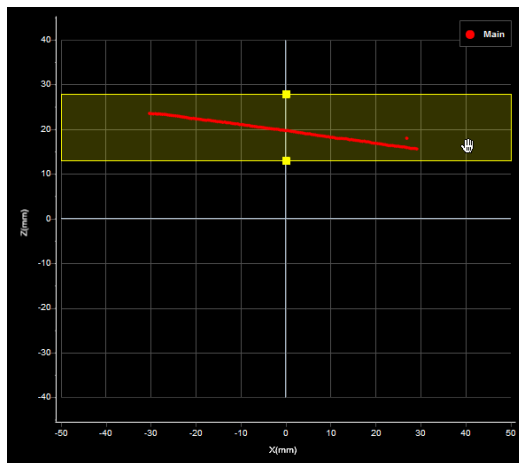
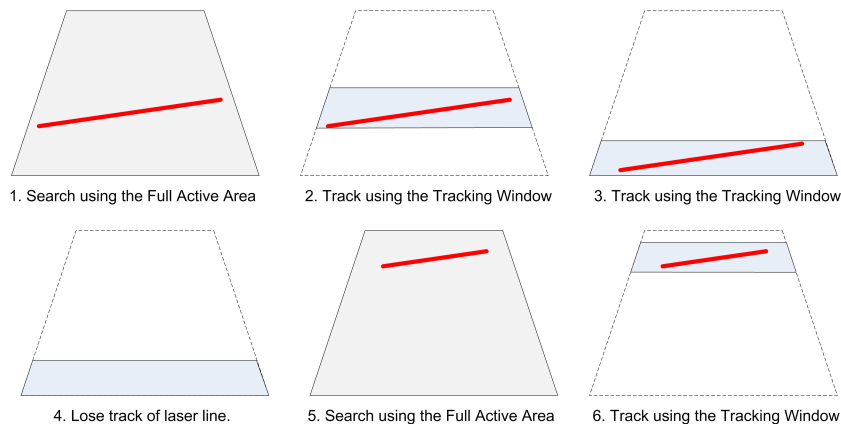


Gocator 2100 series sensors do not support tracking window.



The Gocator can track a relatively flat object in real-time to achieve very high scan rates. This feature tracks the object height using a small window that moves dynamically to cover a larger measurement range. You can balance the gain in speed and the tracking ability by configuring the size of the tracking area. This feature is typically used in road or web scanning applications where the target is a continuous flat surface.

A laser line remains tracked as long as the percentage of detected laser points exceeds the user-defined search threshold. When the sensor loses track of the laser line, the sensor will search for the laser line using the full active area.



☒ **Tracking Window**

Select

Reset

Height:  mm

Search Threshold:  50 %

*To enable the tracking window:*

1. Go to the **Scan** page.
2. Choose Profile or Surface mode in the **Scan Mode** panel.  
If one of these modes is not selected, you will not be able to set the tracking window.
3. Expand the **Sensor** panel by clicking on the panel header.
4. Click on the **Active Area** tab.
5. Check the **Tracking Window** box.

The panel below the checkbox expands and shows the settings for the window used to track the object height.

6. Click the tracking window's **Select** button.
7. Resize the tracking window shown in the data viewer.  
Only the height of the window is required. You can move the position of the tracking window to cover a live profile to help adjust the window height.
8. Edit the **Search Threshold** setting.  
The search threshold defines the minimum percentage of the points detected across the profile for the laser to be considered tracked. If tracking is lost, the sensor will search for the laser using the full active area.
9. Click the **Save** button in the **Sensor** panel.
10. Save the job in the **Toolbar** by clicking the **Save** button .

The sensor adjusts the position of the tracking window so that the area is centered around the average height of the entire visible laser profile. You should adjust the lighting and the active area to remove all background objects, such as the conveyor belt surface, ambient lights, etc.

## Transformations

The transformation settings determine how profiles are converted from sensor coordinates to system coordinates. Typically, transformations are set when you [align a sensor](#). However, you can also manually set values.



The image shows a 'Transformation' settings panel with a hamburger menu icon in the top right corner. It contains three input fields: 'X Offset' with a value of 1.638 mm, 'Z Offset' with a value of 54.556 mm, and 'Angle' with a value of -1.72 °.

| Parameter | Description                                                                                                                                                                                   |
|-----------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| X Offset  | Specifies the shift along the X axis. With Normal orientation, a positive value shifts the profiles to the right. With Reverse orientation, a positive value shifts the profiles to the left. |
| Z Offset  | Specifies the shift along the Z axis. A positive value shifts the profiles toward the sensor.                                                                                                 |
| Angle     | Specifies the tilt (rotation in the X-Z plane). A positive value rotates the profile counter-clockwise.                                                                                       |

When applying the transformations, Angle is applied before the X and Z offsets.

*To configure transformation settings:*

1. Go to the **Scan** page.

2. Choose Profile or Surface mode in the **Scan Mode** panel, depending on the type of measurement whose decision you need to configure.  
If one of these modes is not selected, tools will not be available in the **Measure** panel.
3. Expand the **Sensor** panel by clicking on the panel header.
4. Click the button corresponding to the sensor you want to configure.  
The button is labeled **Top**, **Bottom**, **Top-Left**, or **Top-Right**, depending on the system.  
Transformations can be configured separately for each sensor.
5. Expand the Transformations area by clicking on the expand button .  
See the table above for more information.
6. Set the parameter values.  
See the table above for more information.
7. Save the job in the **Toolbar** by clicking the **Save** button .
8. Check that the transformation settings are applied correctly after profiling is restarted.

## Exposure

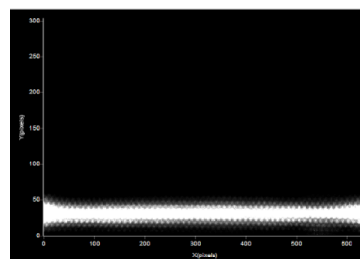
Exposure determines the duration of camera and laser on-time. Longer exposures can be helpful to detect laser signals on dark or distant surfaces, but increasing exposure time decreases the maximum speed. Different target surfaces may require different exposures for optimal results. Gocator sensors provide three exposure modes for the flexibility needed to scan different types of target surfaces.

| Exposure Mode | Description                                                                                                                                                 |
|---------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Single        | Uses a single exposure for all objects. Used when the surface is uniform and is the same for all targets.                                                   |
| Dynamic       | Automatically adjusts the exposure after each frame. Used when the target surface varies between scans.                                                     |
| Multiple      | Uses multiple exposures to create a single profile. Used when the target surface has a varying reflectance within a single profile (e.g., white and black). |

Video mode lets you see how the laser line appears on the camera and identify any stray light or ambient light problems. When exposure is tuned correctly, the laser should be clearly visible along the entire length of the viewer. If it is too dim, increase the exposure value; if it is too bright decrease exposure value.

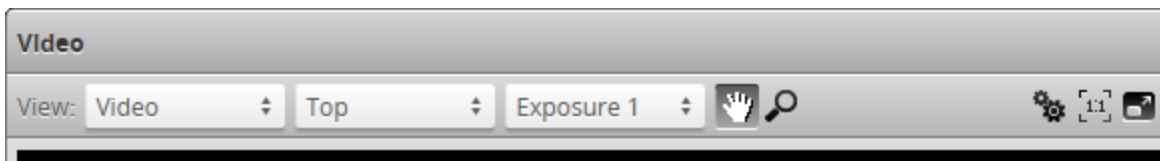


*Under-exposure:  
Laser line is not detected.  
Increase the exposure value.*



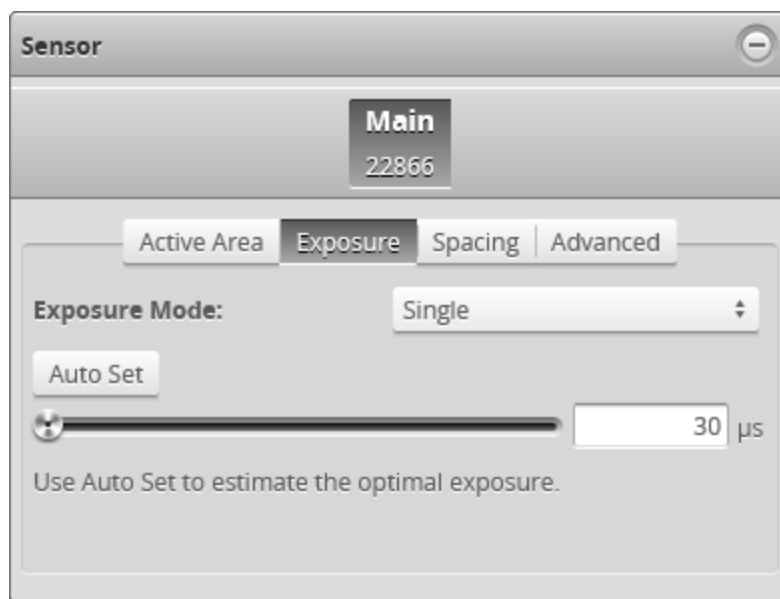
*Over-exposure:  
Laser line is too bright.  
Decrease the exposure value.*

When the Gocator is in Multiple exposure mode, select which exposure to view using the drop-down box next to "View" in the data viewer. This drop-down is only visible in Video scan mode when the **Multiple** option is selected in the **Exposure** section in the **Sensor** panel.



## Single Exposure

The sensor uses a fixed exposure in every scan. Single exposure is used when the target surface is uniform and is the same for all parts.



*To enable single exposure:*

1. Place a representative target in view of the sensor.  
The target surface should be similar to the material that will normally be measured.
2. Go to the **Scan** page.
3. Expand the **Sensor** panel by clicking on the panel header or the  button.
4. Click the button corresponding to the sensor you want to configure.  
The button is labeled **Top**, **Bottom**, **Top-Left**, or **Top-Right**, depending on the system.  
Exposure is configured separately for each sensor.
5. Click the **Exposure** tab.
6. Select **Single** from the **Exposure Mode** drop-down.
7. Edit the exposure setting by using the slider or by manually entering a value.  
You can automatically tune the exposure by pressing the **Auto Set** button, which causes the sensor to turn on and tune the exposure time.

8. Run the sensor and check that laser profiling is satisfactory.

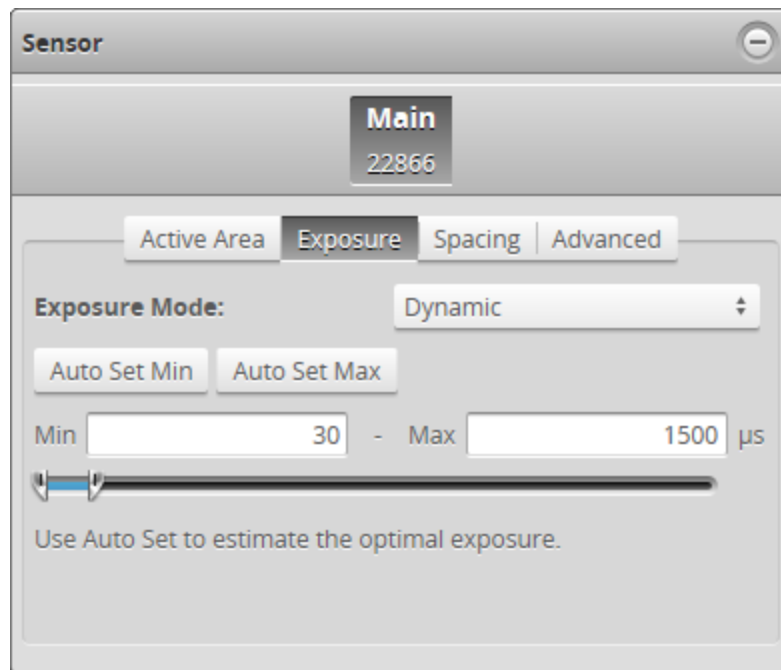
If laser profiling is not satisfactory, adjust the exposure values manually. Switch to **Video** mode to use video to help tune the exposure; see *Exposure* on page 103 for details.

## Dynamic Exposure

The sensor automatically uses past profile information to adjust the exposure for subsequent exposures to yield the best profile. This is used when the target surface changes from exposure to exposure (that is, from scan to scan).



You can tune settings that control the exposure that is chosen by dynamic exposure in the [Material](#) tab.



*To enable dynamic exposure:*

1. Go to the **Scan** page.
2. Expand the **Sensor** panel by clicking on the panel header or the  button.
3. Click the button corresponding to the sensor you want to configure.  
The button is labeled **Top**, **Bottom**, **Top-Left**, or **Top-Right**, depending on the system.  
Exposure is configured separately for each sensor.
4. Click the **Exposure** tab.
5. Select **Dynamic** from the **Exposure Mode** drop-down.
6. Set the minimum and maximum exposure.

The auto-set function can be used to automatically set the exposure. First, place the brightest target in the field of view and press the **Auto Set Min** button to set the minimum exposure. Then, place the darkest target in the field of view and press the **Auto Set Max** button to set the maximum exposure.

7. Run the sensor and check that laser profiling is satisfactory.

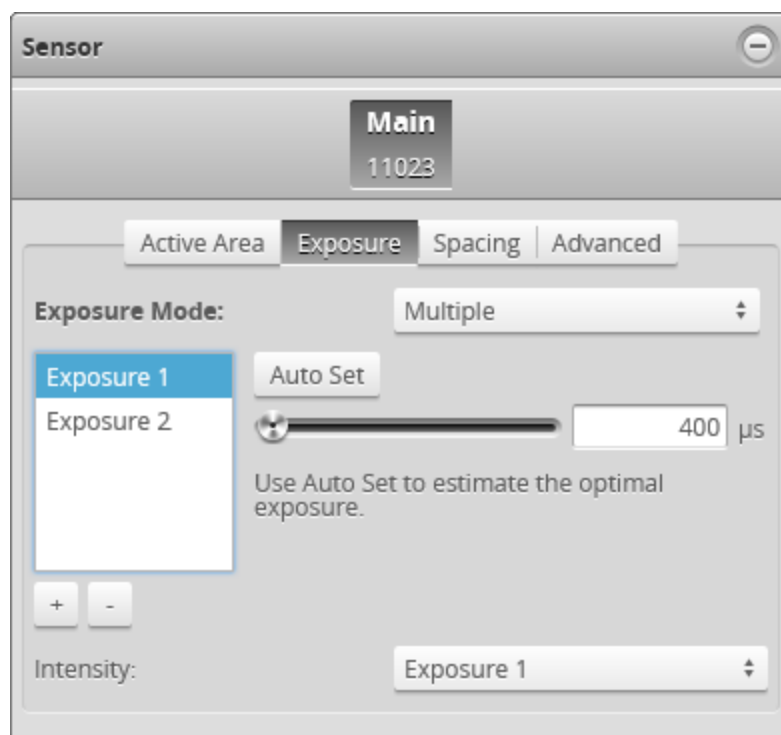
If laser profiling is not satisfactory, adjust the exposure values manually. Switch to **Video** mode to use video to help tune the exposure; see *Exposure* on page 103 for details.

## Multiple Exposure

The sensor combines data from multiple exposures to create a single laser profile. Multiple exposures can be used to increase the ability to detect light and dark materials that are in the field of view simultaneously.

Up to five exposures can be defined with each set to a different exposure level. For each exposure, the sensor will perform a complete scan at the current frame rate making the effective frame rate slower. For example, if two exposures are selected, then the speed will be half of the single exposure frame rate. The sensor will perform a complete multi-exposure scan for each external input or encoder trigger.

The resulting profile is a composite created by combining data collected with different exposures. The sensor will choose profile data that is available from the lowest-numbered exposure step. It is recommended to use a larger exposure for higher-numbered steps.



If you have enabled intensity in the **Scan Mode** tab, you can use the **Intensity** setting to choose which of the exposures Gocator uses for acquiring intensity data. This lets you choose the exposure that produces the best image for intensity data.

*To enable multiple exposure:*

1. Go to the **Scan** page.
2. Expand the **Sensor** panel by clicking on the panel header or the  button.
3. Click the button corresponding to the sensor you want to configure.

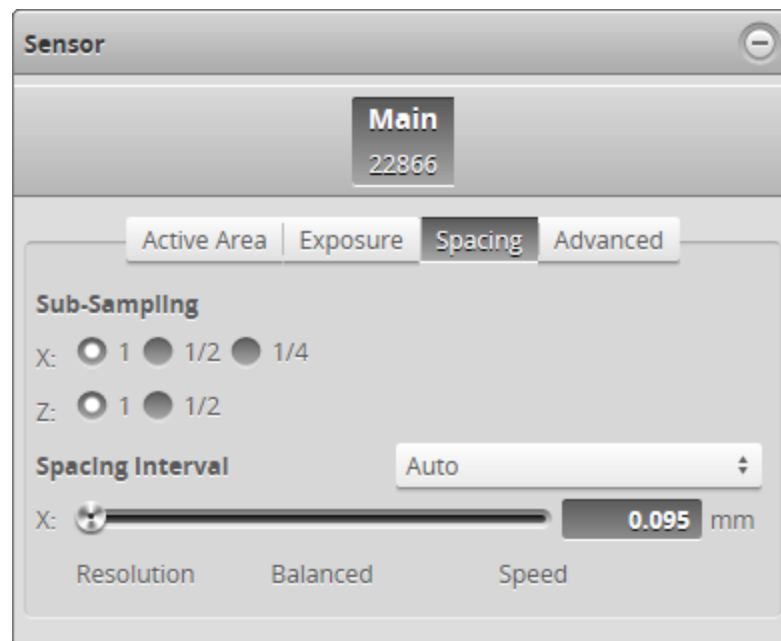
The button is labeled **Top**, **Bottom**, **Top-Left**, or **Top-Right**, depending on the system.

Exposure is configured separately for each sensor.

4. Click the **Exposure** tab.
5. Select **Multiple** from the **Exposure Mode** drop-down.
6. Click the  button to add an exposure step.  
Up to a maximum of five exposure settings can be added.  
To remove an exposure, select it in the exposure list and click the  button
7. Set the exposure level for each exposure to make the Gocator's camera less or more sensitive, as required.
8. If **Acquire Intensity** is enabled in **Scan Mode**, select the exposure that is used to capture the intensity output.
9. Run the sensor and check that laser profiling is satisfactory.  
If laser profiling is not satisfactory, adjust the exposure values manually. Switch to **Video** mode to use video to help tune the exposure; see *Exposure* on page 103 for details.

## Spacing

The **Spacing** tab lets you configure settings related to spacing (sub-sampling and spacing interval).



### Sub-Sampling

Sub-sampling reduces the number of camera columns or rows that are used for laser profiling, reducing the resolution. Reducing the resolution increases speed or reduces CPU usage while maintaining the sensor's field of view. Sub-sampling can be set independently for the X axis and Z axis.

The **X** sub-sampling setting is used to decrease the profile's X resolution to decrease sensor CPU usage. The **X** setting works by reducing the number of image columns used for laser profiling.



The **1/4** sub-sampling setting is not available on Gocator 2100 series sensors.

The **Z** sub-sampling setting is used to decrease the profile's Z resolution to increase speed. The **Z** setting works by reducing the number of image rows used for laser profiling.

Sub-sampling values are expressed as fractions in the Web interface. For example, an X sub-sampling value of 1/2 indicates that every second camera column will be used for laser profiling.



The **CPU Load** bar at the top of the interface displays how much the CPU is being used.



Both the X and the Z sub-sampling settings must be decreased to increase speed.

*To configure X or Z sub-sampling:*

1. Go to the **Scan** page.
2. Expand the **Sensor** panel by clicking on the panel header or the  button.
3. Click the button corresponding to the sensor you want to configure.  
The button is labeled **Top**, **Bottom**, **Top-Left**, or **Top-Right**, depending on the system.  
X and Z sub-sampling is configured separately for each sensor.
4. Click the **Spacing** tab.
5. Select an X or Z sub-sampling value.
6. Save the job in the **Toolbar** by clicking the **Save** button .
7. Check that laser profiling is satisfactory.

## Spacing Interval

Spacing interval is the spacing between data points in resampled data. (In Profile mode, resampled data is only produced if the **Uniform Spacing** option in the **Scan Mode** panel is checked.) A larger interval creates profiles with lower X resolution, reduces CPU usage, and potentially increases the maximum frame rate. A larger interval also reduces the data output rate. For more information on resampled data, see *Uniform Spacing (Data Resampling)* on page 53.



The **Uniform Spacing** option must be checked in the **Scan Mode** panel for the **Spacing Interval** option to be displayed.

You can set the spacing interval either to one of three presets or set a custom value.

*To configure the spacing interval:*

1. Go to the **Scan** page.
2. Choose Profile or Surface mode in the **Scan Mode** panel.  
If one of these modes is not selected, you will not be able to configure the spacing interval.
3. Expand the **Sensor** panel by clicking on the panel header or the  button.
4. Click the button corresponding to the sensor you want to configure.  
The button is labeled **Top**, **Bottom**, **Top-Left**, or **Top-Right**, depending on the system.  
Spacing is configured separately for each sensor.
5. Click the **Spacing** tab.



6. Do one of the following:

- Choose **Auto** and move the slider to one of the following values:

**Speed:** Uses the lowest X resolution within the active area as the spacing interval. This setting minimizes CPU usage and data output rate, but the profile has the lowest X resolution (i.e., least detail).

**Balanced:** Uses the X resolution at the middle of the active area as the spacing interval. This setting balances CPU load, data output rate, and X resolution.

**Resolution:** Uses the highest X resolution within the active area as the spacing interval. This setting maximizes resolution but has higher CPU load and has the highest data output rate (i.e., greatest detail).

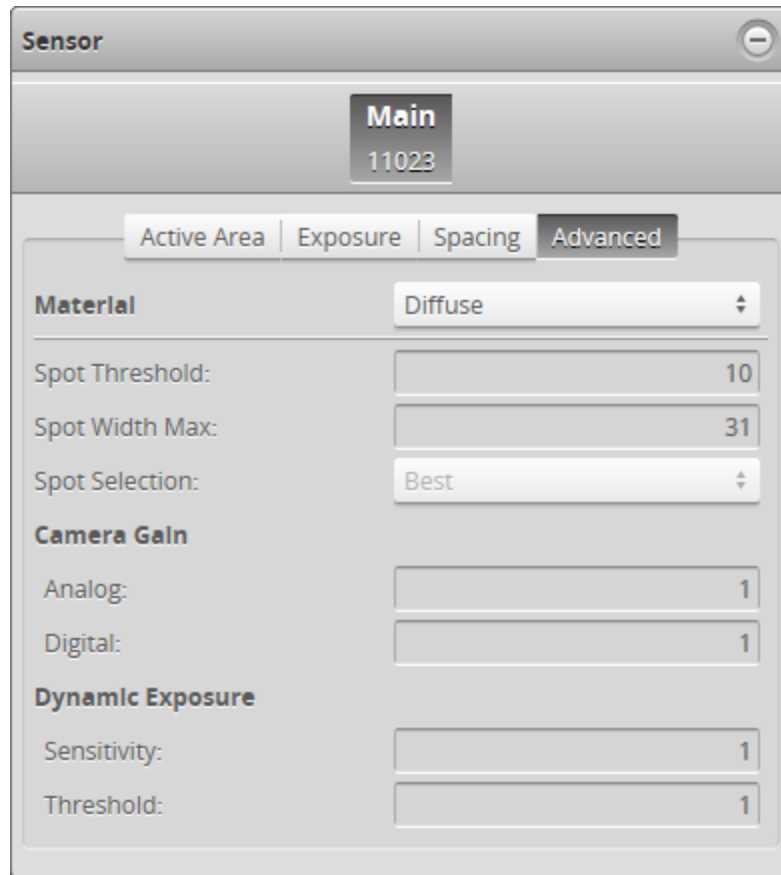
- Choose **Custom** and move the slider to a precise value.

7. Select a spacing interval level.

8. Save the job in the **Toolbar** by clicking the **Save** button .

## Advanced

The Advanced tab contains settings to configure material characteristics, camera gain, and dynamic exposure.



The screenshot shows the 'Sensor' window with the 'Main' tab selected, displaying the 'Advanced' sub-tab. The window has a title bar with a minus button. Below the title bar, the 'Main' tab is active, showing the ID '11023'. The 'Advanced' sub-tab is selected, showing settings for Material, Camera Gain, and Dynamic Exposure.

| Material         | Diffuse |
|------------------|---------|
| Spot Threshold:  | 10      |
| Spot Width Max:  | 31      |
| Spot Selection:  | Best    |
| Camera Gain      |         |
| Analog:          | 1       |
| Digital:         | 1       |
| Dynamic Exposure |         |
| Sensitivity:     | 1       |
| Threshold:       | 1       |

To configure advanced settings:

1. Go to the **Scan** page.
2. Switch to Video mode.
3. Expand the **Sensor** panel by clicking on the panel header or the  button.
4. If you are configuring a dual- or multi-sensor system, click the button corresponding to the sensor you want to configure.  
The button is labeled **Top**, **Bottom**, **Top-Left**, or **Top-Right**, depending on the system.  
Settings can be configured separately for each sensor.
5. Click on the **Advanced** tab.
6. Configure material characteristics, camera gain, or dynamic exposure.  
See *Material* below and *Camera Gain and Dynamic Exposure* on the next page for more information.
7. Save the job in the **Toolbar** by clicking the **Save** button .
8. Check that scan data is satisfactory.

## Material

Profile data acquisition can be configured to suit different types of target materials. This helps maximize the number of useful profile points produced. For many targets, changing the setting is not necessary, but it can make a great difference with others.

For Gocator 2380 sensors (revision B or later), use the **Sensitivity Compensation** setting (not shown below) to make the sensitivity of the sensor compatible with revision A sensors. This setting is enabled by default.

Various settings can affect how the **Material** settings behave. See *Spots and Dropouts* on page 130 for more information.

Preset material types can be selected in the **Materials** setting under the **Advanced** tab.

When **Materials** is set to **Custom**, the following settings can be configured:

| Setting        | Description                                                                                                                                                                                                                                                                                                                                                                           |
|----------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Spot Threshold | The minimum increase in intensity level between neighbouring pixels for a pixel to be considered the start of a potential spot.<br><br>This setting is important for filtering false profile spots generated by sunlight reflection.                                                                                                                                                  |
| Spot Width Max | The maximum number of pixels a spot is allowed to span.<br><br>This setting can be used to filter out data caused by background light if the unwanted light is wider than the laser and does not merge into the laser itself. A lower <b>Spot Width Max</b> setting reduces the chance of false detection, but limits the ability to detect features/surfaces that elongate the spot. |
| Spot Selection | Determines the spot selection method.<br><br><b>Best</b> selects the strongest spot in a given column on the imager.                                                                                                                                                                                                                                                                  |

| Setting | Description                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    |
|---------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
|         | <p><b>Top</b> selects the topmost spot or the one farthest to the left on the imager, and <b>Bottom</b> selects the bottommost spot or the one farthest to the right on the imager. These options can be useful in applications where there are reflections, flying sparks or smoke that are always on one side of the laser.</p> <p><b>None</b> performs no spot filtering. If multiple spots are detected in an imager column, they are left as is. This option is only available if <b>Uniform Spacing</b> is disabled in the <b>Scan Mode</b> panel on the <b>Scan</b> page; for more information on uniform spacing, see <i>Uniform Spacing (Data Resampling)</i> on page 53.</p> <p><b>Continuity</b> considers adjacent horizontal data points on the imager to place spots on pixels, giving preference to more complete profile segments. The setting can improve scans in the presence of reflections and noise.</p> |

## Camera Gain and Dynamic Exposure

You can set camera gain and dynamic exposure to improve data acquisition.

| Setting          | Description                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         |
|------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Camera Gain      | <p><b>Analog</b> camera gain can be used when the application is severely exposure limited, yet dynamic range is not a critical factor.</p> <p><b>Digital</b> camera gain can be used when the application is severely exposure limited, yet dynamic range is not a critical factor.</p>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            |
| Dynamic Exposure | <p><b>Sensitivity</b> controls the exposure that dynamic exposure converges to. The lower the value, the lower the exposure Gocator will settle on.</p> <p>The trade-off is between the number of underexposed spots and the possibility of over-exposing.</p> <p><b>Threshold</b> is the minimum number of spots for dynamic exposure to consider the profile point that make up the spot valid. If the number of spots is below this threshold, the algorithm will walk over the allowed exposure range slowly to find the correct exposure. Because this is slow, the <b>Threshold</b> value typically should be kept as low as possible, so this slow search is not used.</p> <p>These settings let you set tune how dynamic exposure settles on an exposure for a scan. For more information on Dynamic Exposure, see <i>Dynamic Exposure</i> on page 105.</p> |

## Alignment

Gocator sensors are pre-calibrated and ready to deliver profiles in engineering units (mm) out of the box. However, alignment procedures are required to compensate for sensor mounting inaccuracies, to align multiple sensors into a common coordinate system, and to determine the resolution (with encoder) and speed of the transport system. Alignment is performed using the **Alignment** panel on the **Scan** page.

Once alignment has been completed, the derived transformation values are displayed under **Transformations** in the **Sensor** panel; see *Transformations* on page 102 for details.

## Alignment States

A Gocator can be in one of two alignment states: Unaligned and Aligned.

### Alignment State

| State     | Explanation                                                                                                                                                                                                                                                                         |
|-----------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Unaligned | The sensor or sensor system is not aligned. Profiles are reported in sensor coordinates.                                                                                                                                                                                            |
| Aligned   | The sensor is aligned using the alignment procedure (see <i>Aligning Sensors</i> on the next page) or by manually modifying the values under <b>Transformation</b> in the <b>Sensor</b> tab on the <b>Scan</b> page (for more information, see <i>Transformations</i> on page 102). |

An indicator on the **Alignment** panel display ALIGNED or UNALIGNED, depending on the Gocator's state.

## Alignment Types

Gocator sensors support two types of alignment: stationary or moving.

| Type       | Description                                                                                                                                                                                        |
|------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Stationary | <b>Stationary</b> is used when the sensor mounting is constant over time and between scans, for example, when the sensor is mounted in a permanent position over a conveyor belt.                  |
| Moving     | <b>Moving</b> is used when the sensor's position relative to the object scanned is always changing, for example, when the sensor is mounted on a robot arm moving to different scanning locations. |

## Alignment: with and without Encoder Calibration

For systems that use an encoder, encoder calibration can be performed while aligning sensors. The table below summarizes the differences between performing alignment with and without encoder calibration.

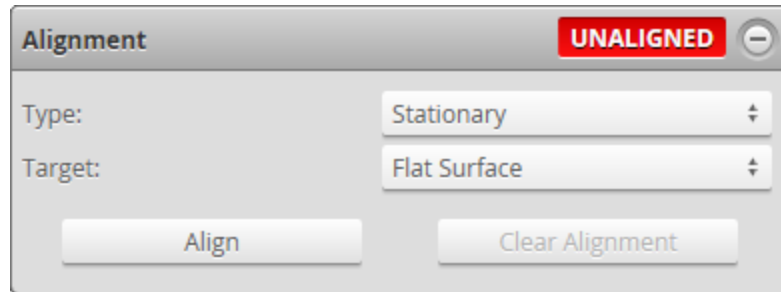
|                                 | With encoder calibration            | Without encoder calibration     |
|---------------------------------|-------------------------------------|---------------------------------|
| <b>Target Type</b>              | Calibration disk or calibration bar | Flat surface or calibration bar |
| <b>Target/Sensor Motion</b>     | Linear motion                       | Stationary                      |
| <b>Calibrates Tilt</b>          | Yes                                 | Yes                             |
| <b>Calibrates Z axis Offset</b> | Yes                                 | Yes                             |
| <b>Calibrates X axis Offset</b> | Yes                                 | Yes (Calibration bar required)  |
| <b>Calibrates Encoder</b>       | Yes                                 | No                              |
| <b>Calibrates Travel Speed</b>  | Yes                                 | No                              |

See *Coordinate Systems* on page 49 for definitions of coordinate axes. See *Calibration Targets* on page 26 for descriptions of calibration disks and bars.

See *Aligning Sensors* on the next page for the procedure to perform alignment. After alignment, the coordinate system for laser profiles will change from sensor coordinates to system coordinates.

## Aligning Sensors

Alignment can be used to compensate for mounting inaccuracies by aligning sensor data to a common reference surface (often a conveyor belt).



The screenshot shows a software window titled "Alignment". In the top right corner, there is a red button labeled "UNALIGNED". Below the title bar, there are two dropdown menus. The first is labeled "Type:" and has "Stationary" selected. The second is labeled "Target:" and has "Flat Surface" selected. At the bottom of the window, there are two buttons: "Align" and "Clear Alignment".

*To prepare for alignment:*

1. Choose an alignment reference in the **Manage** page if you have not already done so. See *Alignment Reference* on page 81 for more information.
2. Go to the **Scan** page.
3. Choose Profile or Surface mode in the **Scan Mode** panel, depending on the type of measurement whose decision you need to configure.  
If one of these modes is not selected, tools will not be available in the **Measure** panel.
4. Expand the **Alignment** panel by clicking on the panel header or the  button.
5. Ensure that all sensors have a clear view of the target surface.  
Remove any irregular objects from the sensor's field of view that might interfere with alignment. If using a bar for a dual- or multi-sensor system, ensure that the lasers illuminate a reference hole on the bar.

*To perform alignment for stationary targets:*

1. In the **Alignment** panel, select **Stationary** as the **Type**.
2. Clear the previous alignment if present.  
Press the **Clear Alignment** button to remove an existing alignment.s
3. Select an alignment **Target**.
  - Select **Flat Surface** to use the conveyor surface (or other flat surface) as the alignment reference
  - Select **Bar** to use a custom calibration bar. If using a calibration bar, specify the bar dimensions and reference hole layout. See *Calibration Targets* on page 26 for details.

Configure the characteristics of the target.

4. Place the target under the sensor
5. Click the **Align** button.  
The sensors will start, and the alignment process will take place. Alignment is performed simultaneously for all sensors. If the sensors do not align, check and adjust the exposure settings (page 103).



Alignment uses the exposure defined for single exposure mode, regardless of the current exposure mode.

6. Use **Profile** mode to inspect alignment results.  
Laser profiles from all sensors should now be aligned to the alignment target surface. The base of the alignment target (or target surface) provides the origin for the system Z axis.

*To perform alignment for moving targets:*

1. Do one of the following if you have not already done so.
  - If the system uses an encoder, configure encoder resolution. See *Encoder Resolution* on page 82 for more information.
  - If the system does not use an encoder, configure travel speed. See *Travel Speed* on page 82 for more information.
2. In the **Alignment** panel, select **Moving** as the **Type**.
3. Clear the previous alignment if present.  
Press the **Clear Alignment** button to remove an existing alignment.
4. Select an alignment **Target**.
  - Select one of the disk **Disk** options to use a disk as the alignment reference.
  - Select **Bar** to use a custom calibration bar. If using a calibration bar, specify the bar dimensions and reference hole layout. See *Calibration Targets* on page 26 for details.

Configure the characteristics of the target.

5. Place the target under the sensor
6. If the system uses an encoder and you want to calibrate it, check the **Encoder Calibration** checkbox.
7. Click the **Align** button.  
The sensors will start and then wait for the calibration target to pass through the laser plane.  
Alignment is performed simultaneously for all sensors. If the sensors do not align, check and adjust the exposure settings (page 103).

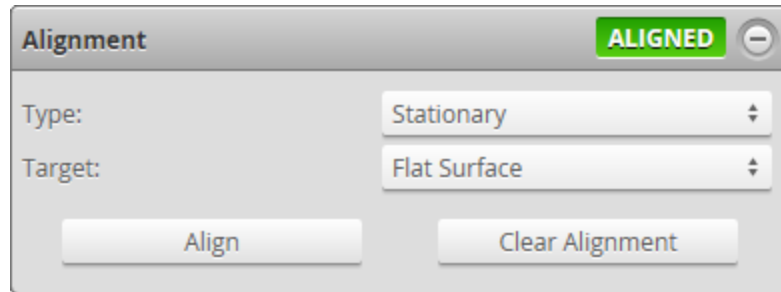
 Alignment uses the exposure defined for single exposure mode, regardless of the current exposure mode

8. Engage the transport system.  
When the calibration target has passed completely through the laser plane, the calibration process will complete automatically. To properly calibrate the travel speed, the transport system must be running at the production operating speed before the target passes through the laser plane.
9. Use **Profile** mode to inspect alignment results.  
Laser profiles from all sensors should now be aligned to the alignment target surface. The base of the alignment target (or target surface) provides the origin for the system Z axis.

 When using an alignment bar, there can be at most one hole in each sensor's field of view.

## Clearing Alignment

Alignment can be cleared to revert the sensor to sensor coordinates.



*To clear alignment:*

1. Go to the **Scan** page.
2. Choose Profile or Surface mode in the **Scan Mode** panel, depending on the type of measurement whose decision you need to configure.  
If one of these modes is not selected, tools will not be available in the **Measure** panel.
3. Expand the **Alignment** panel by clicking on the panel header or the  button.
4. Click the **Clear Alignment** button.  
The alignment will be erased and sensors will revert to using sensor coordinates.

## Filters

Filters are used to post-process scan data along the X or Y axis to remove noise or clean it up before it is output or is used by measurement tools.

The following types of filters are supported:

| Filter      | Description                                                                                                                                                                                                                                                                 |
|-------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Gap Filling | Fills in missing data caused by occlusions using information from the nearest neighbors. Gap filling also fills gaps where no data is detected, which can be due to the surface reflectivity, for example dark or specular surface areas, or to actual gaps in the surface. |
| Median      | Substitutes the value of a data point with the median within a specified window around the data point.                                                                                                                                                                      |
| Smoothing   | Applies moving window averaging to reduce random noise.                                                                                                                                                                                                                     |
| Decimation  | Reduces the number of data points.                                                                                                                                                                                                                                          |

Filters are applied in the order displayed in the table above. The filters are configured in the **Filters** panel on the **Scan** page.

## Gap Filling

Gap filling works by filling in missing data points using either the lowest values from the nearest neighbors or linear interpolation between neighboring values (depending on the Z difference between neighboring values), in a specified X or Y window. The sensor can fill gaps along both the X axis and the Y axis. X gap filling works by filling in the gaps within the same profile. Y gap filling works by filling in gaps in the direction of travel at each X location.



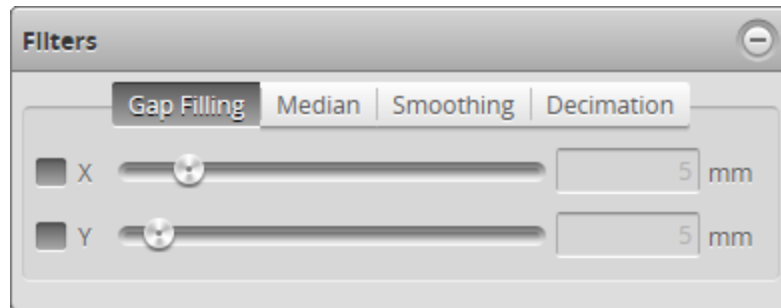
If both X and Y gap filling are enabled, missing data is filled along the X and Y axes at the same time, using the available neighboring data.



In Profile mode, Gap Filling is limited to the X axis. (The Y setting is not available.)



X Gap Filling is enabled by default



*To configure X or Y gap filling:*

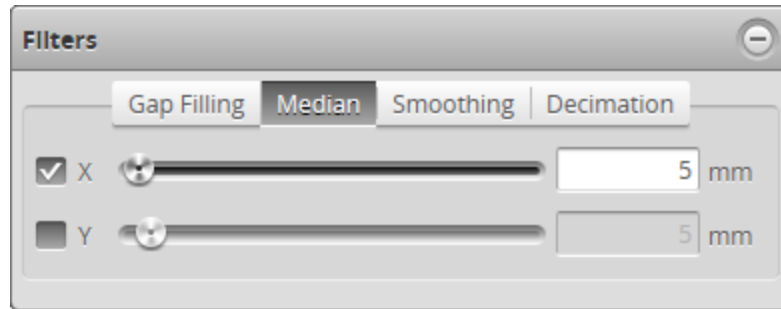
1. Go to the **Scan** page.
2. Choose Profile or Surface mode in the **Scan Mode** panel.  
If one of these modes is not selected, you will not be able to configure gap filling.
3. Expand the **Filters** panel by clicking on the panel header or the button.
4. Click on the **Gap Filling** tab.
5. Enable the **X** or **Y** setting and select the maximum width value.  
The value represents the maximum gap width that the Gocator will fill. Gaps wider than the maximum width will not be filled.
6. Save the job in the **Toolbar** by clicking the **Save** button .
7. Check that the laser profiling is satisfactory.

## Median

The Median filter substitutes the value of a data point with the median calculated within a specified window around the data point.



Missing data points will not be filled with the median value calculated from data points in the neighbourhood.



*To configure X or Y median:*

1. Go to the **Scan** page.
2. Choose Profile or Surface mode in the **Scan Mode** panel.  
If one of these modes is not selected, you will not be able to configure the median filter.
3. Expand the **Filters** panel by clicking on the panel header or the button.
4. Click on the **Median** tab.
5. Enable the **X** or **Y** setting and select the maximum width value.
6. Save the job in the **Toolbar** by clicking the **Save** button .
7. Check that the laser profiling is satisfactory.

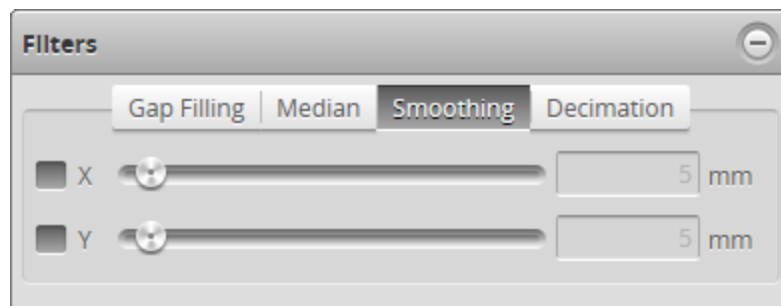
## Smoothing

Smoothing works by substituting a data point value with the average value of that data point and its nearest neighbors within a specified window. Smoothing can be applied along the X axis or the Y axis. X smoothing works by calculating a moving average across samples within the same profile. Y smoothing works by calculating a moving average in the direction of travel at each X location.

If both X and Y smoothing are enabled, the data is smoothed along X axis first, then along the Y axis.



Missing data points will not be filled with the mean value calculated from data points in the neighbourhood.



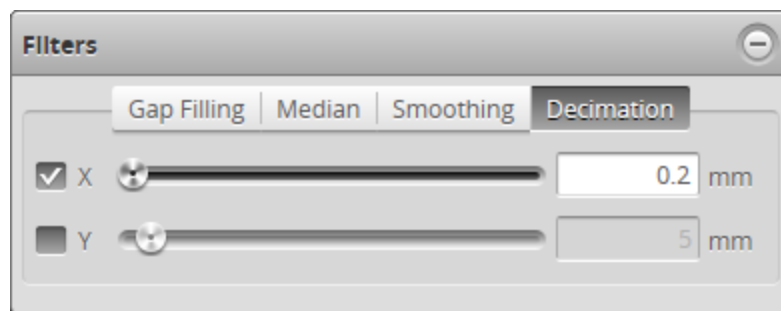
*To configure X or Y smoothing:*

1. Go to the **Scan** page.

2. Choose Profile or Surface mode in the **Scan Mode** panel.  
If one of these modes is not selected, you will not be able to configure smoothing.
3. Expand the **Filters** panel by clicking on the panel header or the  button.
4. Click on the **Smoothing** tab.
5. Enable the **X** or **Y** setting and select the averaging window value.
6. Save the job in the **Toolbar** by clicking the **Save** button .
7. Check that the laser profiling is satisfactory.

## Decimation

Decimation reduces the number of data points along the X or Y axis by choosing data points at the end of a specified window around the data point. For example, by setting X to .2, only points every .2 millimeters will be used.



*To configure X or Y decimation:*

1. Go to the **Scan** page.
2. Choose Profile or Surface mode in the **Scan Mode** panel.  
If one of these modes is not selected, you will not be able to configure the decimation filter.
3. Expand the **Filters** panel by clicking on the panel header or the  button.
4. Click on the **Decimation** tab.
5. Enable the **X** or **Y** setting and select the decimation window value.
6. Save the job in the **Toolbar** by clicking the **Save** button .
7. Check that the laser profiling is satisfactory.

## Surface Generation

The sensor can generate a surface by combining a series of profiles gathered along the direction of travel.

The sensor uses different methods to generate a surface, depending on the needs of the application. Surface generation is configured in the **Surface Generation** panel on the **Scan** page.

**Surface Generation**

Type: Continuous

\*Part Detection is enabled

**Surface Generation**

Type: Fixed Length

Start Trigger: Sequential

Length: 100 mm

**Surface Generation**

Type: Variable Length

Max Length: 100 mm

**Surface Generation**

Type: Rotational

Encoder Resolution: 360 ticks/rev

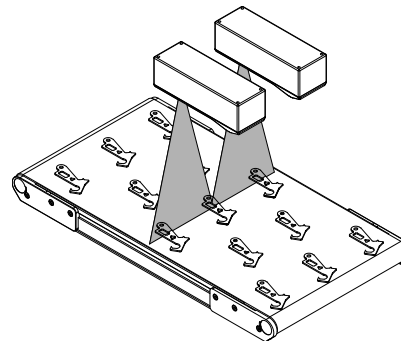
\* Assuming one millimeter per degree.

The types in the table below correspond to the **Type** setting in the panel.

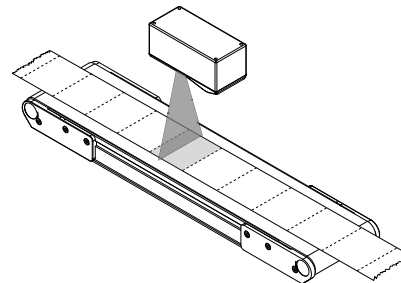


When **Type** is set to **Continuous**, part detection is automatically enabled. When **Type** is set to any of the other settings, part detection can be enabled and disabled in the **Part Detection** panel. For descriptions of the settings that control part detection logic, *Part Detection* on page 123.

**Continuous:** The sensor continuously generates surfaces of parts that are detected under the sensor. This type is typically used when the transport system continuously feeds material or parts under a sensor. The materials have a distinguishable start and stop edge.



**Fixed Length:** The sensor generates surfaces of a fixed length (in mm) using the value in the **Length** setting. Like Continuous mode, Fixed Length mode is used when material or parts continuously pass under the sensor. Unlike Continuous mode, parts/material do not have distinguishable start and stop edge.



For correct length measurement, you should ensure that motion is calibrated (that is, encoder resolution for encoder triggers or travel speed time triggers).

Two types of start triggers are

available:

- **Sequential:** Continuously generates back-to-back fixed length surfaces.
- **External Input:** A pulse on the digital input triggers the generation of a single surface of fixed length.

For more information on connecting external input to a Gocator sensor, see *Digital Input* on page 561.

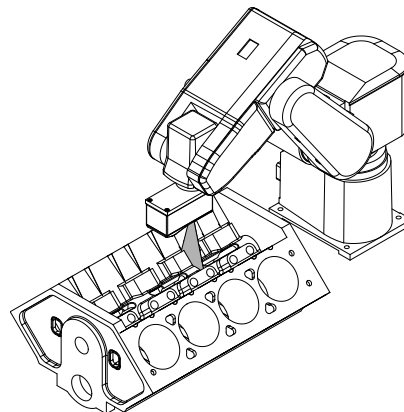
You can optionally enable part detection to process the **profile** surface after it has been generated, but the generation itself does not depend on the detection logic. To do this, check **Enabled** in the **Part Detection** panel.

**Variable Length:** The sensor generates surfaces of variable length. Profiles collected while the external digital input is held high are combined to form a surface. If the value of the **Max Length** setting is reached while external input is still high, the next surface starts immediately with the next profile. This mode is typically used in robot-mounted applications, for example, measuring different parts on an engine block.

For correct length measurement, you should ensure that motion is calibrated (i.e., encoder resolution for encoder triggers or travel speed for time triggers).

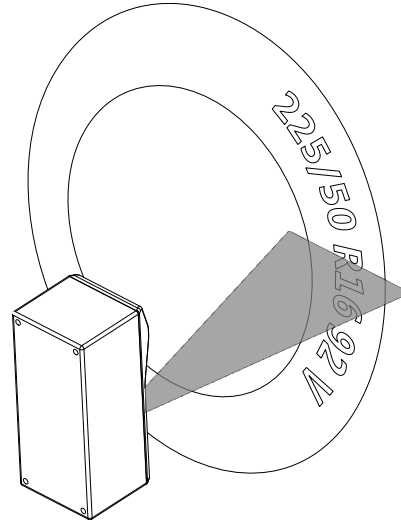
For more information on connecting external input to a Gocator sensor, see *Digital Input* on page 561.

You can optionally enable part detection to process the surface



after it has been generated, but the generation itself does not depend on the detection logic. To do this, check **Enabled** in the **Part Detection** panel.

**Rotational:** The sensor reorders profiles within a surface to be aligned with the encoder's index pulse. That is, regardless of the radial position the sensor is started at, the generated surface always starts at the position of the index pulse. If the index pulse is not detected and the rotation circumference is met, the surface is dropped and the Encoder Index Drop indicator will be incremented. This mode is typically used in applications where measurements of circular objects or shafts need to be taken, such as tire tread inspection, or label positioning on bottles.



To scan exactly one revolution of a circular target without knowing the circumference, manually set the encoder resolution (page 82) to 1, the encoder trigger spacing (page 93) to (number of encoder ticks per revolution) / (number of desired profiles per revolution), and **Encoder Resolution** in the **Surface Generation** panel to the number of encoder ticks per revolution.

You can optionally enable part detection to process the surface after it has been generated, but the generation itself does not depend on the detection logic. To do this, check **Enabled** in the **Part Detection** panel.

*To configure surface generation:*

1. Go to the **Scan** page and choose **Surface** in the **Scan Mode** panel.  
If this mode is not selected, you will not be able to configure surface generation.
2. Expand the **Surface Generation** panel by clicking on the panel header or the  button.
3. Choose an option from the **Type** drop-down and any additional settings.  
See the types and their settings described above.

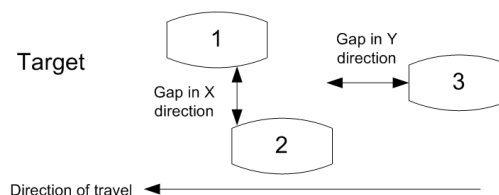
## Part Detection

In Surface mode, the Gocator sensor can analyze the 3D point cloud created from profiles to identify discrete objects. Surface measurements can then be performed on each discrete object. Part detection is configured using the **Part Detection** panel on the **Scan** page.

Part detection must be manually enabled when **Type** is set to **Fixed Length**, **Variable Length**, or **Rotational** in the **Surface Generation** panel. When **Type** is set to **Continuous**, part detection is always enabled.

Part detection can be performed when **Source** in the **Trigger** panel is set to **Time** or **Encoder**. To use the **Time** trigger source, the travel speed must be calibrated. To use the **Encoder** trigger source, the encoder resolution must be calibrated. See *Aligning Sensors* on page 113 for more information.

Multiple parts can pass through the laser at the same time and will be individually tracked. Parts can be separated along the laser line (X axis), in the direction of travel (Y axis), or by gated external input.



Part Detection

Frame Of Reference

Sensor

Part

Height Threshold:

5 mm

Threshold Direction:

Above

Gap Width:

5 mm

Gap Length:

5 mm

Padding Width:

0 mm

Padding Length:

0 mm

Min Area:

5 mm<sup>2</sup>

Max Part Length:

210 mm

☒ Edge Filtering

The following settings can be tuned to improve the accuracy and reliability of part detection.

| Setting             | Description                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  |
|---------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Height Threshold    | <p>Determines the profile height threshold for part detection. The setting for <b>Threshold Direction</b> determines if parts should be detected above or below the threshold. Above is typically used to prevent the belt surface from being detected as a part when scanning objects on a conveyor.</p> <p>In an Opposite layout, the threshold is applied to the difference between the top and the bottom profile. A target thinner than the threshold value is ignored, including places where only one of either top or bottom is detected.</p> <p>To separate parts by gated external input, set the <b>Height Threshold</b> to the active area Z offset (i.e., minimum Z position of the current active area), set <b>Source</b> to <b>Time</b> or <b>Encoder</b> and check the <b>Gate Using External Input</b> checkbox in the <b>Trigger</b> panel (page 93).</p> |
| Threshold Direction | Determines if parts should be detected above or below the height threshold.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  |
| Gap Width           | Determines the minimum separation between objects on the X axis. If parts are closer than the gap interval, they will be merged into a single part.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          |
| Gap Length          | Determines the minimum separation between objects on the Y axis. If parts are closer than the gap interval, they will be merged into a single part.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          |
| Padding Width       | Determines the amount of extra data on the X axis from the surface surrounding the detected part that will be included. This is mostly useful when processing part data with third-party software such as HexSight, Halcon, etc.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             |



| Setting            | Description                                                                                                                                                                                                                                        |
|--------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Padding Length     | Determines the amount of extra data on the Y axis from the surface surrounding the detected part that will be included. This is mostly useful when processing part data with third-party software such as HexSight, Halcon, etc.                   |
| Min Area           | Determines the minimum area for a detected part. Set this value to a reasonable minimum in order to filter out small objects or noise.                                                                                                             |
| Max Part Length    | Determines the maximum length of the part object. When the object exceeds the maximum length, it is automatically separated into two parts. This is useful to break a long object into multiple sections and perform measurements on each section. |
| Frame of Reference | Determines the coordinate reference for surface measurements.                                                                                                                                                                                      |

### Sensor

When **Frame of Reference** is set to **Sensor**, the sensor's frame of reference is used. The way the sensor's frame of reference is defined changes depending on the surface generation **Type** setting ( and *Surface Generation* on page 119 for more information):

- When parts are segmented from a continuous surface (the surface generation **Type** setting is set to **Continuous**), measurement values are relative to a Y origin at the center of the part (the same as for Part frame of reference; see below).
- When parts are segmented from other types of surfaces (the surface generation **Type** setting is set to **Fixed Length**, **Variable Length**, or **Rotational**), measurement values are relative to a Y origin at the center of the surface from which the part is segmented.

The Surface Bounding Box GlobalX and GlobalY measurements (see *Bounding Box* on page 218) are exceptions: regardless of the **Frame of Reference** setting, these measurements produce the Sensor frame of reference values of the Part frame of reference origin (which is the bounding box center), except for GlobalY when parts are segmented from continuous surfaces. In this case the GlobalY value is the Y value relative to the encoder zero position. These values can be used to locate Part frame of reference measurements in a world space.

### Part

When **Frame of Reference** is set to **Part**, all measurements except Bounding Box X and Y are relative to the center of the bounding box of the part. For Bounding Box X and Y, the measurement values are always relative to the sensor frame of reference (see *Bounding Box* on page 218).

|                |                                             |
|----------------|---------------------------------------------|
| Edge Filtering | See <i>Edge Filtering</i> on the next page. |
|----------------|---------------------------------------------|

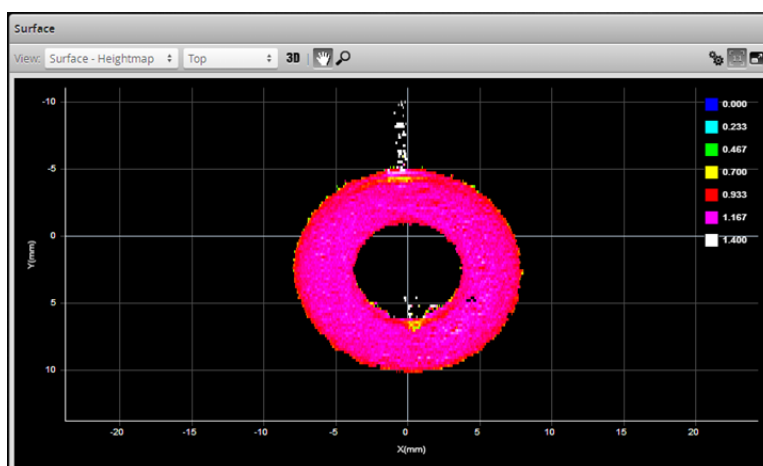
### To set up part detection:

1. Go to the **Scan** page and choose **Surface** in the **Scan Mode** panel.  
If this mode is not selected, you will not be able to configure part detection.
2. Expand the **Part Detection** panel by clicking on the panel header or the  button.

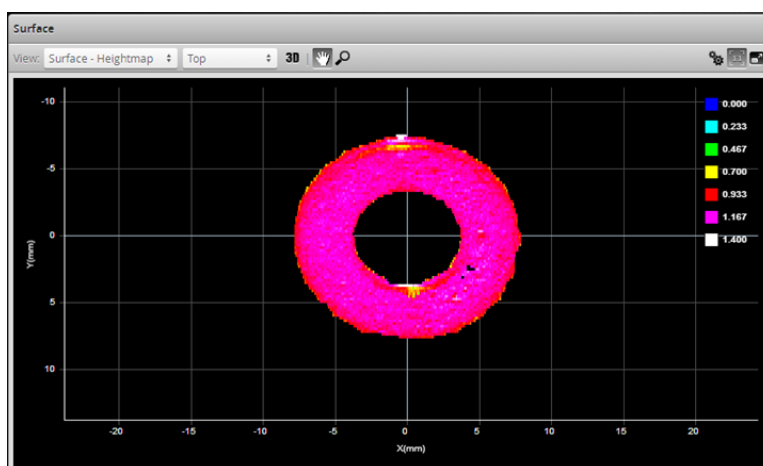
3. If necessary, check the **Enabled** option.  
When **Surface Generation** is set to **Continuous**, part detection is always enabled.
4. Adjust the settings.  
See the part detection parameters above for more information.

## Edge Filtering

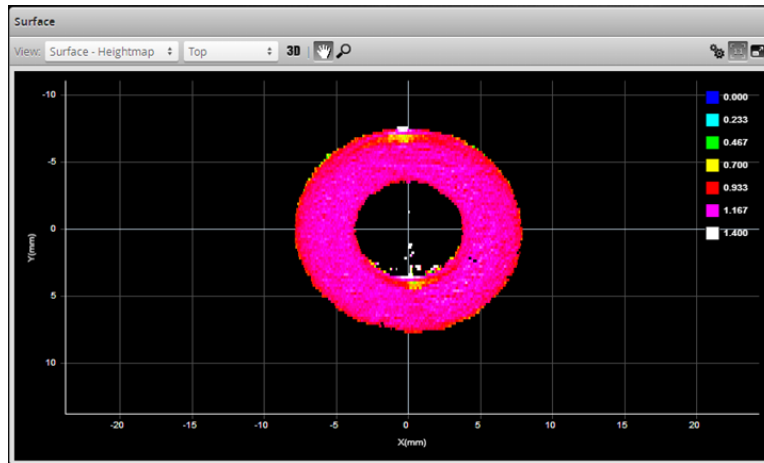
Part scans sometimes contain noise around the edges of the target. This noise is usually caused by the sensor's light being reflected off almost vertical sides, rounded corners, etc. Edge filtering helps reduce edge noise in order to produce more accurate and repeatable volume and area measurements, as well as to improve positioning of relative measurement regions. Optionally, the **Preserve Interior Feature** setting can be used to limit filtering to the outside edges of the target.



*Edge Filtering disabled (scan shows reflection noise)*



*Edge Filtering enabled (reflection noise eliminated or reduced)*



*Edge Filtering enabled, Preserve Interior Feature enabled*

☒ **Edge Filtering**

Preserve Interior Feature: ☐

Width:  mm

Length:  mm

*To configure edge filtering:*

1. Go to the **Scan** page and choose **Surface** in the **Scan Mode** panel.  
If this mode is not selected, you will not be able to configure part detection.
2. Expand the Part Detection panel by clicking on the panel header or the button and enable part detection if necessary.  
Part detection can be enabled and disabled when **Type** in the **Surface Generation** panel is set to **Fixed Length**, **Variable Length**, or **Rotational**. Part detection is automatically enabled when **Type** is set to **Continuous**.
3. Check the **Edge Filtering** checkbox to enable edge filtering.
4. Configure the **Width** and **Length** settings.  
The **Width** and **Length** settings represent the size of the filter on the X axis and the Y axis, respectively.
5. Set the **Preserve Interior Feature** setting if necessary.  
The **Preserve Interior Feature** setting limits filtering to the outside edges of the target.

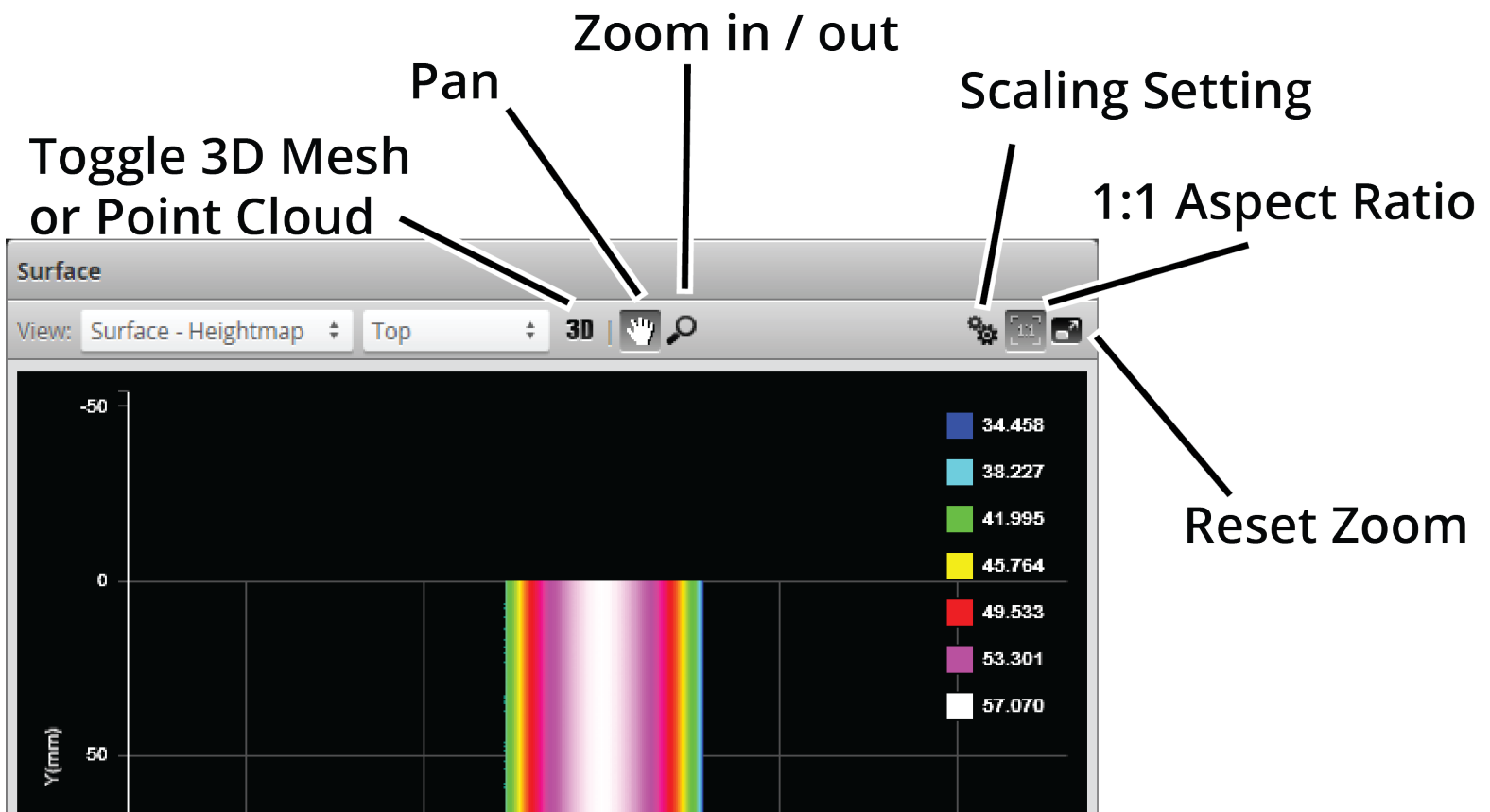
## Data Viewer

The data viewer can display video images, , profiles, sections, surfaces, height maps, and intensity images. It is also used to configure the active area (*Active Area* on page 99) and measurement tools (see *Measurement* on page 161). The data viewer changes depending on the current operation mode and the panel that has been selected.

## Data Viewer Controls

The data viewer is controlled by mouse clicks and by the buttons on the display toolbar. The mouse wheel can also be used for zooming in and out.

Press 'F' when the cursor is in the data viewer to switch to full screen.



## Video Mode

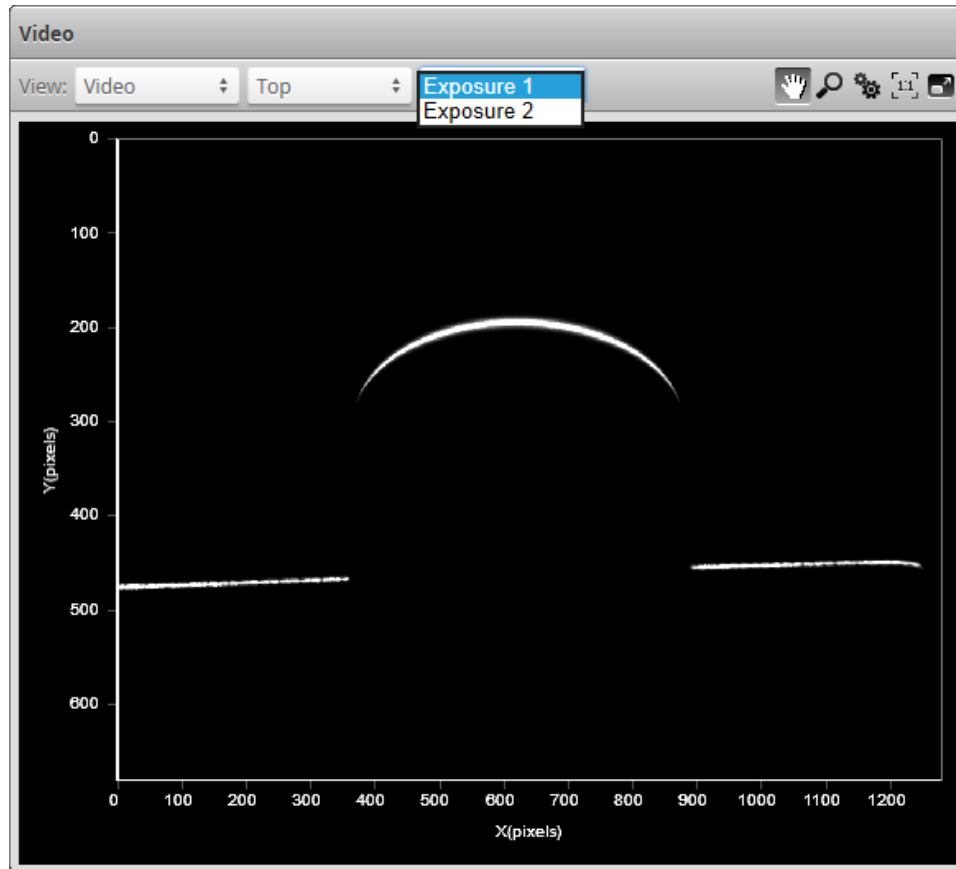
In Video mode, the data viewer displays a camera image. In a dual- or multi-sensor system, camera images from any camera can be displayed. In this mode, you can configure the data viewer to display exposure, spot, and dropout information that can be useful in properly setting up the system for scanning.

### Exposure Information

In Video mode, you can display exposure-related information.

#### Exposures

If you have set **Exposure Mode** to **Multiple**, and have set more than one exposure, a drop-down at the top of the data viewer lists the available exposures. Choosing an exposure changes the view of the data viewer to that exposure.



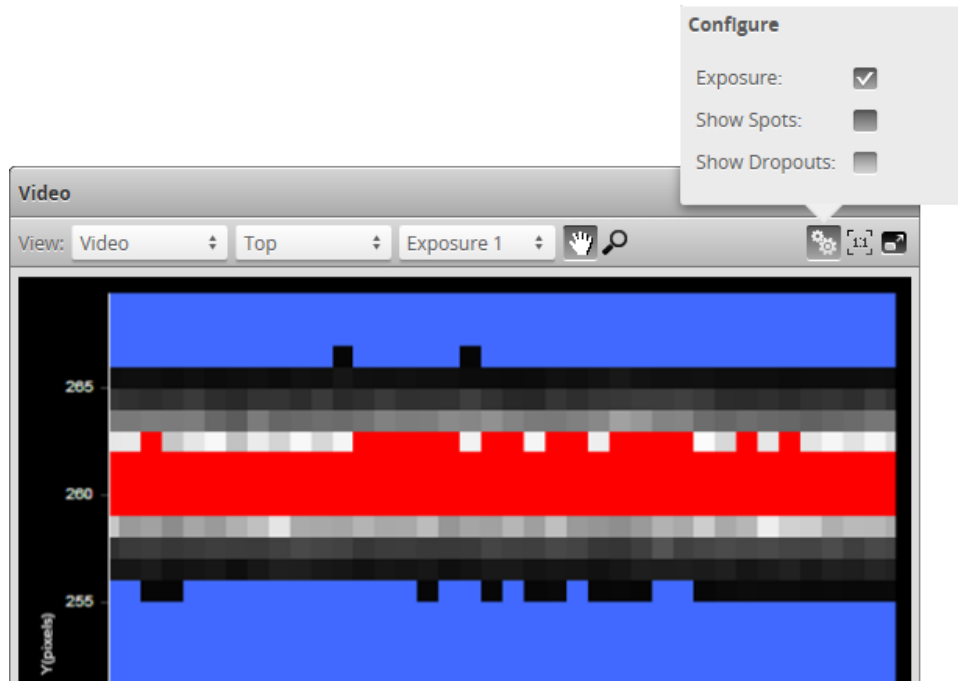
For details on setting exposure in the **Exposure** tab in the **Sensor** panel, see *Exposure* on page 103.

*To select the exposure view of the display:*

1. Go to the **Scan** page and choose **Video** mode in the **Scan Mode** panel.
2. Select the camera view in the data viewer.  
Use the first drop-down list next to **View** at the top of the data viewer to select **Main** or **Buddy**.
3. Select the exposure.  
Use the second drop-down list next to **View** at the top of the data viewer to select the exposure.

### **Overexposure and Underexposure**

You can display a color exposure overlay on the video image to help set the correct exposure.



The **Exposure** setting uses the following colors:

- Blue: Indicates background pixels ignored by the sensor.
- Red: Indicates saturated pixels.

Correct tuning of exposure depends on the reflective properties of the target material and on the requirements of the application. Settings should be carefully evaluated for each application, but often a good starting point is to set the exposure so that there are 2 to 3 red pixels in the center of the laser line.

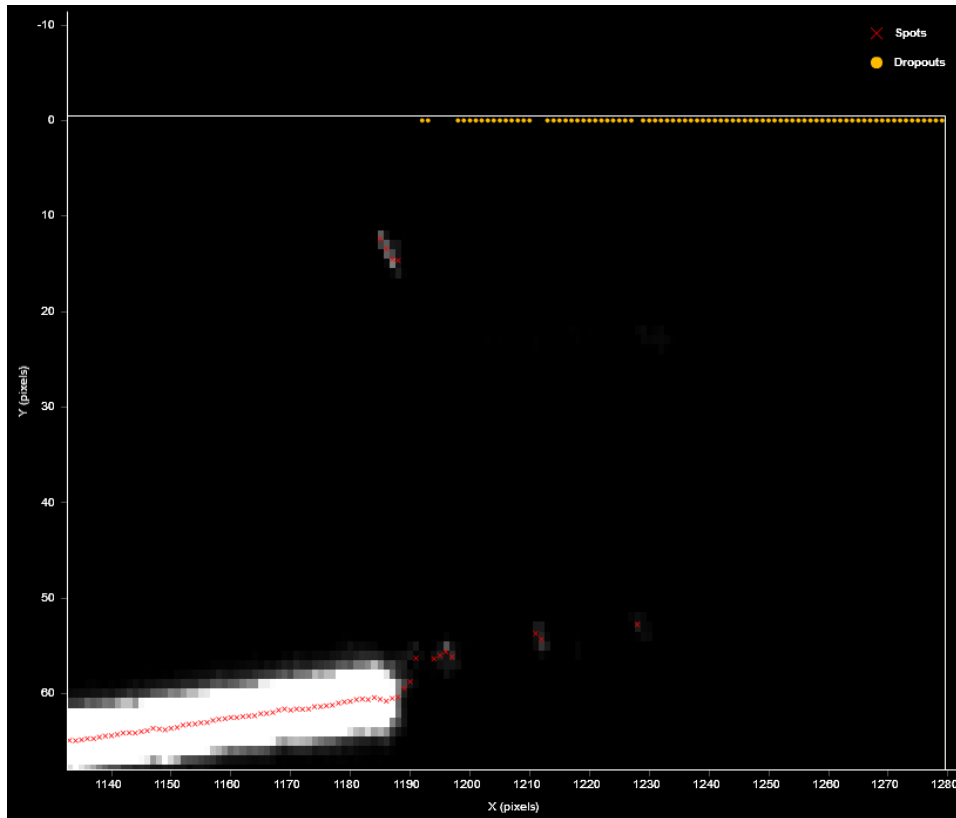
*To display an overlay:*

1. Go to the **Scan** page and choose **Video** mode in the **Scan Mode** panel.
2. Check **Exposure** at the top of the data viewer.

## Spots and Dropouts

Various settings can affect how the **Material** settings behave. In Video mode, you can examine how the **Material** settings are affected. To do this, in Video mode, check the **Show Spots** option at the top of the data viewer to overlay a representation of the spots in the data viewer.

In the image below, the white and gray squares represent the laser line as it appears on the camera sensor. Spots (which represent the center of the laser line on the camera sensor for each column) are displayed as red "x" symbols. Dropouts (where no spot is detected on the camera sensor in a given column) are depicted at the upper edge of the data viewer as yellow dots.



To show data dropouts:

1. Go to the **Scan** page and choose **Video** mode in the **Scan Mode** panel.
2. check the **Show Dropouts** option at the top of the data viewer.

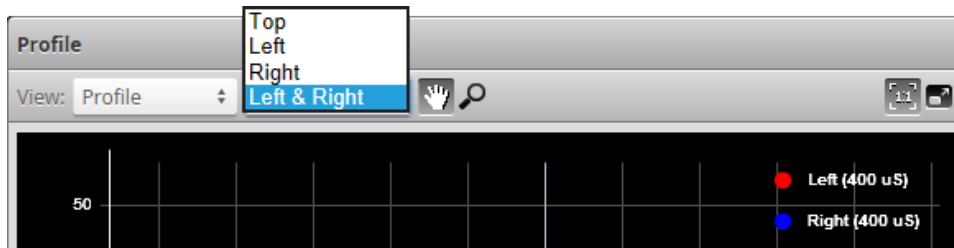
For more information on the material settings, see *Advanced* on page 109.

## Profile Mode

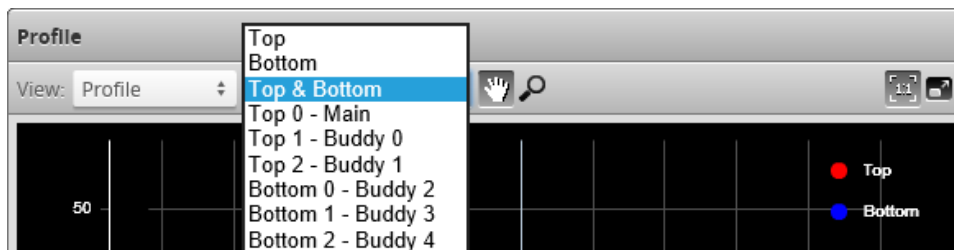
When the Gocator is in Profile scan mode, the data viewer displays profile plots.



In a dual-sensor system, profiles from individual sensors or from a combined view can be displayed.



In a multi-sensor system, profiles from individual sensors or from combined views can be displayed.



When in the **Scan** page, selecting a panel (e.g., **Sensor** or **Alignment** panel) automatically sets the display to the most appropriate display view.



To manually select the display view in the Scan page:

1. Go to the **Scan** page.
2. Choose **Profile** mode in the **Scan Mode** panel.
3. Select the view.
  - Top:** View from a single sensor, from the top sensor in an opposite-layout dual-sensor system, or the combined view of sensors in the top position.
  - Bottom:** View from the bottom sensor in an opposite-layout dual-sensor system, or all sensors in the bottom row of a multi-sensor system.
  - Top & Bottom:** Combined view from all sensors in a multi-sensor system set up with sensors on the top and bottom rows in the [layout grid](#).
  - Left:** View from the left sensor in a dual-sensor system.
  - Right:** View from the right sensor in a dual-sensor system.
  - Left & Right:** In a dual-sensor system, views from both sensors, displayed at the same time in the data viewer, using the coordinate systems of each sensor.

In the **Measure** page, the view of the display is set to the profile source of the selected measurement tool.

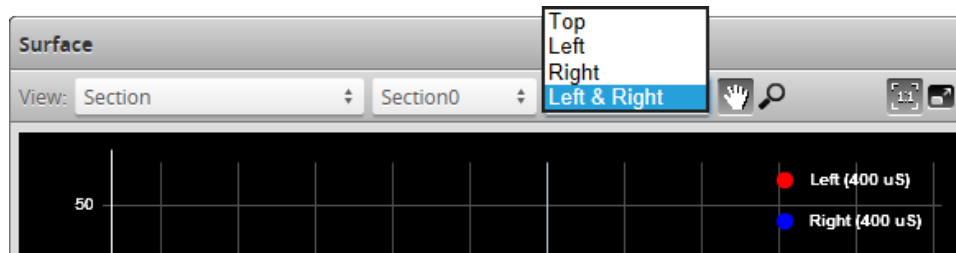
## Section Mode

When the Gocator is in Surface scan mode, the data viewer can display [sections](#) (profiles extracted from surfaces).



In a dual-sensor system, profiles from individual sensors or from a combined view can be displayed.

When in the **Scan** page, selecting a panel (e.g., **Sensor** or **Alignment** panel) automatically sets the display to the most appropriate display view.



*To manually select the display view in the Scan page:*

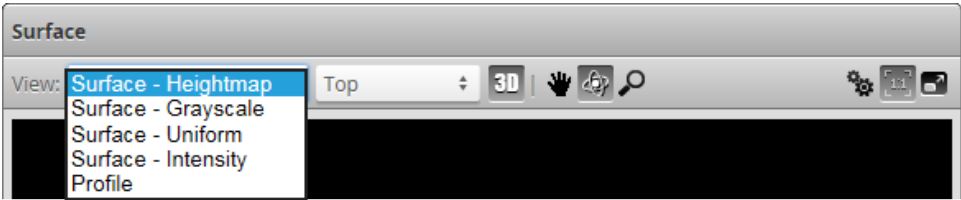
1. Go to the **Scan** page.
2. Choose **Surface** mode in the **Scan Mode** panel.
3. Just above the data viewer, choose **Section** in the **View** drop-down.  
 The view from an individual sensor or the combined view of two sensors can be selected from the drop-down list at the top of the data viewer.  
**Top:** View from a single sensor, from the top sensor in an opposite-layout dual-sensor system, or the combined view of sensors that have been aligned to use a common coordinate system.  
**Bottom:** View from the bottom sensor in an opposite-layout dual-sensor system.  
**Left:** View from the left sensor in a dual-sensor system.  
**Right:** View from the right sensor in a dual-sensor system.  
**Left & Right:** Views from both sensors, displayed at the same time in the data viewer, using the coordinate systems of each sensor.

1. Go to the **Scan** page.
2. Choose **Surface** mode in the **Scan Mode** panel.
3. Just above the data viewer, choose **Section** in the **View** drop-down.  
 The view from an individual sensor or the combined view of two sensors can be selected from the drop-down list at the top of the data viewer.  
**Top:** View from a single sensor, from the top sensor in an opposite-layout dual-sensor system, or the combined view of sensors that have been aligned to use a common coordinate system.  
**Bottom:** View from the bottom sensor in an opposite-layout dual-sensor system.  
**Left:** View from the left sensor in a dual-sensor system.  
**Right:** View from the right sensor in a dual-sensor system.  
**Left & Right:** Views from both sensors, displayed at the same time in the data viewer, using the coordinate systems of each sensor.

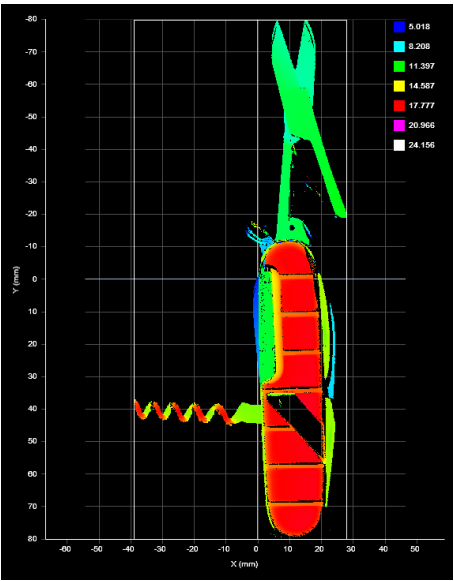
In the **Measure** page, the view of the display is set to the profile source of the selected measurement tool.

# Surface Mode

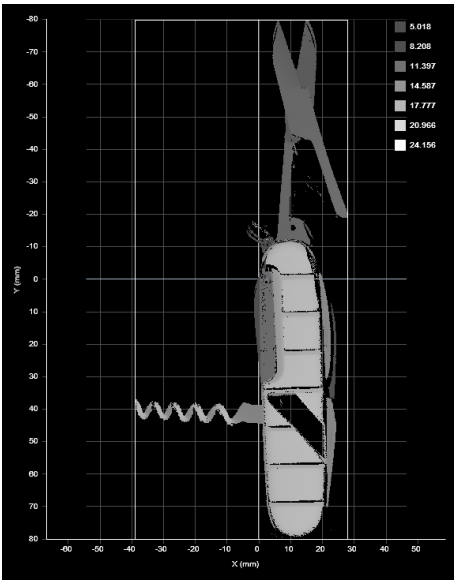
When the Gocator is in Surface [scan mode](#), the data viewer can display height maps and intensity images. You can select the data to display from the **View** drop-down.



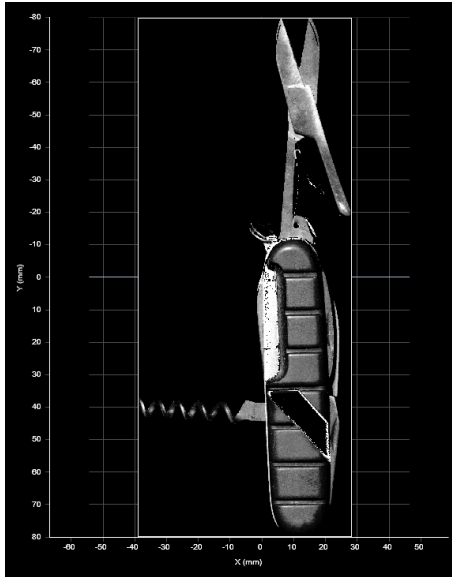
| View Option         | Description                                                                                                                                                   |
|---------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Profile             | Plots the last collected profile. (Only available in 2D view.)                                                                                                |
| Surface - Heightmap | In 2D view, displays the pseudo color height map.<br>In 3D view, overlays the 2D pseudo color height map on the 3D model.                                     |
| Surface - Grayscale | In 2D view, displays the grayscale height map.<br>In 3D view, overlays the grayscale height map on the 3D model.                                              |
| Surface - Uniform   | Overlays a uniform shaded surface on the 3D model. (Only available in 3D view.)                                                                               |
| Surface - Intensity | In 2D view, displays the intensity.<br>In 3D view, overlays the intensity map on the 3D model.<br>(Acquire Intensity must be checked in the Scan Mode panel.) |



2D viewer with height map overlay



2D viewer with grayscale overlay

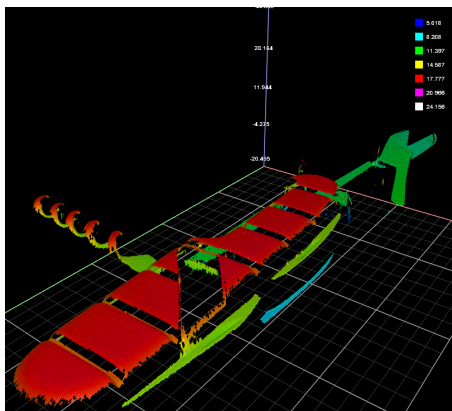


*2D viewer with intensity overlay*

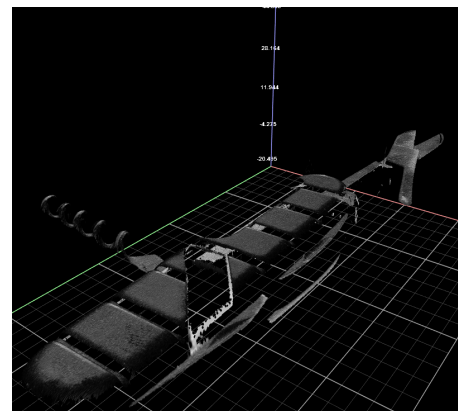
Choosing the **Profile** view option will switch the data viewer out of the 3D viewer and display the profile plot.

If you have defined any [sections](#), a **Sections** option will display.

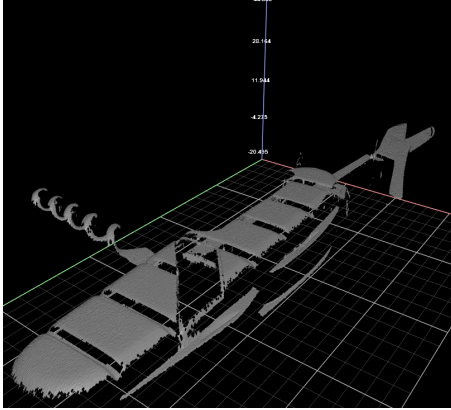
Clicking the **3D** button toggles between the 2D and 3D viewer. The 3D model is overlaid with the information that corresponds to the selected **View** option.



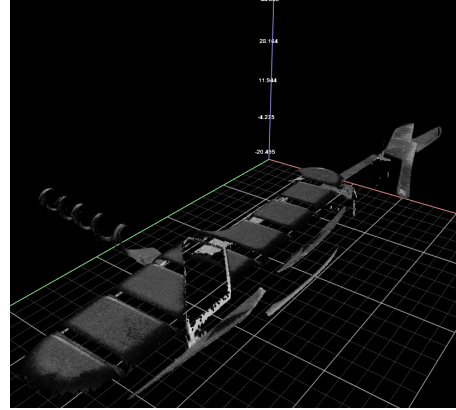
*3D viewer with height map overlay*



*3D viewer with grayscale overlay*



3D viewer with uniform overlay



3D viewer with uniform overlay

In 3D mode, you can choose how the data viewer renders the model:

| Rendering Mode                                                                                             | Description                                                                                                             |
|------------------------------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------------------------------------------|
| Point Cloud (default)<br> | Renders 3D models using point clouds. Useful in scan data that contains noise around edges, and shows hidden structure. |
| Mesh<br>                  | Renders 3D models using "meshing," connecting 3D point clouds with polygons.                                            |

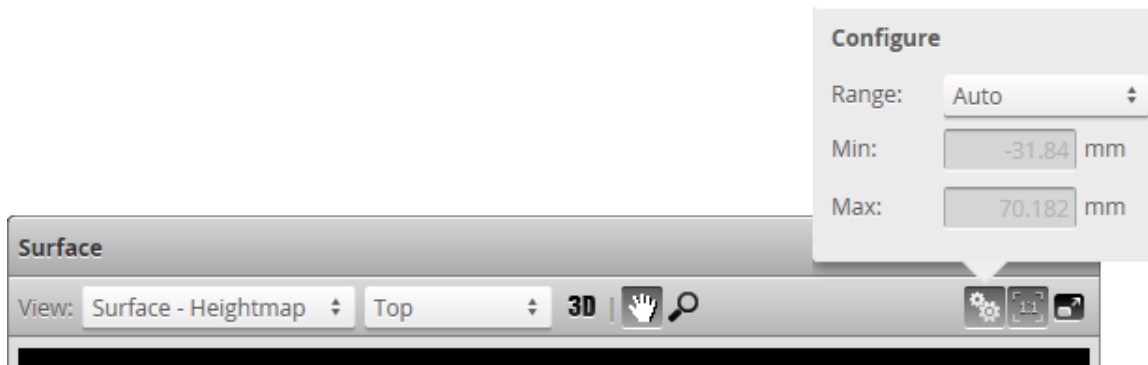
In a dual-sensor system, data from individual sensors or from a combined view can be selected. While in the **Scan** page, selecting a panel (e.g., **Sensor** or **Part Detection** panel) will automatically set the display to the most appropriate display type and display view.

*To manually select the display type and the display view in the Scan page:*

1. Go to the **Scan** page.
2. Select the View options in the data viewer.  
**Profile, Heightmap, Grayscale, Uniform, or Intensity** can be selected from the left drop-down list.  
 The view from an individual sensor or the combined view of two sensors can be selected from the right drop-down list.

## Height Map Color Scale

Height maps are displayed in pseudo-color. The height axis (Z) is color-coded. The scaling of the height map can be adjusted.



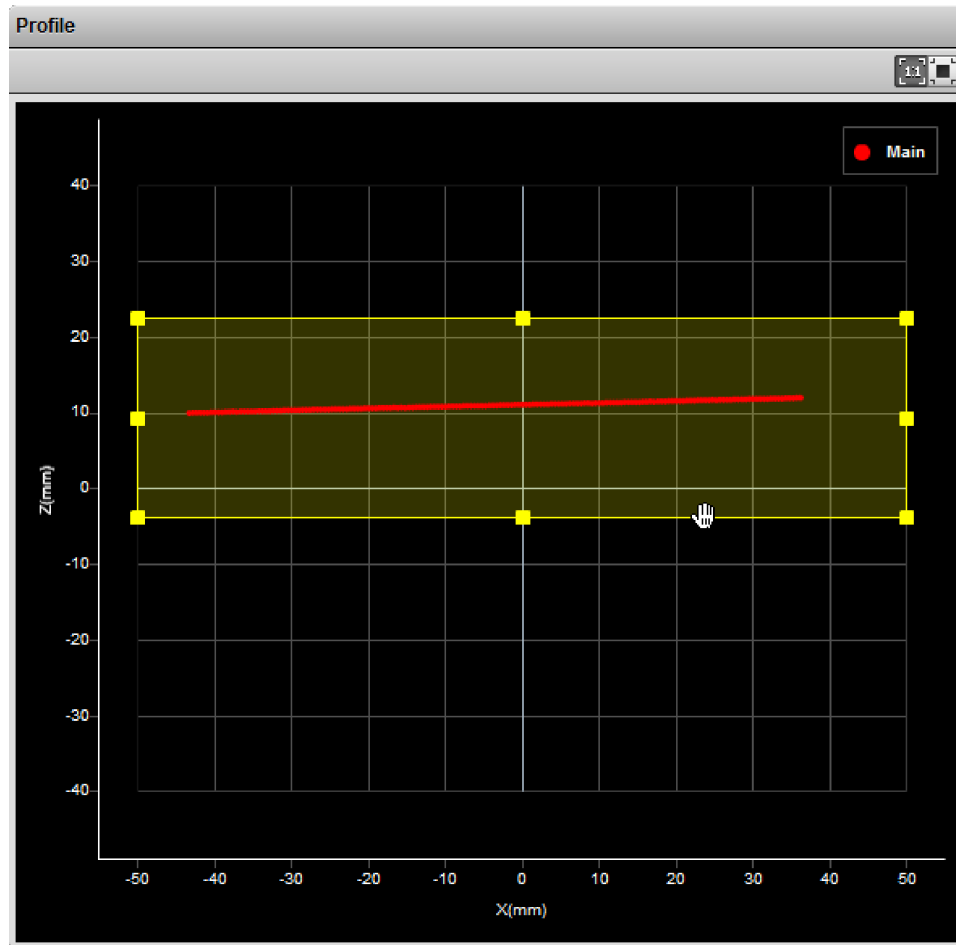
To change the scaling of the height map:

1. Select **Heightmap** from the **View** drop-down in the data viewer.
2. Click the **Scaling** button.
  - To automatically set the scale, choose **Auto** in the **Range** drop-down.
  - To automatically set the scale based on a user-selected sub-region of the heightmap, choose **Auto - Region** in the **Range** drop-down and adjust the yellow region box in the data viewer to the desired location and size.
  - To manually set the scale, choose the **Manual** in the **Range** drop-down and enter the minimum and maximum height to which the colors will be mapped.

## Region Definition

Regions, such as an active area or a measurement region, can be graphically set up using the data viewer.

When the **Scan** page is active, the data viewer can be used to graphically configure the active area. The **Active Area** setting can also be configured manually by entering values into its fields and is found in the **Sensor** panel (see *Sensor* on page 99).



*To set up a region of interest:*

1. Move the mouse cursor to the rectangle.  
The rectangle is automatically displayed when a setup or measurement requires an area to be specified.
2. Drag the rectangle to move it, and use the handles on the rectangle's border to resize it.

## Intensity Output

Gocator sensors can produce intensity images that measure the amount of light reflected by an object. An 8-bit intensity value is output for each range value along the laser line. Gocator applies the same coordinate system and resampling logic as the ranges to the intensity values.

Intensity output is enabled by checking **Acquire Intensity** in the **Scan Mode** panel.



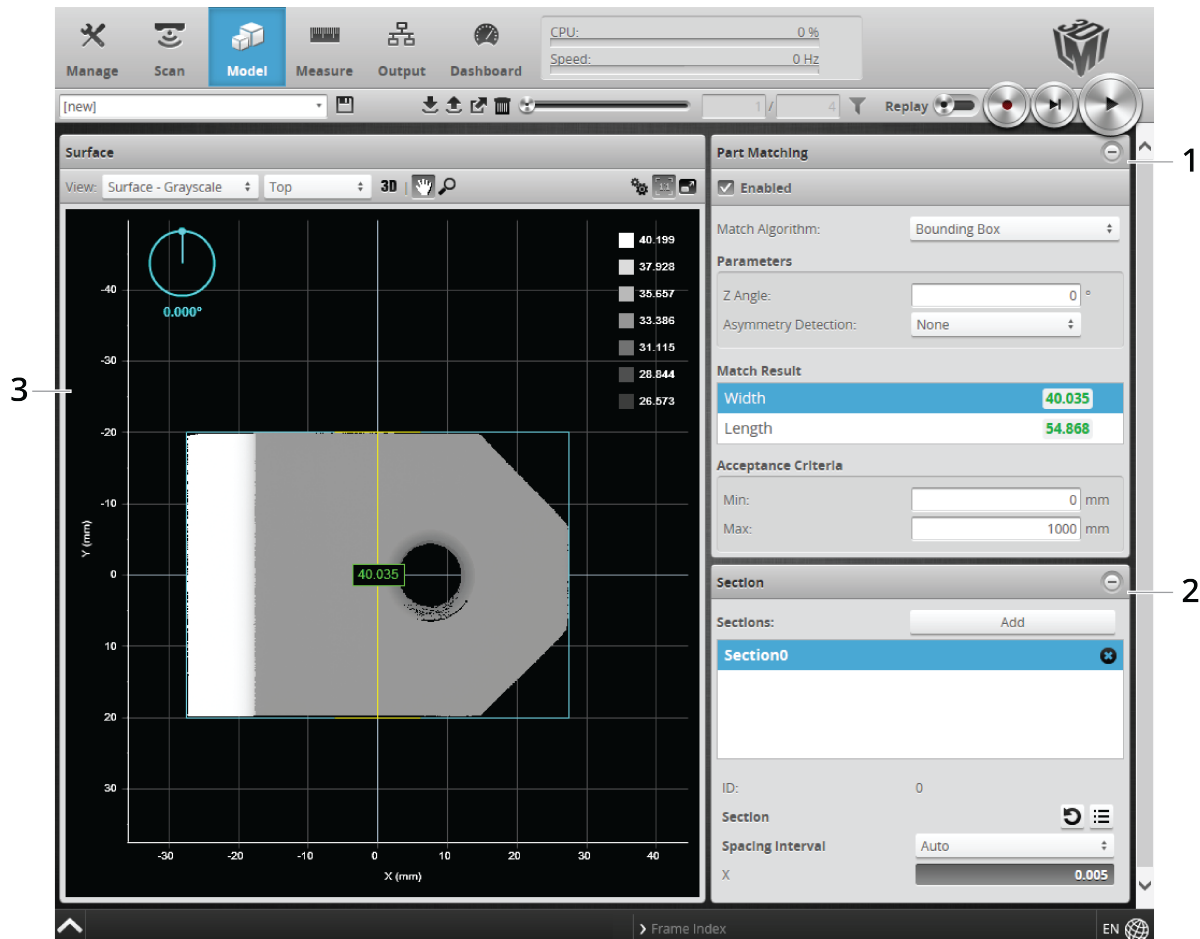
## Models

The following sections describe how to set up part matching using a model, a bounding box, or an ellipse. It also describes how to configure sections.

### Model Page Overview

The **Model** page lets you set up part matching and sections.





| Element | Description         |
|---------|---------------------|
| 1       | Part Matching panel |
| 2       | Sections panel      |
| 3       | Data Viewer         |

## Part Matching

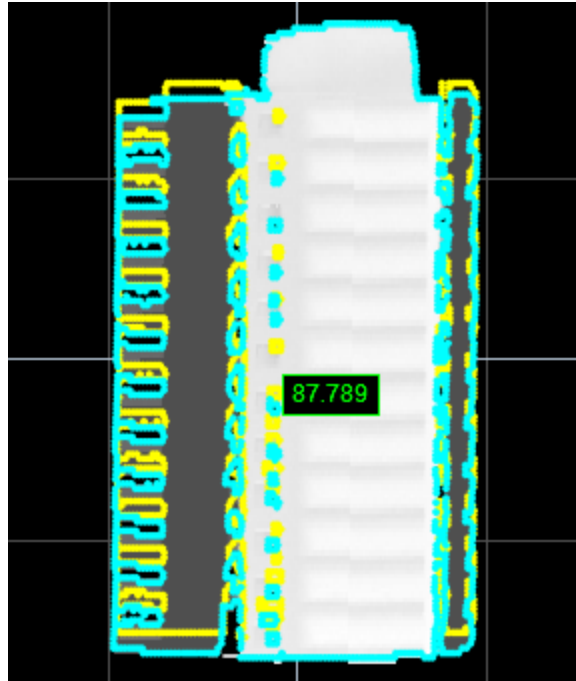
Gocator can match scanned parts to the edges of a model based on a previously scanned part (see *Using Edge Detection* on page 142) or to the dimensions of a fitted bounding box or ellipse that encapsulate the model (see *Using Bounding Box and Ellipse* on page 151). When parts match, Gocator can rotate scans so that they are all oriented in the same way. This allows measurement tools to be applied consistently to parts, regardless of the orientation of the part you are trying to match.

When the match quality between a model and a part reaches a minimum value (a percentage), or the bounding box or ellipse that encapsulates the part is between minimum and maximum dimension values, the part is "accepted" and any measurements that are added in the **Measure** page will return valid values, as long as the target is in range, etc. If the part is "rejected," any measurements added in the **Measure** page will return an Invalid value. For more information on measurements and decision values, see *Measurement* on page 161.

## Using Edge Detection

When using edge detection for part matching, the Gocator compares a model that you must create from a previous scan to a "target" (one of the parts you want to match to the model).

In the data viewer, a model is represented as a yellow outline. The target is represented as a blue outline. If the part match quality above a minimum user-defined level, any measurements configured on the **Measure** page are applied.



*Model (yellow outline) and target (blue outline).  
Part match quality is 87.789%, which is greater  
than the minimum set by the user, so the parts match.*

When you create a model, the Gocator runs an edge detection algorithm on either the heightmap or intensity image of a scanned part. The resulting model is made up of the detected edge points. The scan used to create the model should be of a reference (or "golden") part to which all other parts will be compared.

After the model has been created, you optionally modify the model by adjusting the sensitivity (how many edge points are detected), or selectively remove edge points from the model, to improve matching.

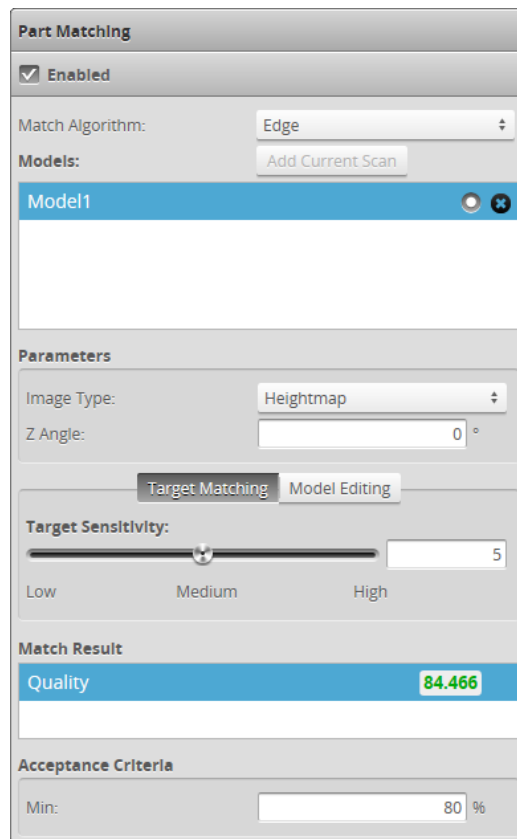


Models are saved as part of a job.

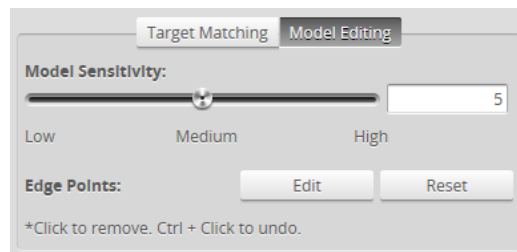
Once you have finished modifying the model, you can also modify target sensitivity, which controls how many edge points are detected on the subsequently scanned targets that will be compared to the model; the same edge detection algorithm used for creating models is used to compare a model to a part.

Typically, setting up edge detection to perform part matching involves the following steps:

1. Scan a reference part (you can also use replay data that you have previously saved).
2. Create a model based on the scan (using either heightmap or intensity data).
3. Adjust the model (edge detection algorithm sensitivity and selective removal of edge points).
4. Scan another part typical of the parts that would need to match the model.
5. Adjust the target sensitivity.
6. Set match acceptance level.



*Part Matching panel showing Target Matching tab*



*Model Editing tab on Part Matching panel*

The following settings are used to configure part matching using edge detection.

| Setting                                          | Description                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   |
|--------------------------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Match Algorithm                                  | Determines which algorithm the sensor will use to attempt a match. Set this to <b>Edge</b> for edge detection.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                |
| Image Type                                       | <p>Determines what kind of data the Gocator will use to detect edges and therefore for part matching. Choose this setting based on the kinds of features that will be used for part matching:</p> <p><b>Heightmap:</b> Surface elevation information of the scanned part will be used to determine edges. This setting is most commonly used.</p> <p><b>Intensity:</b> Intensity data (how light or dark areas of a scanned part are) will be used to determine edges. Use this setting if the main distinguishing marks are printed text or patterns on the parts. The <b>Acquire Intensity</b> option must be checked in the <b>Scan Mode</b> panel on the <b>Scan</b> page for this option to be available.</p>                                                                            |
| Z Angle                                          | Corrects the orientation of the model to accurately match typical orientation and simplify measurements.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      |
| Target Sensitivity ( <b>Target Matching</b> tab) | <p>Controls the threshold at which an edge point is detected on the target's heightmap or intensity image. (The "target" is any part that is matched to the model and which will subsequently be measured if the match is accepted.)</p> <p>Setting <b>Target Sensitivity</b> higher results in more edge points. Setting it lower results in fewer edge points and results in higher performance. Use this setting to exclude noise from the detected edges and to make sure distinguishing features are properly detected.</p> <p>The level of this setting should generally be similar to the level of <b>Model Sensitivity</b>.</p>                                                                                                                                                       |
| Model Sensitivity ( <b>Model Editing</b> tab)    | <p>Controls the threshold at which an edge point is detected on the heightmap or intensity image used to create the model. Setting <b>Model Sensitivity</b> higher results in more edge points. Setting it lower results in fewer edge points and results in higher performance. Use this setting to exclude noise from the detected edges and to make sure distinguishing features are properly detected.</p> <p>The level of this setting should generally be similar to the level of <b>Target Sensitivity</b>.</p> <p>Changing this setting causes the edge detection algorithm to run again at the new threshold. If you have edited edge points manually (removing them selectively), those changes will be lost. See <i>Using Edge Detection</i> on page 142 for more information.</p> |
| Edge Points ( <b>Model Editing</b> tab)          | The <b>Edit</b> button lets you selectively remove edge point that are detected by the edge detection algorithm at the current <b>Model Sensitivity</b> setting. See <i>Using Edge Detection</i> on page 142 for more information.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            |
| Acceptance Criteria                              | <p>Determines the minimum quality level of the match as a percentage value.</p> <p><i>Part rejected: Quality result is less than Min</i></p>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  |

To run part matching, simply make sure that the **Enabled** option is checked on the **Part Matching** panel when the Gocator is running. Any measurements that are added and configured on the **Measure**

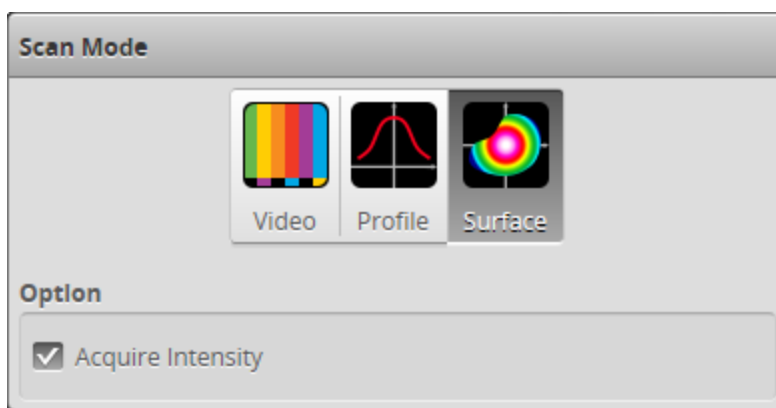
page will be applied to parts if a part match is accepted, regardless of the part's orientation (a successfully matched part is rotated to match orientation of the model), returning a value and decision (as long as the part is in range, etc.). If a part match is rejected, measurements will return an Invalid value.

## Creating a Model

Gocator creates a model by running an edge detection algorithm on the heightmap or intensity image of a scan. The algorithm is run when a model is first created and whenever the **Model Sensitivity** setting is changed.

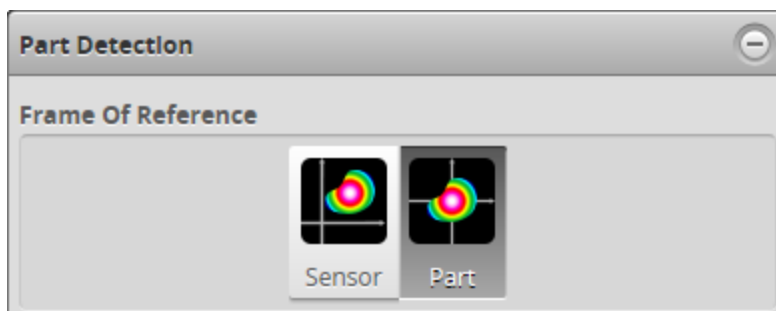
*To create a model:*

1. Go to the **Scan** page.
  - a. In the **Scan Mode** panel, choose **Surface**.



You must choose **Surface** in order to scan a part. Furthermore, the **Model** page is only displayed in Surface mode.

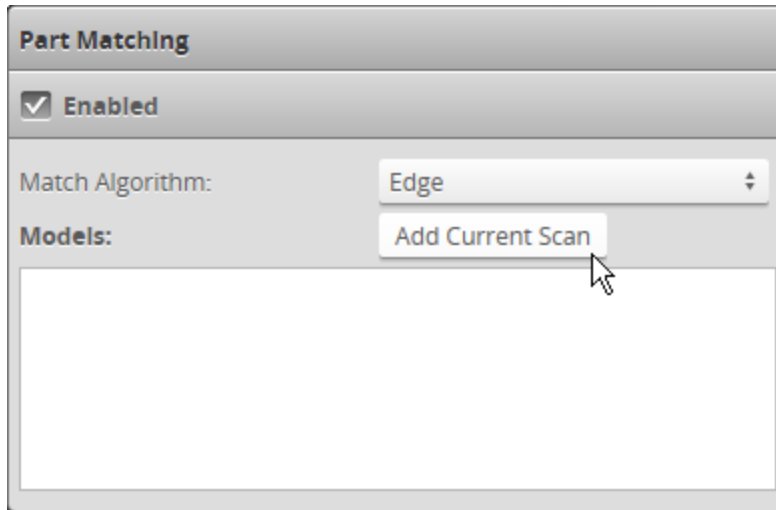
- b. If you want to use intensity data to create the model, make sure **Acquire Intensity** is checked.
  - c. In the **Part Detection** panel, choose **Part** for the **Frame of Reference**.



Part matching is only available when **Part** has been selected.

2. Do one of the following:
  - Scan a reference part. See *Scan Setup and Alignment* on page 91 for more information on setting up and aligning Gocator. See *Running a Standalone Sensor System* on page 39 or *Running a Dual-Sensor System on page 40* for more information on running a system to scan a part.

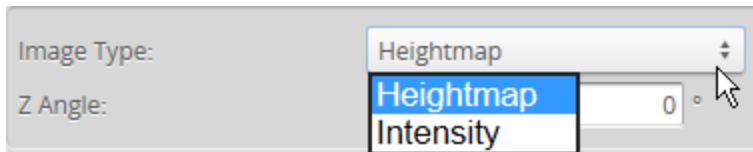
- Locate some previously recorded replay data and load it. See *Recording, Playback, and Measurement Simulation* on page 61 and *Downloading, Uploading, and Exporting Replay Data* on page 64 for more information on replay data.
- Go to the **Model** page.
    - Make sure the **Enabled** option is checked in the **Part Matching** panel.
    - In the **Match Algorithm** drop-down, choose **Edge**.



- Click **Stop** on the toolbar if the sensor is running.
- Click **Add Current Scan**.


 After adding the model, the Gocator will show that the match quality is 100%, because it is in effect comparing the model to the scan that was used to create the model. This value can be ignored.

- In the **Image Type** drop-down, choose **Heightmap** or **Intensity**.



- If you need to correct the orientation of the model, provide a value in the **Z Angle** field.  
Correcting the Z angle is useful if the orientation of the model is not close to the typical angle of target parts on the production line.
- Save the job by clicking the **Save** button .  
Models are saved in job files.  
See *Creating, Saving and Loading Jobs (Settings)* on page 59 for more information on saving jobs.

After you have created a model, you may wish to modify it to remove noise to improve its matching capabilities. You may also wish to modify a model to exclude certain areas. See *Creating a Model* on the previous page for more information.

Model names can be renamed.

*To rename a model:*

1. In the **Models** list, double-click on a model name.
2. Type a new name in the model name field.
3. Press Enter or click outside the model name field.
4. Save the job by clicking the **Save** button .

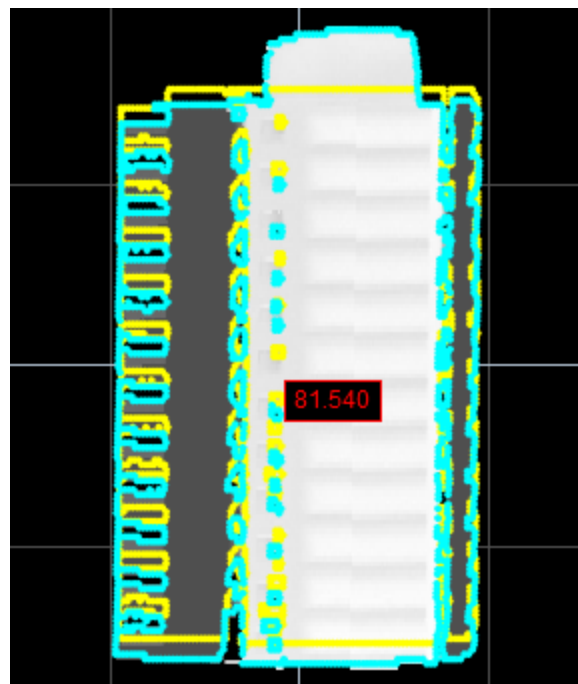
To delete a model, click the  button.

## Modifying a Model's Edge Points

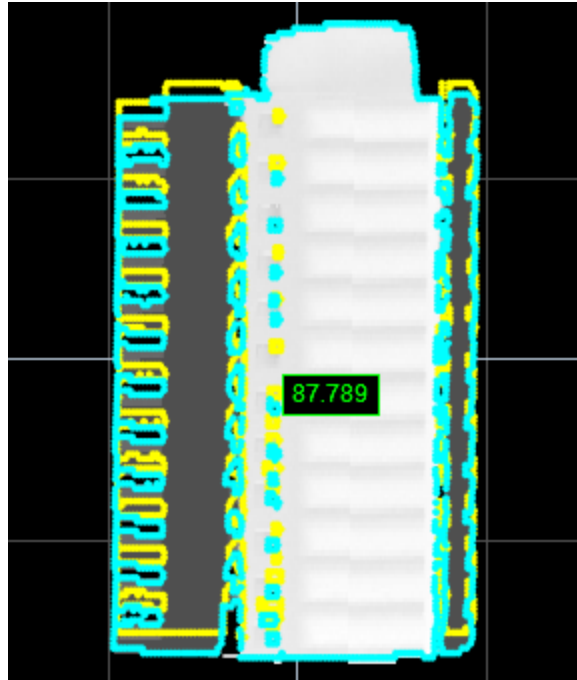
Modifying a model's edge points is useful to exclude noise in the detected edge points and to make sure distinguishing features are properly detected, which can improve matching. You can modify edge points in two ways.

First, you can control the overall number of edge points that are detected by the edge detection algorithm by raising and lowering the edge detection threshold (the **Model Sensitivity** setting). Modifying **Model Sensitivity** causes the edge detection algorithm to run again.

Second, you can fine-tune the model's edge points by selectively removing edge points that are detected by the edge detection algorithm. This could be useful, for example, if an edge on the target parts frequently presents minor variations such as flashing (excess material caused by leakage during molding): the edge points that make up the model can be edited to exclude that region. Editing the model can allow parts to match it more easily.



*Edge points along top of model not removed.  
Part is rejected. (Min set to 85%.)*



*Edge points along top of model removed.  
Part is accepted. (Min set to 85%.)*

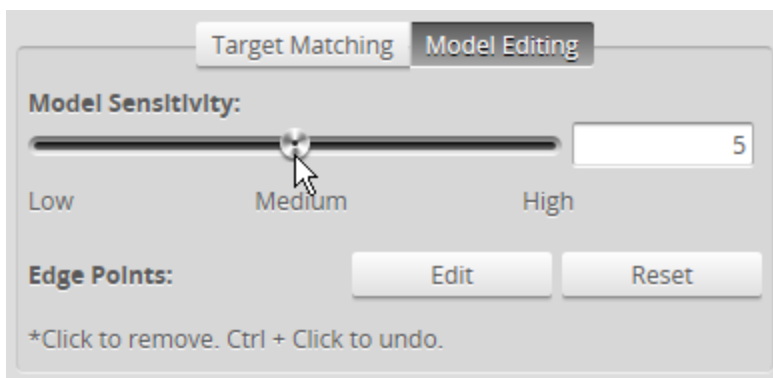
Removing edge points does not cause the edge detection algorithm to run again.

*To change model sensitivity:*

1. In the **Models** list, select the model you want to configure by clicking on its selection control.



2. Click the **Model Editing** tab.
3. Adjust the **Model Sensitivity** slider to exclude noise and to properly detect the distinguishing features that will match parts.



You can also set the sensitivity value manually in the provided text box.

4. Save the job by clicking the **Save** button .

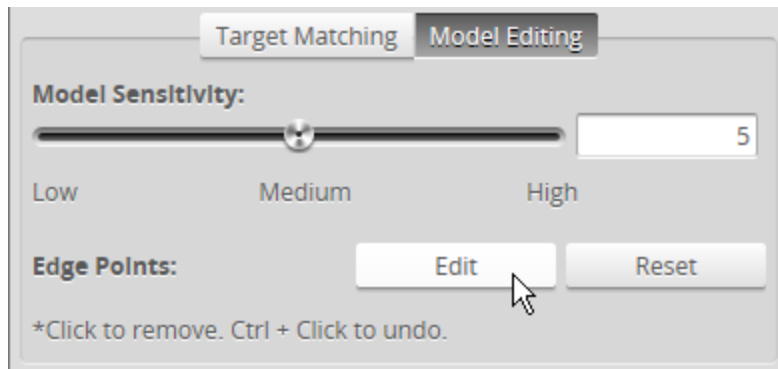


*To manually remove model edge points:*

1. In the **Models** list, select the model you want to configure by clicking on its selection control.



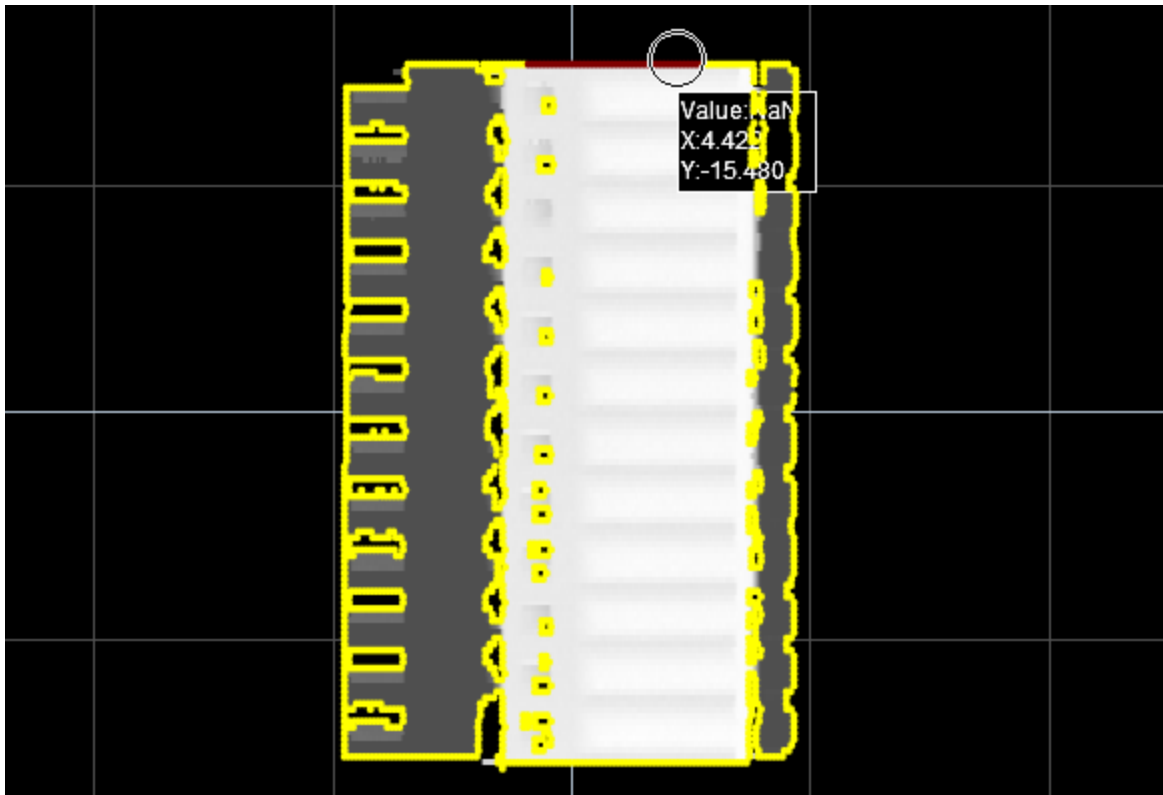
2. In the **Model Editing** tab, click on the **Edit** button.



3. On the toolbar above the data viewer, make sure the **Select** tool is active.



4. Click in the data viewer and hold the mouse button while moving the pointer over the edge points you want to remove.



Points within the circular **Select** tool are removed from the model. Removed edge points turn red in the data viewer.

You can zoom in to see individual edge points by using the mouse wheel or by using the Zoom mode (.

5. If you have removed too many edge points, use Ctrl + Click in the data viewer to add the edge points back.
6. When you have finished editing the model, click **Save** in the **Model Editing** tab.
7. Save the job by clicking the **Save** button  on the toolbar.

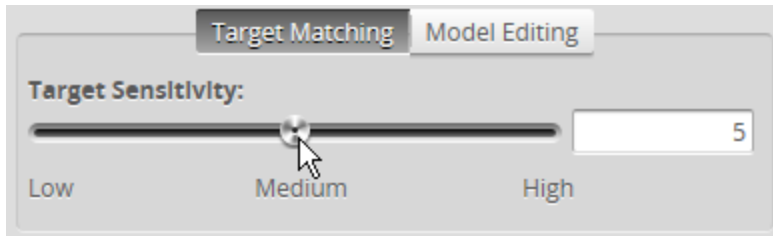
## Adjusting Target Sensitivity

After you have added a model and optionally adjusted it, you must scan a different part, one that is typical of parts that must match the model.

Much in the same way that you can adjust a model's sensitivity, you can adjust the target sensitivity, that is, the threshold at which edge points are detected on the heightmaps or intensity images of parts that you want to match to the model. Adjusting the target sensitivity is useful to exclude noise, improving part matching.

*To change target sensitivity:*

1. Click the **Target Matching** tab.
2. Adjust the **Target Sensitivity** setting to exclude noise in order to properly detect the distinguishing features that will allow parts to match.



You can also set the sensitivity value manually in the provided text box.

## Setting the Match Acceptance Criteria

In order for a part to match a model, the match quality must reach the minimum set in the **Min** field in **Acceptance Criteria** section of the **Part Matching** panel.

 A screenshot of the 'Match Result' and 'Acceptance Criteria' section. The 'Match Result' section shows a 'Quality' value of 87.789 in a green box. The 'Acceptance Criteria' section shows a 'Min:' value of 85 %.

*Part accepted: Quality result is greater than Min*

 A screenshot of the 'Match Result' and 'Acceptance Criteria' section. The 'Match Result' section shows a 'Quality' value of 87.789 in a red box. The 'Acceptance Criteria' section shows a 'Min:' value of 90 %.

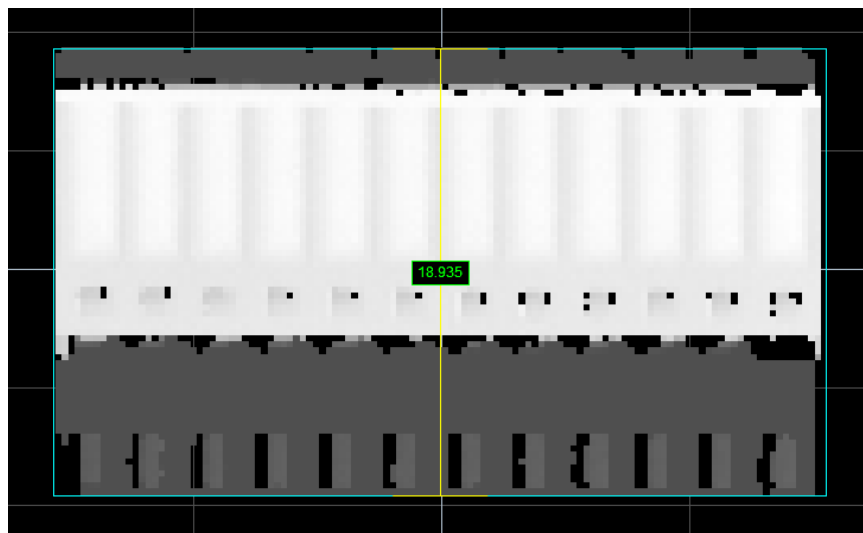
## Running Part Matching

To run part matching, simply make sure that the **Enabled** option is checked on the **Part Matching** panel when the Gocator is running. Any measurements that are added and configured on the **Measure** page will be applied to parts if a part match is accepted, regardless of the part's orientation (a successfully matched part is rotated to match orientation of the model), returning a value and decision (as long as the part is in range, etc.). If a part match is rejected, measurements will return an Invalid value.

## Using Bounding Box and Ellipse

When using a bounding box or an ellipse to match parts, the Gocator tests whether a part fits into a bounding box or ellipse that you define. A match will occur regardless of orientation.

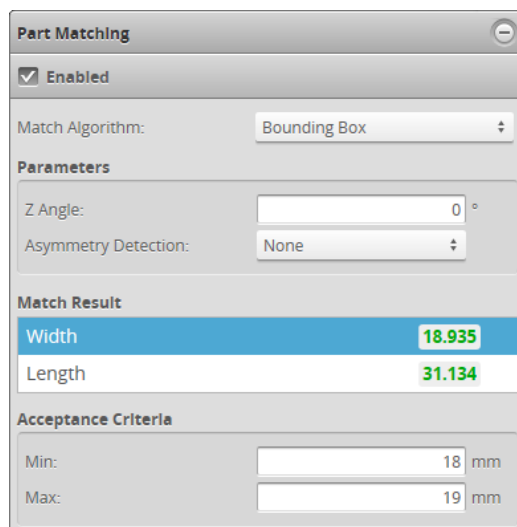
In the data viewer, a bounding box or ellipse is displayed with a blue outline. If a part fits in the bounding box or ellipse, any measurements configured on the **Measure** page are applied.



*Blue bounding box around a part.  
(Yellow lines show currently selected  
dimension in Part Matching panel.)*

Typically, setting up a bounding box or an ellipse to perform part matching involves the following steps:

1. Scan a reference part (you can also use replay data that you have previously saved).
2. Set the characteristics of the bounding box (width and length) or ellipse (major and minor axes).



*Part Matching panel (Bounding Box match algorithm)*

The following settings are used to configure part matching using a bounding box or ellipse.

| Setting         | Description                                                                    |
|-----------------|--------------------------------------------------------------------------------|
| Match Algorithm | Determines which algorithm the sensor will use to attempt a match. Set this to |

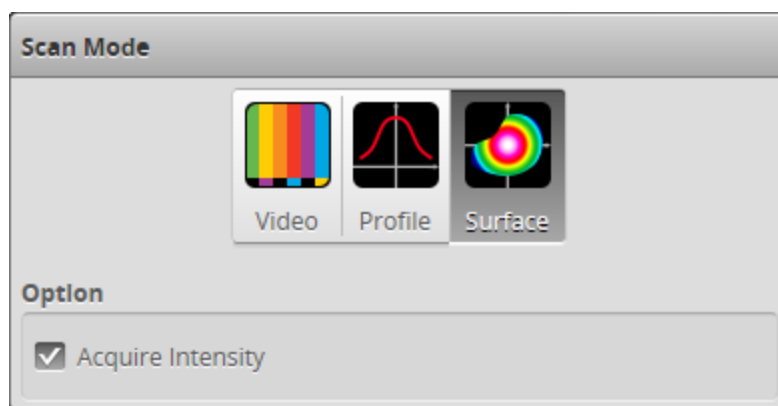
| Setting             | Description                                                                                                                                                                                                                                                                                                                                                                                                                                             |
|---------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
|                     | <b>Bounding Box or Ellipse.</b>                                                                                                                                                                                                                                                                                                                                                                                                                         |
| Z Angle             | Corrects the orientation of the bounding box or ellipse to accurately match typical orientation and simplify measurements.                                                                                                                                                                                                                                                                                                                              |
| Asymmetry Detection | <p>Rotates scans based on the asymmetry of the scanned part.</p> <p>Gocator calculates the number of points on each side of the part's centroid in the bounding box or ellipse.</p> <p><b>Along Major Axis</b> – The scan is flipped so that the greater number of points is to the left.</p> <p><b>Along Minor Axis</b> – The scan is flipped so that the greater number of points is on the bottom.</p> <p><b>None</b> – The scan is not flipped.</p> |
| Acceptance Criteria | <p>Determines the minimum and maximum acceptable values of the selected dimension (Width and Length for bounding box, Major and Minor for ellipse) in <b>Match Result</b>.</p>                                                                                                                                                                                                                                                                          |

### Configuring a Bounding Box or an Ellipse

To use a bounding box or an ellipse to match a part, you must set its dimensions, taking into account expected acceptable variations when compared to a reference (or "golden") part.

*To configure a bounding box or ellipse for part matching:*

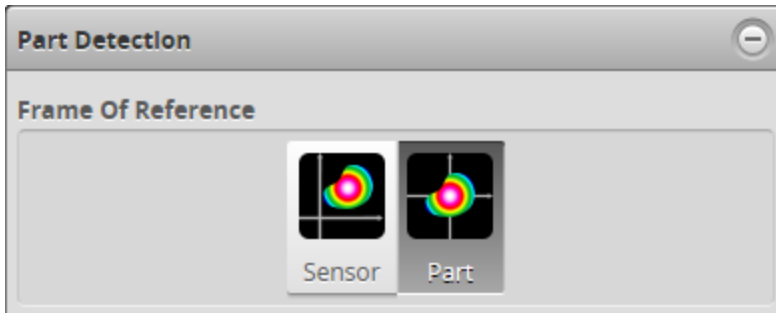
1. Go to the **Scan** page.
  - a. In the **Scan Mode** panel, choose **Surface**.



You must choose **Surface** in order to scan a part. Furthermore, the **Model** page is only displayed in Surface mode.

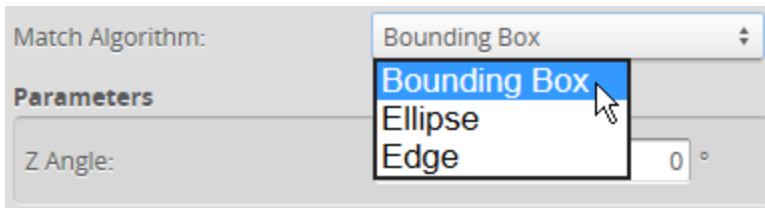
Intensity data is not used when part matching using a bounding box or an ellipse, but you can enable the **Acquire Intensity** option if you need intensity data for other reasons.

- b. In the **Part Detection** panel, choose **Part** for the **Frame of Reference**.



Part matching is only available when **Part** has been selected.

2. Do one of the following:
  - Scan a reference part. See *Scan Setup and Alignment* on page 91 for more information on setting up and aligning Gocator. See *Running a Standalone Sensor System* on page 39 or *Running a Dual-Sensor System on page 40* for more information on running a system to scan a part.
  - Locate some previously recorded replay data and load it. See *Recording, Playback, and Measurement Simulation* on page 61 and *Downloading, Uploading, and Exporting Replay Data* on page 64 for more information on replay data.
3. Go to the **Model** page.
  - a. Make sure the **Enabled** option is checked in the **Part Matching** panel.
  - b. In the **Match Algorithm** drop-down, choose **Bounding Box** or **Ellipse**.



4. Set **Min** and **Max** of both of the dimensions of the selected match algorithm shape, taking into account expected acceptable variations.
    - If you chose **Bounding Box** for the match algorithm, select **Width** and then **Length** in **Match Result**, setting the minimum and maximum values acceptable for each dimension.
    - If you chose **Ellipse** for the match algorithm, select **Minor** and then **Major** in **Match Result**, setting the minimum and maximum values acceptable for each dimension.
  5. Save the job by clicking the **Save** button .
- See *Creating, Saving and Loading Jobs (Settings)* on page 59 for more information on saving jobs.

## Running Part Matching

To run part matching, simply make sure that the **Enabled** option is checked on the **Part Matching** panel when the Gocator is running. Any measurements that are added and configured on the **Measure** page will be applied to parts if a part match is accepted, regardless of the part's orientation (a successfully matched part is rotated to match orientation of the bounding box or ellipse), returning a value and decision (as long as the part is in range, etc.). If a part match is rejected, measurements will return an Invalid value.

## Using Part Matching to Accept or Reject a Part

Part matching results only determine whether a measurement is applied to a part. Whether the measurement returns a pass or fail value—its decision—depends on whether the measurement's value is between the **Min** and **Max** values set for the measurement. This decision, in addition to the actual value, can in turn be used to control a PLC for example. The part matching "decision" itself is not passed to the Gocator output, but you can simulate this by setting up a measurement that will always pass if it is applied.

For example, you could set up a Position Z measurement, choosing Max Z as the feature type, and setting the **Min** and **Max** values to the measurement range of the sensor. This way, as long as a part matches and the target is in range, etc., the measurement will pass. This measurement decision, which is passed to the Gocator's output, could in turn be used to control a PLC.

## Sections

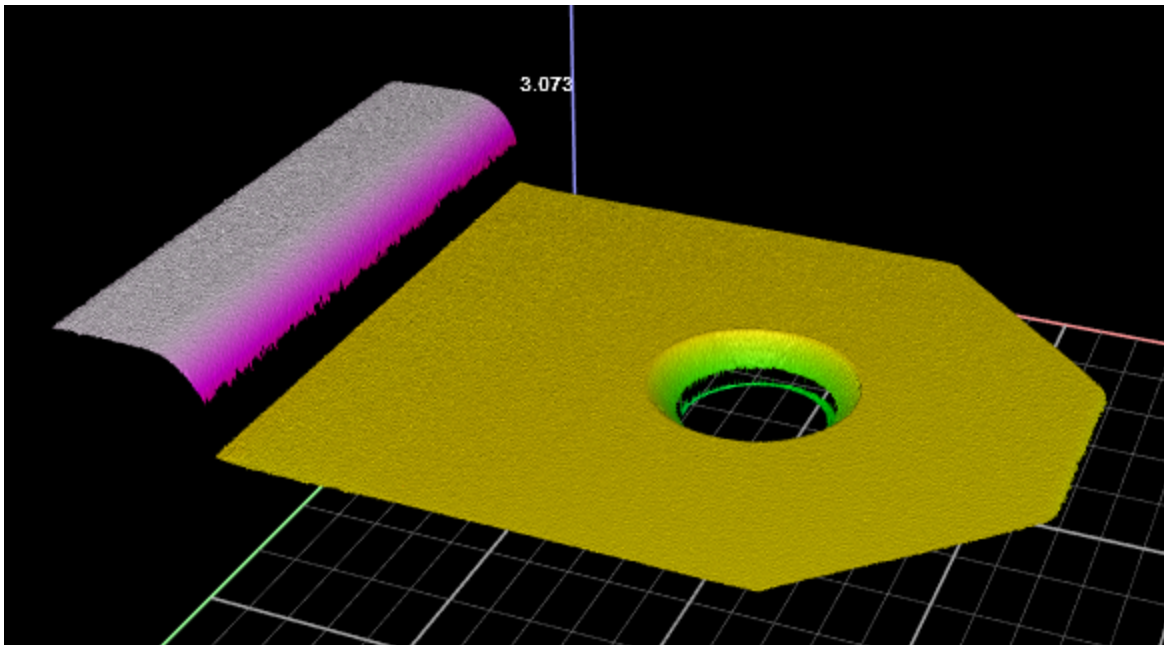
In Surface mode, Gocator can also extract a profile from a surface or part using a line you define on that surface or part. The resulting profile is called a "section." A section can have any orientation on the surface, but its profile is parallel to the Z axis.

You can use most [profile measurement tools](#) on a section: you can't use tools that work with unresampled data. Using sections and the profile measurements, you can therefore use measurements that are not otherwise possible in Surface mode, for example:

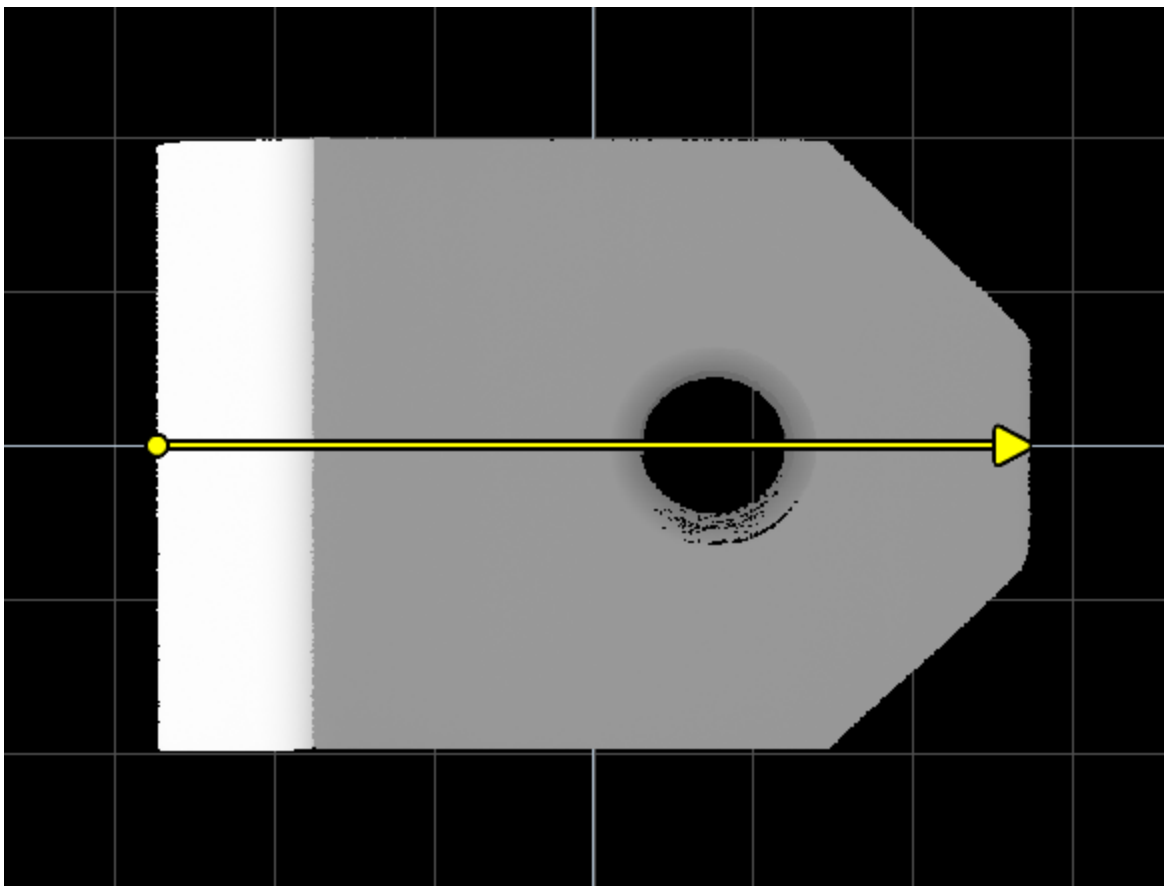
- Gap and flush measurements
- Surface radius measurements (for example, rounded edges or corners)
- Intersections
- Point-to-point dimension measurements between profile features

Gocator supports multiple sections, letting you take multiple measurements on the same object.

On the **Output** page, in Surface mode, you can output both surface measurements and section-based profile measurements at the same time. Gocator can also output the surfaces and section profiles themselves at the same time.

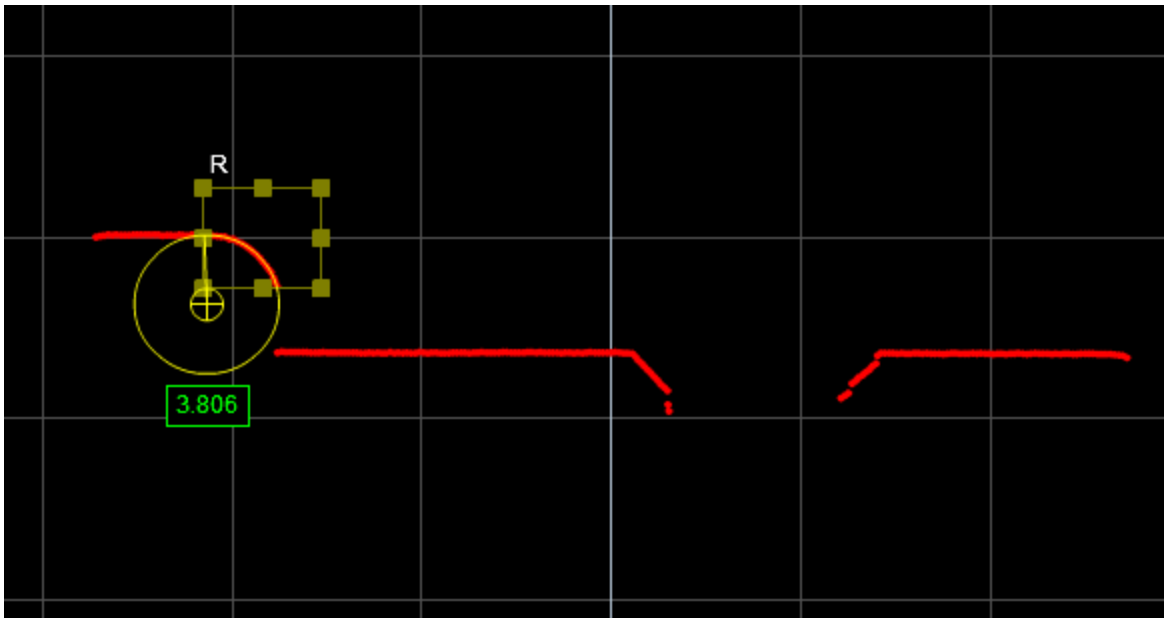


*Part in data viewer (3D view)*



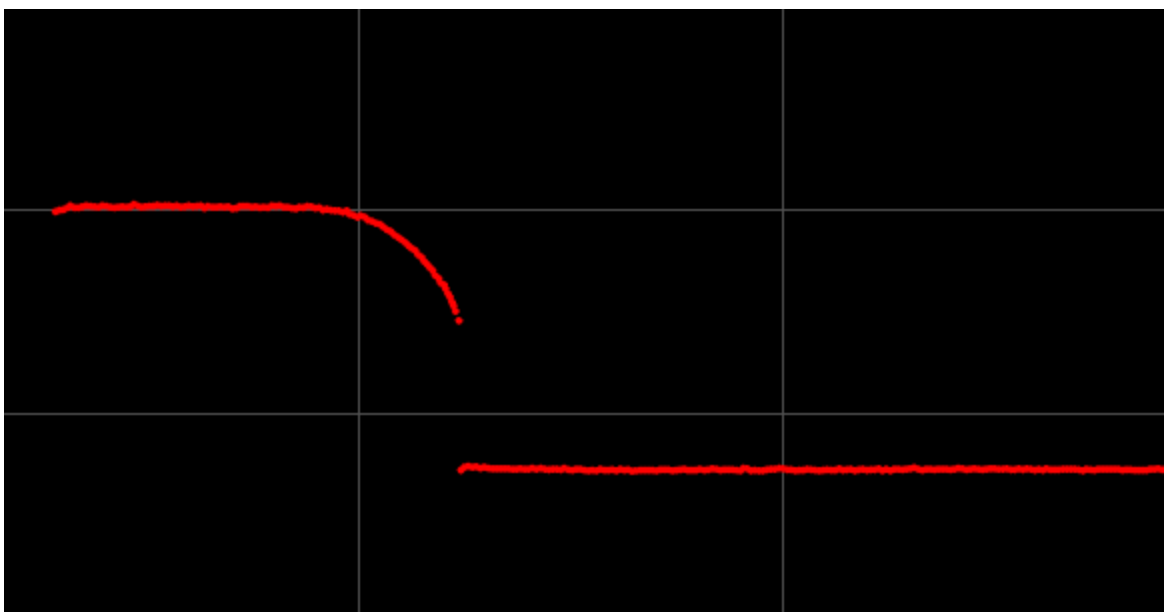
*Section defined on top of part (2D view)*



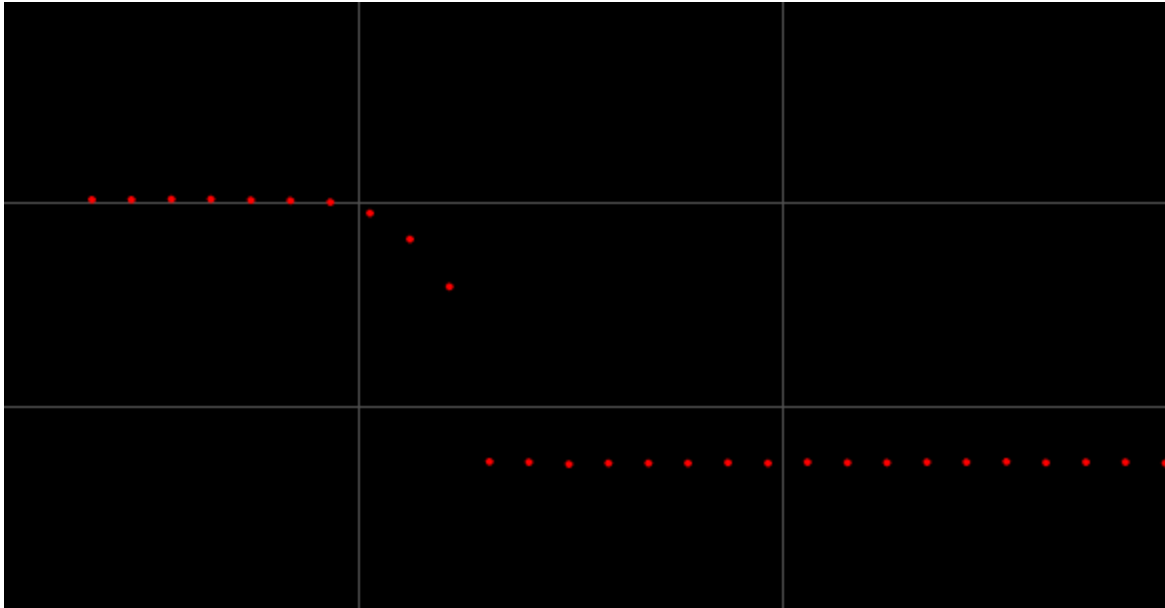


*Circle Radius measurement running on profile extracted from surface using defined section*

You can configure the sampling distance between points along the section. Reducing the sampling distance reduces the resolution of the profile, but increases the sensor's performance and results in less data being sent over the output.



*Minimum spacing interval: highest profile resolution, greater sensor CPU usage and data output*



*Maximum spacing interval: lowest profile resolution,  
lower sensor CPU usage and data output*



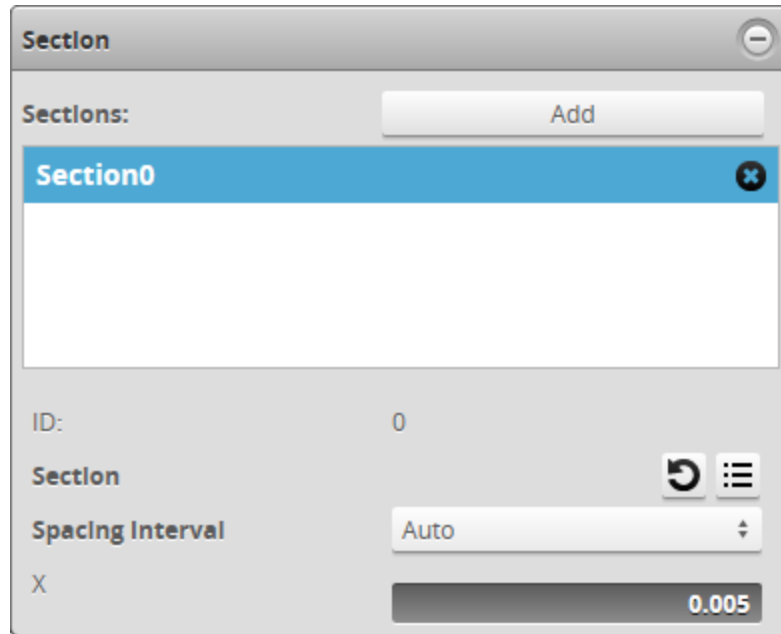
Using a higher spacing interval can produce different measurement results compared to using a smaller spacing interval. You should therefore compare results using different spacing intervals before using sections in production.

The sections you add to a surface are directional, and their start and end points are defined using X and Y coordinates. The start point always corresponds to the leftmost point on the extracted profile, whereas the end point always corresponds to the rightmost point on the extracted profile, no matter the orientation of the section on the surface.

For more information on profile tools, see *Profile Measurement* on page 183.

## Creating a Section

Before you create a section, you should first scan a target in Surface mode to create a surface on which you can create the section. You can use either live data or recorded data.



After creating a section, the following settings are available:

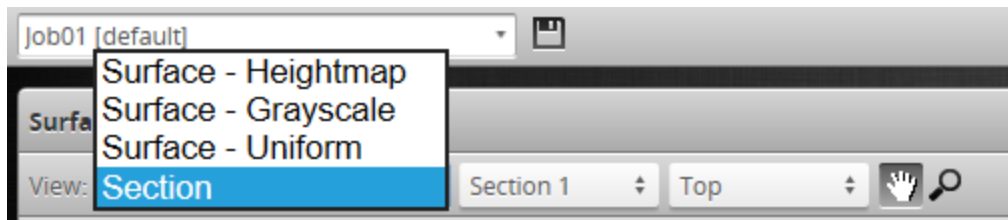
| Setting          | Description                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       |
|------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Spacing Interval | <p>Determines the space between the points of the extracted profile.</p> <p><b>Auto:</b> The highest resolution, calculated using the X and Y resolution of the scan.</p> <p><b>Custom:</b> Lets you set the spacing interval by using a slider or setting the value manually.</p>                                                                                                                                                                                                                                                                                                                                                                                                                |
| Section          | <p>Lets you manually set the X and Y coordinates of the start and end points of the section.</p> <p>Setting the coordinates manually is useful if you need to create a section that is perfectly horizontal or vertical. For example, to create a horizontal section, copy the Y value of either the start or end point to the other point's Y field.</p> <p>You can reverse the start and end points by clicking the  button.</p> <p>To reset the start and end points to their initial values, click the  button.</p> |

*To create a section:*

1. On the **Scan** page, in the **Scan Mode** panel, click **Surface**.
2. On the **Model** page, in the **Section** panel, click **Add**.  
You may need to click the  button to expand the panel.  
Gocator creates a section on the surface.
3. Rename the section if you want.
4. Move the section and adjust the start and end points of the section to extract the desired profile.  
You can move or adjust the section graphically in the data viewer, or you can manually adjust the X and Y coordinates of the section.
5. (Optional) Adjust the **Spacing Interval**.

After you create a section, Gocator lists the profile measurement tools in the **Tools** panel on the **Measure** page. If you have created more than one section, you must select it in the tool. For more information on profile measurement tools, see *Profile Measurement* on page 183.

Gocator also adds a **Section** option to the **View** drop-down above the data viewer, which lets you view an extracted profile, as well as a section selector drop-down for cases where multiple sections are defined.



Sections are also added to the [Stream](#) drop-down in [Profile](#) and [Feature](#) tools.

If parts are not consistently oriented in the same way from scan to scan, you can use [part matching](#) to correct their rotation, if the entire part is visible in the scan. Parts will then be consistently oriented, and sections will fall on the same area on each part. You can also use [anchoring](#) to ensure that measurements are consistently placed on a part.

## Deleting a Section

When you delete a section, Gocator removes any associated measurements. After you remove the last section, Gocator no longer displays profile measurement tools in the **Measure** page.

*To delete a section:*

1. On the **Scan** page, in the **Scan Mode** panel, click **Surface**.
2. On the **Model** page, in the **Section** panel, click the  button of the section you want to delete.

You may need to click the  button to expand the panel.

If you have associated a measurement tool to the section by setting the tool's **Stream** setting to the section, Gocator asks if you want to delete all of the associated measurement tools.

Gocator deletes the section on the surface.

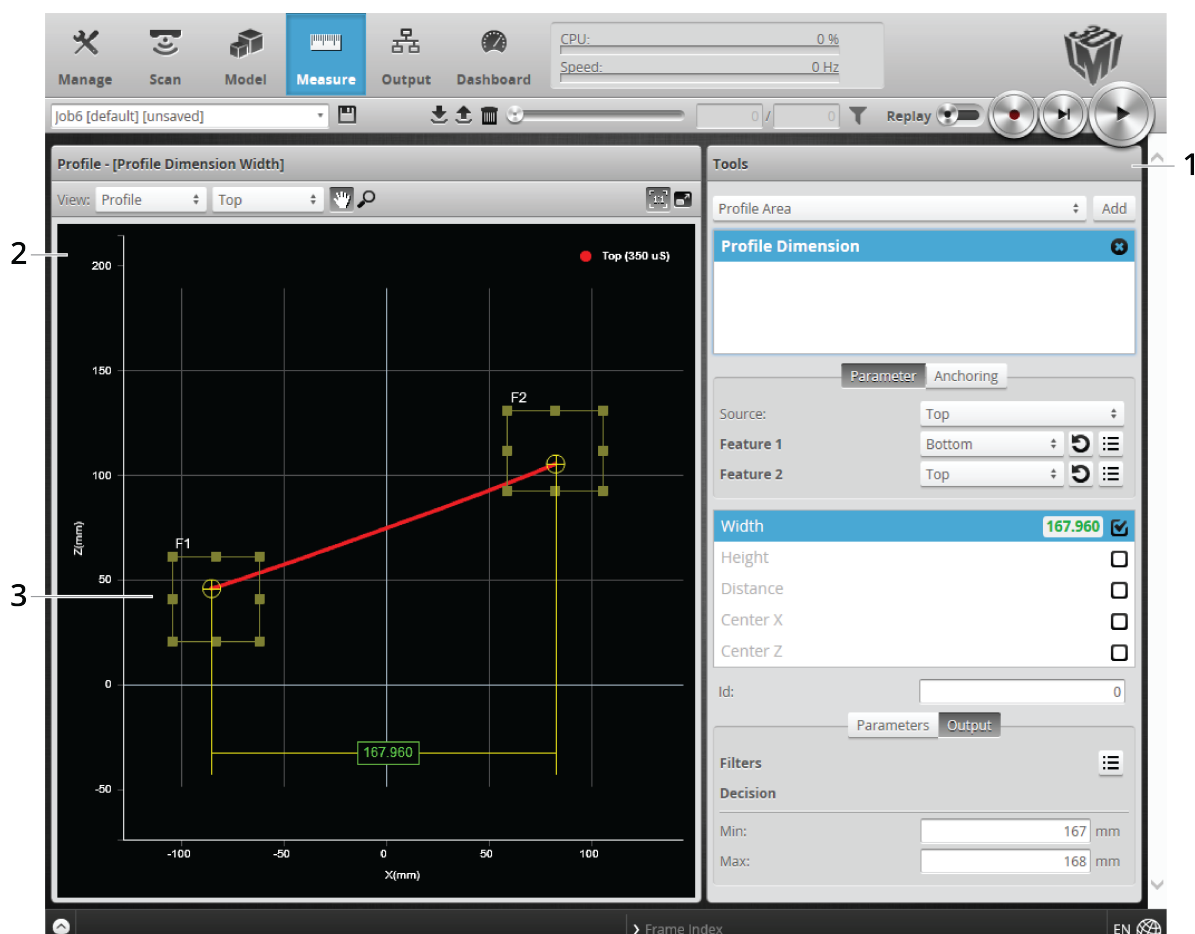
# Measurement

The following sections describe Gocator's tools and measurements.

## Measure Page Overview

Measurement tools are added and configured in the **Measure** page.

The content of the **Tools** panel in the **Measure** page depends on the current scan mode. In Profile mode, the **Measure** page displays tools for profile measurement. In Surface mode, the **Measure** page displays tools for surface measurement. If you have defined a section in Surface mode, profile tools are also displayed. In Video mode, tools are not accessible.



| Element       | Description                                                                                                                                                            |
|---------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 1 Tools panel | Used to add, manage, and configure tools and measurements (see <i>Tools Panel</i> on the next page) and to choose anchors ( <i>Measurement Anchoring</i> on page 175). |

| Element        | Description                                                                                                                                                                                                                                                                            |
|----------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 2 Data Viewer  | <p>Displays profile or surface data, sets up tools, and displays result calipers related to the selected measurement.</p> <p>Parts are displayed using a height map, which is a top-down view of the XY plane, where color represents height.</p> <p>See <i>Data Viewer</i> below.</p> |
| 3 Feature Area | <p>Configurable region of interest from which feature points are detected. These feature points are used to calculate the measurements. The number of feature areas displayed depends on which measurement tool is currently selected.</p>                                             |

## Data Viewer

When the **Measure** page is active, the data viewer can be used to graphically configure measurement regions in the 2D or in the 3D views. Measurement regions can also be configured manually in measurements by entering values into the provided fields (see *Regions* on page 165).

For instructions on how to set up measurement regions graphically, *Region Definition* on page 138.

## Tools Panel

The **Tools** panel lets you add, configure, and manage measurement tools. Tools contain related measurements. For example, the Dimension tool provides Height, Width, and other measurements.

Some settings apply to tools, and therefore to all measurements; these settings are found in the **Parameters** tab below the list of tools. Other settings apply to specific measurements, and are found in a **Parameters** tab below the list of measurements; not all measurements have parameters.

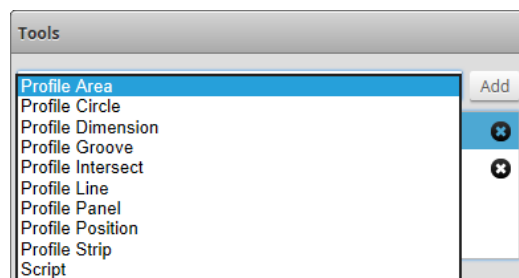
See *Profile Measurement* on page 183 and *Surface Measurement* on page 217 for information on the measurement tools and their settings.



Tool names in the user interface include the scan mode, but not in the manual. So for example, you will see "Profile Area" or "Surface Bounding Box" in the user interface, but simply "Area" or "Bounding Box" in the manual.

## Adding and Configuring a Tool

Adding a tool adds all of the tool's measurements to the **Tools** panel. You can then enable and configure the measurements selectively.



*To add and configure a tool:*

1. Go to the **Scan** page by clicking on the **Scan** icon.
2. Choose Profile or Surface mode in the **Scan Mode** panel.  
If one of these modes is not selected, tools will not be available in the **Measure** panel.
3. Go to the **Measure** page by clicking on the **Measure** icon.
4. In the Tools panel, select the tool you want to add from the drop-down list of tools.
5. Click on the **Add** button in the Tools panel.  
The tool and its available measurements are added to the tool list. The tool parameters are listed in the area below the tool list.
6. (Optional) If you are running a dual-sensor system, choose the sensor that will provide data to the measurement tool in **Source**.  
For more information on sources, see *Source* on the next page.
7. (Optional) If the measurement is a profile measurement running on a section, and you have created more than one section, choose the section that will provide data to the measurement in **Stream**.  
For more information on streams, see *Streams (Sections)* on page 165.
8. Select a measurement at the bottom of the tool panel.
9. Set any tool- or measurement-specific settings.  
For tool- and measurement-specific settings, see the topics for the individual [profile](#) or [surface](#) tools.
10. Set the **Min** and **Max** decision values.  
For more information on decisions, see *Decisions* on page 172.
11. (Optional) Set one or more filters.  
For more information on filters, see *Filters* on page 173.
12. (Optional) Set up anchoring.  
For more information on anchoring, see *Measurement Anchoring* on page 175.

## Source

For dual- or multi-sensor systems, you must specify which sensor provides data for the measurement.



The **Source** setting applies to all of a tool's measurements.

Depending on the layout you have selected, the **Source** drop-down will display one of the following (or a combination). For more information on layouts, see *Layout* on page 73.

| Setting      | Description                                                                                                                                                                                                                                                                                                                 |
|--------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Top          | <p>The Main sensor in a standalone system.</p> <p>In a dual-sensor system, refers to the Main sensor in Opposite layout, or to the combined data from both the Main and Buddy sensors.</p> <p>In a multi-sensor system, refers to the combined data from all sensors in the top row of the <a href="#">layout grid</a>.</p> |
| Bottom       | <p>The Buddy sensor in Opposite layout in a dual-sensor system.</p> <p>In a multi-sensor system, refers to the combined data from all sensors in the bottom row of the layout grid.</p>                                                                                                                                     |
| Top & Bottom | <p>In a dual-sensor system, refers to the combined data from the Main and Buddy sensor.</p> <p>In a multi-sensor system, refers to the combined data from all sensors in the top and bottom row of the layout grid.</p>                                                                                                     |

*To select the source:*

1. Go to the **Measure** page by clicking on the **Measure** icon.



The [scan mode](#) must be set to the type of measurement you need to configure. Otherwise, the wrong tools, or no tools, will be listed on the **Measure** page.

2. In the **Tools** panel, click on a tool in the tool list.
3. If it is not already selected, click on the **Parameter** tab in the tool configuration area.
4. Select the profile source in the **Source** drop-down list.

## Streams (Sections)

If you create more than one [section](#) on a surface and then add a [profile measurement](#), you must choose which section profile that measurement uses using the **Stream** setting in the measurement.



The **Stream** setting applies to all of a tool's measurements.

*To choose a stream:*

1. Go to the **Measure** page by clicking on the **Measure** icon.



The [scan mode](#) must be set to the type of measurement you need to configure. Otherwise, the wrong tools, or no tools, will be listed on the **Measure** page.

2. In the **Tools** panel, click on a tool in the tool list.
3. In the measurement list, select a measurement.  
To select a measurement, it must be enabled. See *Enabling and Disabling Measurements* on page 180 for instructions on how to enable a measurement.
4. If it is not already selected, click on the **Parameter** tab in the tool configuration area.
5. Select the section in the **Stream** drop-down list.



## Regions

Many measurement tools use user-defined regions to limit the area in which measurements occur or to help in the identification of a feature (*Feature Points* on page 168), a fit line (*Fit Lines* on page 170), or left or right side of the Panel tool ( see *Panel* on page 203). Unlike reducing the [active area](#), reducing the measurement region does not increase the maximum frame rate of the sensor.



You can disable regions entirely and cause the measurement tool uses the entire [active area](#) by unchecking the checkbox next to the **Regions** setting.

All tools provide region settings under the upper **Parameters** tab. Regions apply to all of a tool's measurements.

| Region  |            |
|---------|------------|
| X:      | -54.122 mm |
| Z:      | -36.593 mm |
| Width:  | 109.67 mm  |
| Height: | 109.67 mm  |

Region settings are often found within expandable feature sections in the tool's panel.



In 2D mode, the tool region defaults to the center of the current data view, not the global field of view. In 3D mode, the region defaults to the global field of view.

*To configure regions:*

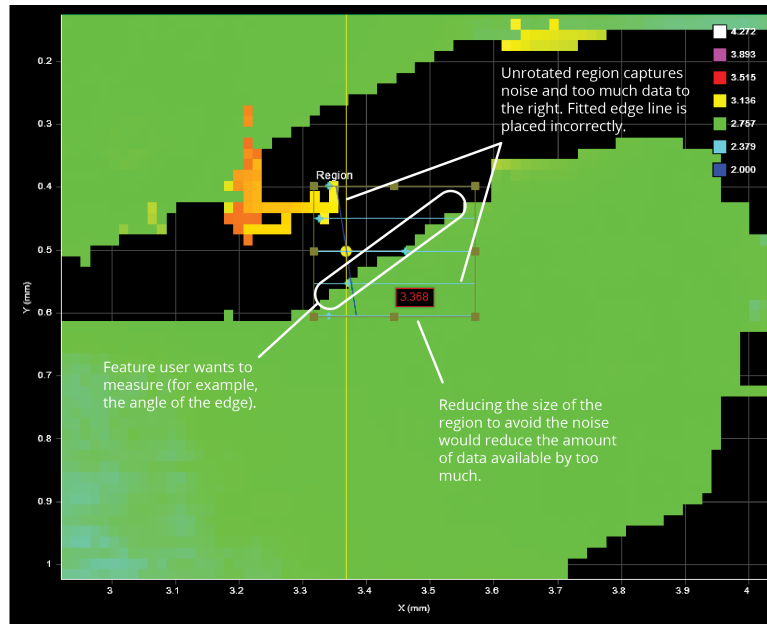
1. Go to the **Measure** page by clicking on the **Measure** icon.



The [scan mode](#) must be set to the type of measurement you need to configure. Otherwise, the wrong tools, or no tools, will be listed on the **Measure** page.

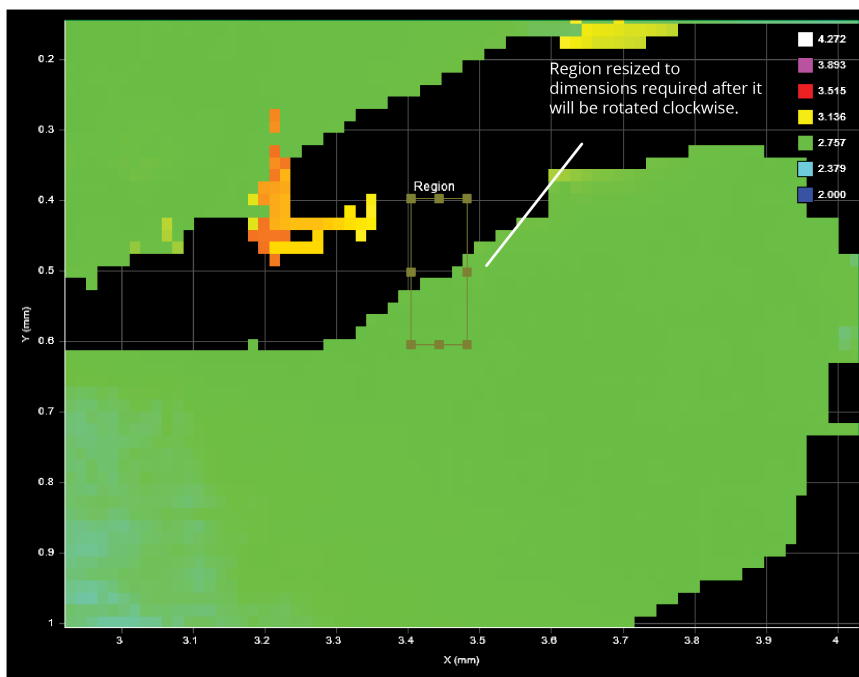
2. In the **Tools** panel, click on a tool in the tool list.
3. Expand the region section by clicking on the expand button . Some region settings are found within other settings in this area.
4. Configure the region using the fields or graphically using the mouse in the data viewer.

The measurement region of some tools can be rotated by setting the region's **Z Angle** to better accommodate features that are on an angle on a target. By rotating the measurement region, data not related to the feature can often be excluded, improving accuracy of measurements.



*To rotate measurement regions:*

1. Determine the length and width of the region that will be required once it is rotated.

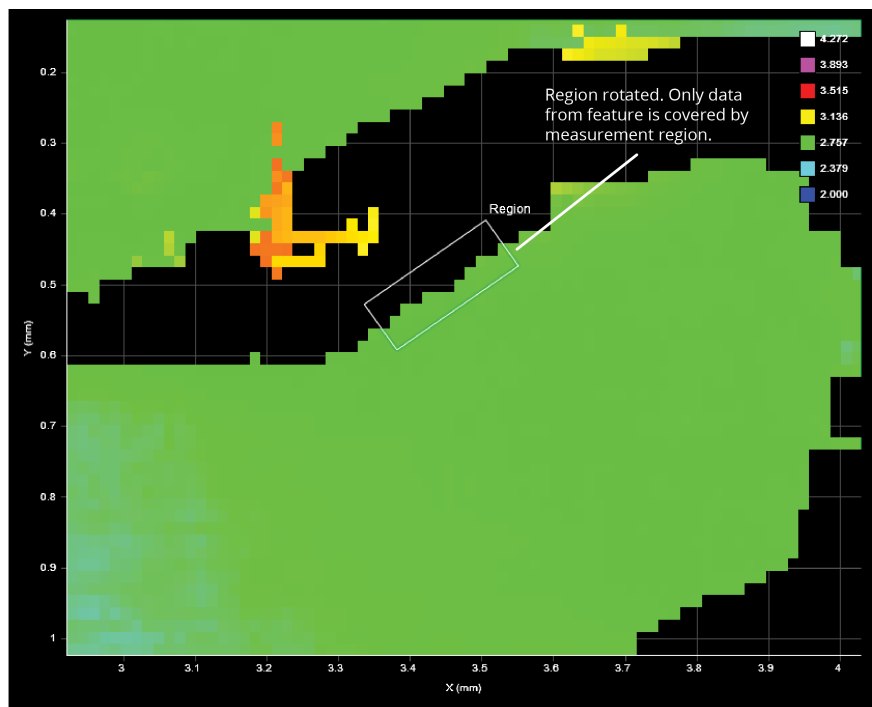


2. Expand the **Region** setting and then set a value in **Z Angle**.

Region

|          |                                      |    |
|----------|--------------------------------------|----|
| X:       | <input type="text" value="3.404"/>   | mm |
| Y:       | <input type="text" value="0.397"/>   | mm |
| Z:       | <input type="text" value="-16.725"/> | mm |
| Width:   | <input type="text" value="0.079"/>   | mm |
| Length:  | <input type="text" value="0.207"/>   | mm |
| Height:  | <input type="text" value="28.346"/>  | mm |
| Z angle: | <input type="text" value="55"/>      | °  |

The region rotates clockwise around the Z axis relative to the X axis.

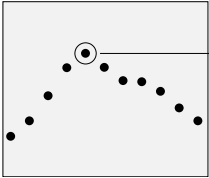
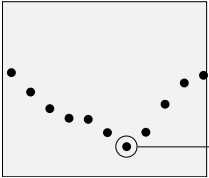
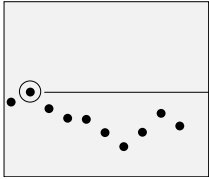
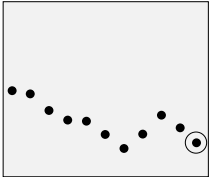
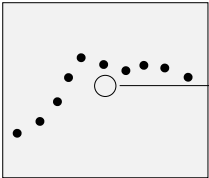
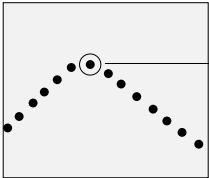
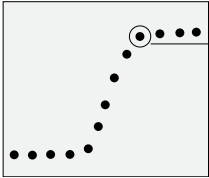
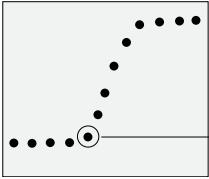


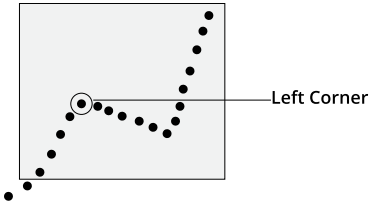
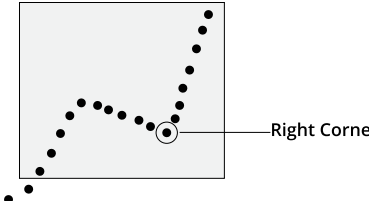
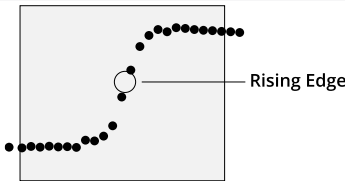
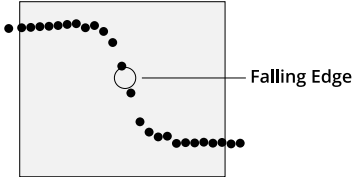
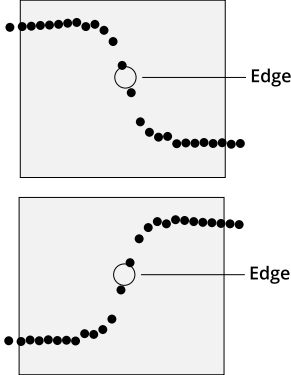
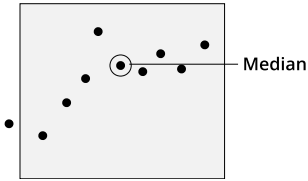
Once the region has been rotated, you cannot modify it in the data viewer using the mouse. You can however modify its dimensions and its location manually by changing the region's values in the **Region** setting.

**Feature Points**

Dimensional and positional measurements detect *feature points* found within the defined [measurement region](#) and then compare measurement values taken at the selected point with minimum and maximum thresholds to produce a *decision*. Feature points are selected in one or more **Feature** dropdowns in a tool and are used for all of the tool's measurements.

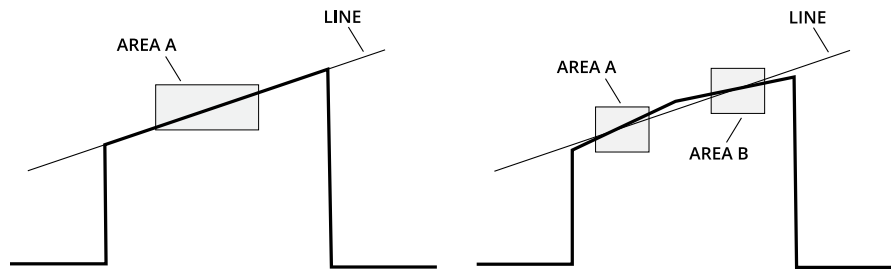
The following types of points can be identified in a measurement region.

| Point Type                                                                                                                            | Examples                                                                              |
|---------------------------------------------------------------------------------------------------------------------------------------|---------------------------------------------------------------------------------------|
| <b>Max Z</b><br>Finds the point with the maximum Z value in the region of interest.                                                   |    |
| <b>Min Z</b><br>Finds the point with the minimum Z value in the region of interest.                                                   |    |
| <b>Min X</b><br>Finds the point with the minimum X value in the region of interest.                                                   |    |
| <b>Max X</b><br>Finds the point with the maximum X value in the region of interest.                                                   |   |
| <b>Average</b><br>Determines the average location of points in the region of interest.                                                |  |
| <b>Corner</b><br>Finds a dominant corner in the region of interest, where corner is defined as a change in profile slope.             |  |
| <b>Top Corner</b><br>Finds the top-most corner in the region of interest, where corner is defined as a change in profile shape.       |  |
| <b>Bottom Corner</b><br>Finds the bottom-most corner in the region of interest, where corner is defined as a change in profile shape. |  |

| Point Type                                                                                                                          | Examples                                                                              |
|-------------------------------------------------------------------------------------------------------------------------------------|---------------------------------------------------------------------------------------|
| <b>Left Corner</b><br>Finds the left-most corner in the region of interest, where corner is defined as a change in profile shape.   |    |
| <b>Right Corner</b><br>Finds the right-most corner in the region of interest, where corner is defined as a change in profile shape. |    |
| <b>Rising Edge</b><br>Finds a rising edge in the region of interest.                                                                |    |
| <b>Falling Edge</b><br>Finds a falling edge in the region of interest.                                                              |   |
| <b>Any Edge</b><br>Finds a rising or falling edge in the region of interest.                                                        |  |
| <b>Median</b><br>Determines the median location of points in the region of interest.                                                |  |

## Fit Lines

Some measurements involve estimating lines in order to measure angles or intersection points. A fit line can be calculated using data from either one or two fit areas.



A line can be defined using one or two areas. Two areas can be used to bypass discontinuity in a line segment.

## Geometric Features

Most Surface tools, and many Profile tools, can output features that Feature tools can take as input to produce measurements. These features are called *geometric features*. Feature tools use these entities to produce measurements based on more complex geometry. (For more information on Feature tools, see *Feature Measurement* on page 271.)

Gocator's measurement tools can currently generate the following kinds of geometric features:

**Points:** A 2D or 3D point. Can be used for point-to-point or point-to-line measurements.

**Lines:** A straight line that is infinitely long. Useful for locating the orientation of an enclosure or part, or to intersect with another line to form a reference point that can be consumed by a Feature tool.

The following tables list Gocator's measurement tools and the geometric features they can generate:

*Geometric features generated by Surface tools*

|                                  | Point  |     |      |       | Line |            |            |
|----------------------------------|--------|-----|------|-------|------|------------|------------|
|                                  | Center | Tip | Base | Point | Edge | Major Axis | Minor Axis |
| <b>Tool</b>                      |        |     |      |       |      |            |            |
| <a href="#">Bounding Box</a>     | X      |     |      |       |      |            |            |
| <a href="#">Countersunk Hole</a> | X      |     |      |       |      |            |            |
| <a href="#">Dimension</a>        |        |     |      |       |      |            |            |
| <a href="#">Edge</a>             | X      |     |      |       | X    |            |            |
| <a href="#">Ellipse</a>          | X      |     |      |       |      | X          | X          |
| <a href="#">Hole</a>             | X      |     |      |       |      |            |            |
| <a href="#">Opening</a>          | X      |     |      |       |      |            |            |
| <a href="#">Plane</a>            |        |     |      |       |      |            |            |
| <a href="#">Position</a>         |        |     |      | X     |      |            |            |
| <a href="#">Stud</a>             |        | X   | X    |       |      |            |            |
| <a href="#">Volume</a>           |        |     |      |       |      |            |            |

### Geometric features generated by Profile tools

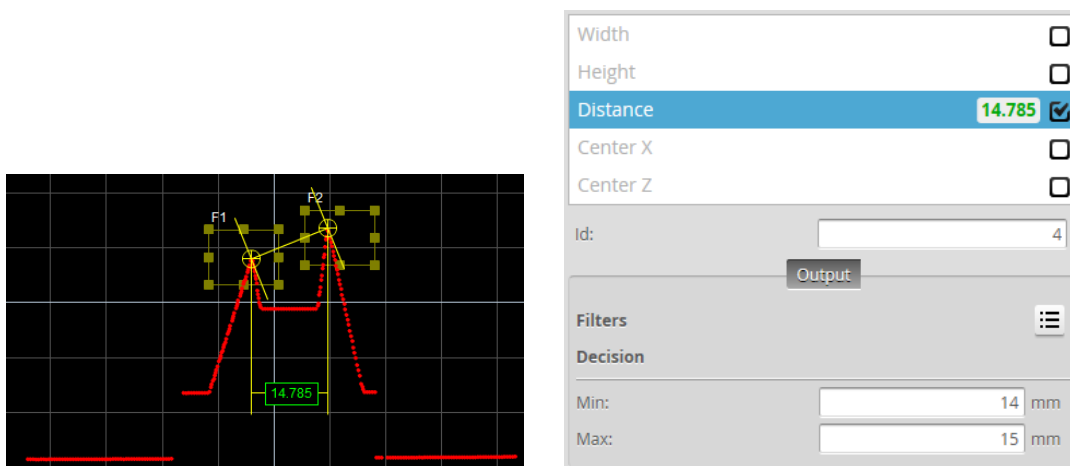
|              | Point  |       |           |        |           | Line      |      |      |
|--------------|--------|-------|-----------|--------|-----------|-----------|------|------|
|              | Center | Point | Intersect | Corner | Min Point | Max Point | Line | Base |
| Tool         |        |       |           |        |           |           |      |      |
| Area         | X      |       |           |        |           |           |      |      |
| Bounding Box | X      |       |           | X      |           |           |      |      |
| Circle       | X      |       |           |        |           |           |      |      |
| Dimension    |        |       |           |        |           |           |      |      |
| Groove       |        |       |           |        |           |           |      |      |
| Intersect    |        |       | X         |        |           |           | X    | X    |
| Line         |        |       |           |        | X         | X         | X    |      |
| Panel        |        |       |           |        |           |           |      |      |
| Position     |        | X     |           |        |           |           |      |      |
| Round Corner |        |       |           |        |           |           |      |      |
| Strip        |        |       |           |        |           |           |      |      |

The [Feature Intersect](#) tool can also produce an intersect point. [Script tools](#) do not currently take geometric features as input.

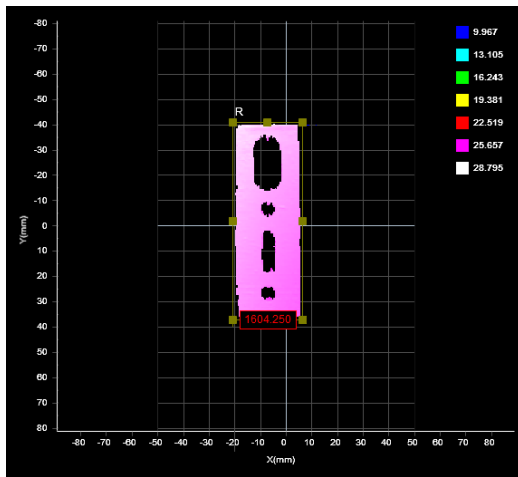
### Decisions

Results from a measurement can be compared against minimum and maximum thresholds to generate *pass* / *fail* decisions. The decision state is *pass* if a measurement value is between the minimum and maximum threshold. In the data viewer and next to the measurement, these values are displayed in green. Otherwise, the decision state is *fail*. In the user interface, these values are displayed in red.

All measurements provide decision settings under the **Output** tab.



Value (14.786) within decision thresholds (Min: 14, Max: 15). Decision: Pass



Parameter

Anchoring

Source:

Top

☒ Region

Volume

Area

Thickness

1604.250

☒

Id:

4

Output

Filters

Decision

Min:

1500

mm<sup>2</sup>

Max:

1600

mm<sup>2</sup>

*Value (1604.250) outside decision thresholds (Min: 1500, Max: 1600). Decision: Fail*

Along with measurement values, decisions can be sent to external programs and devices. In particular, decisions are often used with digital outputs to trigger an external event in response to a measurement. See *Output* on page 283 for more information on transmitting values and decisions.

*To configure decisions:*

1. Go to the **Measure** page by clicking on the **Measure** icon.



The [scan mode](#) must be set to the type of measurement you need to configure. Otherwise, the wrong tools, or no tools, will be listed on the **Measure** page.

2. In the **Tools** panel, click on a tool in the tool list.
3. In the measurement list, select a measurement.  
To select a measurement, it must be enabled. See *Enabling and Disabling Measurements* on page 180 for instructions on how to enable a measurement.
4. Click on the **Output** tab.  
For some measurements, only the **Output** tab is displayed.
5. Enter values in the **Min** and **Max** fields.

## Filters

Filters can be applied to measurement values before they are output from the Gocator sensors.



**Filters**

Scale:

Offset:

Hold Last Valid: ☐

☒ Smoothing:   Samples

Preserve Invalid: ☐

All measurements provide filter settings under the **Output** tab. The following settings are available.

| Filter           | Description                                                                                                                                                                                                                                                                                                                                                                                                                                             |
|------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Scale and Offset | <p>The Scale and Offset settings are applied to the measurement value according to the following formula:</p> $\text{Scale} * \text{Value} + \text{Offset}$ <p><b>Scale</b> and <b>Offset</b> can be used to transform the output without the need to write a script. For example, to convert the measurement value from millimeters to thousands of an inch, set <b>Scale</b> to 39.37. To convert from radius to diameter, set <b>Scale</b> to 2.</p> |
| Hold Last Valid  | Holds the last valid value when the measurement is invalid. Measurement is invalid if there is no valid value.                                                                                                                                                                                                                                                                                                                                          |
| Smoothing        | <p>Applies moving window averaging to reduce random noise in a measurement output. The averaging window is configured in number of frames.</p> <p>If <b>Hold Last Valid</b> is enabled, smoothing uses the output of the <b>Hold Last Valid</b> filter.</p>                                                                                                                                                                                             |
| Preserve Invalid | When enabled, smoothing is only applied to valid measurements and not to invalid results. When disabled, smoothing is applied to both valid and invalid results. (This setting is only visible when <b>Smoothing</b> is enabled.)                                                                                                                                                                                                                       |

*To configure the filters:*

1. Go to the **Measure** page by clicking on the **Measure** icon.

 The [scan mode](#) must be set to the type of measurement you need to configure. Otherwise, the wrong tools, or no tools, will be listed on the **Measure** page.

2. In the **Tools** panel, click on a tool in the tool list.
3. In the measurement list, select a measurement.  
To select a measurement, it must be enabled. See *Enabling and Disabling Measurements* on page 180 for instructions on how to enable a measurement.
4. Click on the **Output** tab.  
For some measurements, only the **Output** tab is displayed.

5. Expand the **Filters** panel by clicking on the panel header or the  button.
6. Configure the filters.  
Refer to the table above for a list of the filters.

## Measurement Anchoring

When parts that a sensor is scanning move on a transport mechanism such as a conveyor, their position typically changes from part to part in one or both of the following ways:

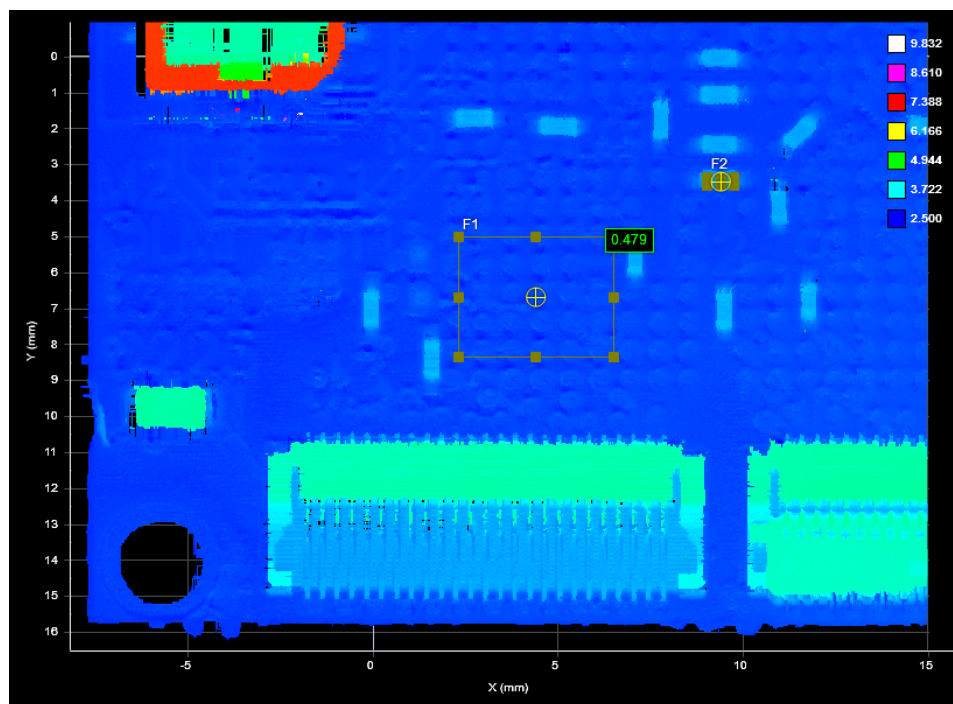
- along the X, Y, and Z axes (basically, horizontally and vertically)
- around the Z axis (orientation angle)

When the position and angle variation between parts is minor—for example, when scanning electronic parts in trays—you can anchor one tool to one or more measurements from another tool to compensate for these minor shifts. As a result, Gocator can correctly place the anchored tool's measurement regions on each part. This increases the repeatability and accuracy of measurements.

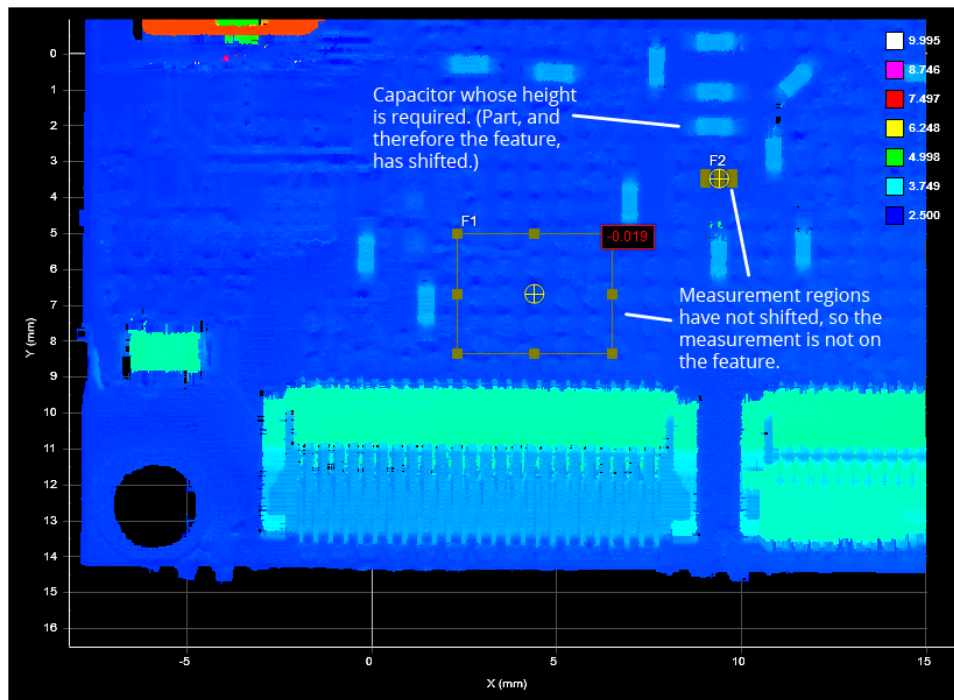


For cases where movement from part to part is more drastic, you can use part matching to compensate. However, in order for [part matching](#) to work properly, the entire part typically must be visible in the field of view.

For example, the following image shows a surface scan of a PCB. A [Surface Dimension](#) height measurement returns the height of a surface-mount capacitor relative to a nearby surface (the F1 region).

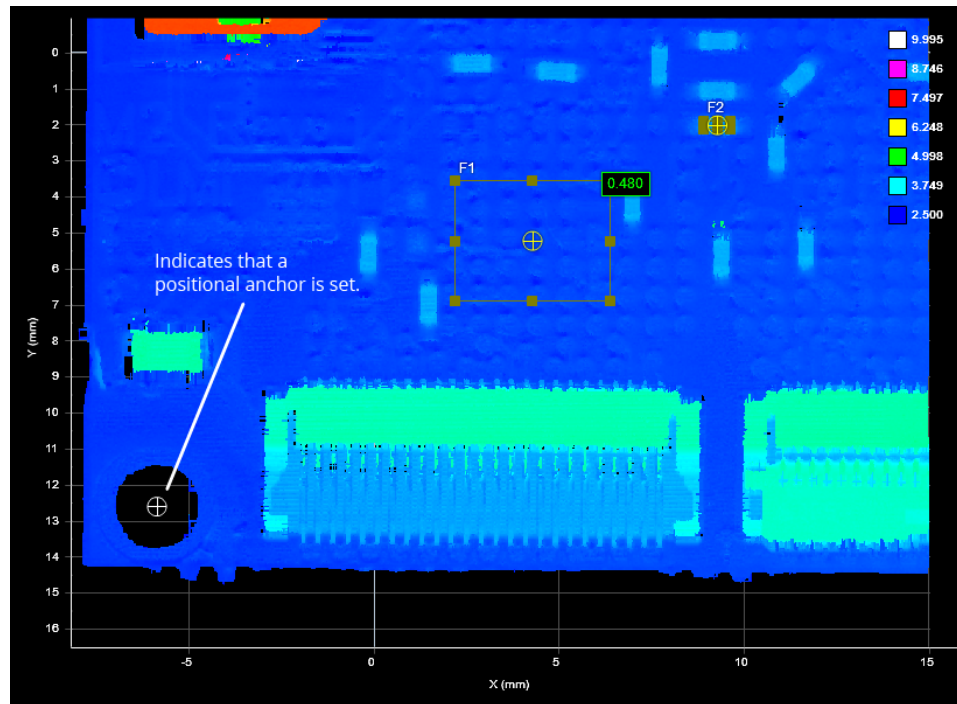


In the following scan, the part has shifted, but the measurement regions remain where they were originally configured, in relation to the sensor or system coordinate system, so the measurement returned is incorrect:

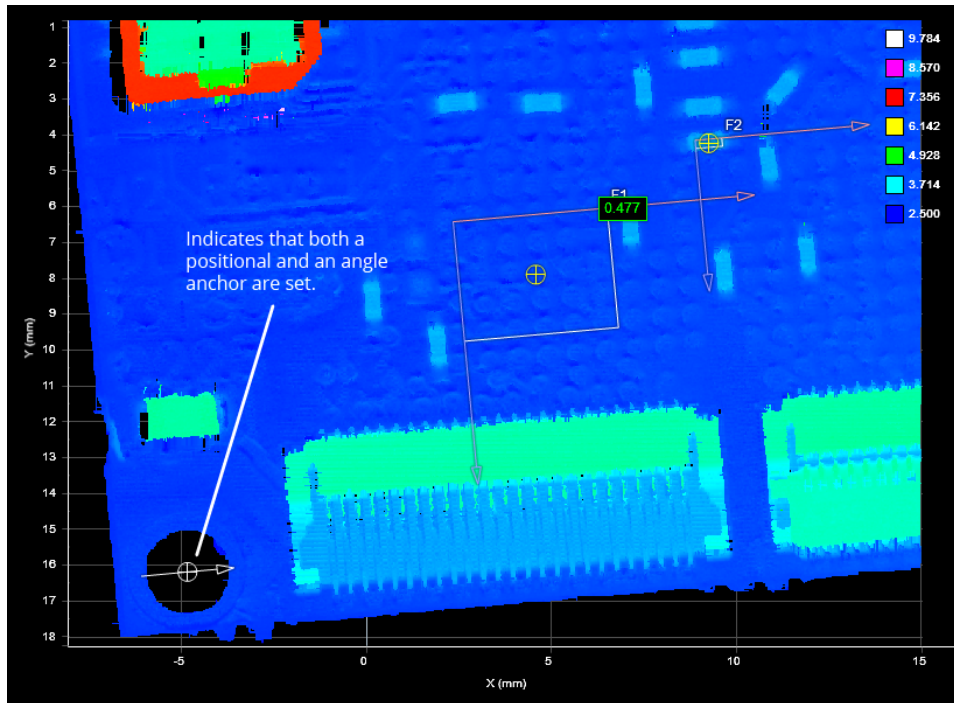


When you set a tool's anchor source, an offset is calculated between the anchored tool and the anchor source. This offset is used for each frame of scanned data: the anchored tool's [measurement region](#) is placed in relation to the anchor source, at the calculated offset.

In the following image, after the Surface Dimension tool is anchored to the X and Y measurements from a [Surface Hole tool](#) (placed over the hole to the lower left), Gocator compensates for the shift—mostly along the Y axis in this case—and returns a correct measurement, despite the shift.



You can combine the positional anchors (X, Y, or Z measurements) with an angle anchor (a Z Angle measurement) for optimum measurement placement. For example, in the following scan, the part has not only shifted on the XY plane but also rotated around the Z axis. Anchoring the Surface Dimension tool to the Z Angle measurement of a [Surface Edge tool](#) (placed on the lower edge in this case) compensates for the rotation, and the anchored tool returns a correct measurement.



If Z Angle anchoring is used with both X and Y anchoring, the X and Y anchors should come from the same tool.



If Z Angle anchoring is used without X or Y anchoring, the tool's measurement region rotates around its *center*. If only one of X or Y is used, the region is rotated around its center and then shifted by the X or Y offset.

Several anchors can be created to run in parallel. For example, you could anchor the measurements of one tool relative to the left edge of a target, and anchor the measurements of another tool relative to the right edge of a target.

You can combine positional anchors (X, Y, or Z) with angle anchors (Z Angle) for optimum measurement placement.

#### *To anchor a profile or surface tool to a measurement:*

1. Place a representative target object in the field of view.

##### *In Profile mode*

- a. Use the **Start** or **Snapshot** button to view live profile data to help position the target.

##### *In Surface mode*

- a. Select a Surface Generation type (*Surface Generation* on page 119) and adjust Part Detection settings (see *Part Detection* on page 123) if applicable.
  - b. Start the sensor, scan the target, and then stop the sensor.
2. On the **Measure** page, add a suitable tool to act as an anchor.  
A suitable tool is one that returns an X, Y, or Z position or Z Angle as a measurement value.

3. Adjust the anchoring tool's settings and measurement region, and choose a feature type (if applicable). You can adjust the measurement region graphically in the data viewer or manually by expanding the **Regions** area.

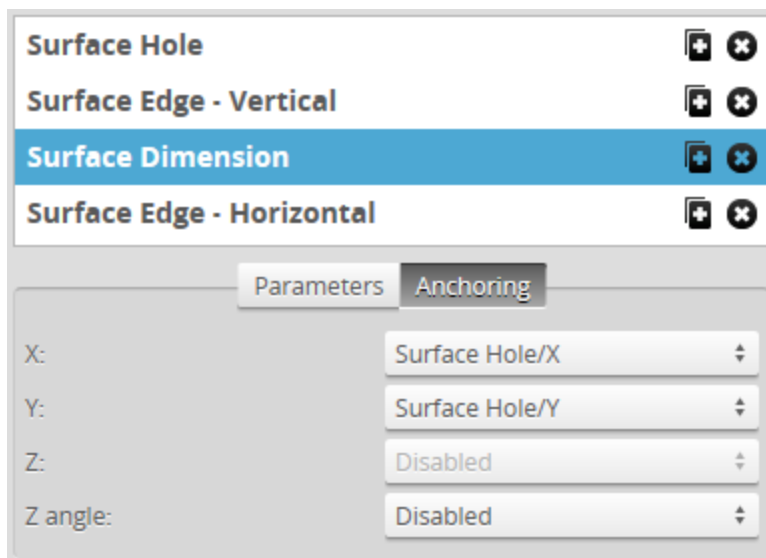
The position and size of the anchoring tool's measurement regions define the zone within which movement will be tracked.



If you intend to use angle anchoring and the part in the initial scan is rotated too much, you may need to rotate the anchoring tool's region to accommodate this rotation. For more information on region rotation, see *Regions* on page 165.

See *Feature Points* on page 168 for more information on feature types.

4. Add the tool that you want to anchor.  
Any tool can be anchored.
5. Adjust the tool and measurement settings, as well as the measurement regions, on a scan of the representative target.
6. Click on the tool's **Anchoring** tab.
7. Choose an anchor from one of the drop-down boxes.



If the sensor is running, the anchored tool's measurement regions are shown in white to indicate the regions are locked to the anchor. The measurement regions of anchored tools cannot be adjusted. The anchored tool's measurement regions are now tracked and will move with the target's position and angle under the sensor, as long as the anchoring measurement produces a valid measurement value. If the anchoring measurement is invalid, for example, if part moves outside its measurement region, the anchored tool will not show the measurement regions at all and an "Invalid-Anchor" message will be displayed in the tool panel.

8. Verify that the anchored tool works correctly on other scans of targets in which the part has moved slightly.

*To remove an anchor from a tool:*

1. Click on the anchored tool's Anchoring tab.  
Select **Disabled** in the X, Y, or Z drop-down.

## Enabling and Disabling Measurements

All of the measurements available in a tool are listed in the measurement list in the **Tools** panel after a tool has been added. To configure a measurement, you must enable it.

The screenshot shows the 'Tools' panel in the Gocator Web Interface. At the top, there's a 'Profile Area' dropdown and an 'Add' button. Below this is the 'Profile Dimension' section, which is currently active. It contains a list of measurements: 'Width' (167.960), 'Height', 'Distance', 'Center X', and 'Center Z'. The 'Width' measurement is checked, and its value is displayed in a green box. Below the measurements list, there's an 'Id' field with the value '0'. The 'Parameter' and 'Anchoring' tabs are visible. The 'Output' tab is also visible, showing 'Filters' and 'Decision' settings. The 'Decision' section has 'Min' and 'Max' fields with values '167 mm' and '168 mm' respectively.

*To enable a measurement:*

1. Go to the **Scan** page by clicking on the **Scan** icon.
2. Choose Profile or Surface mode in the **Scan Mode** panel.  
If one of these modes is not selected, tools will not be available in the **Measure** panel.
3. Go to the **Measure** page by clicking on the **Measure** icon.
4. In the measurements list, check the box of the measurement you want to enable.  
The measurement will be enabled and selected. The **Output** tab, which contains output settings will be displayed below the measurements list. For some measurements, a **Parameters** tab, which contains measurement-specific parameters, will also be displayed.

*To disable a measurement:*

1. Go to the **Scan** page by clicking on the **Scan** icon.
2. Choose Profile or Surface mode in the **Scan Mode** panel.
3. Go to the **Measure** page by clicking on the **Measure** icon.
4. In the measurement list, uncheck the box of the measurement you want to disable.  
The measurement will be disabled and the **Output** tab (and the **Parameters** tab if it was available) will be hidden.

## Editing a Tool or Measurement Name

You can change the names of tools you add in Gocator. You can also change the names of their measurements. This allows multiple instances of tools and measurements of the same type to be more easily distinguished in the Gocator web interface. The measurement name is also referenced by the Script tool.

*To change a tool or measurement name:*

1. Go to the **Scan** page by clicking on the **Scan** icon.
2. Choose Profile or Surface mode in the **Scan Mode** panel.  
If one of these modes is not selected, tools will not be available in the **Measure** panel.
3. Go to the **Measure** page by clicking on the **Measure** icon.
4. Do one of the following:
  - **Tool:** In the tool list, double-click the tool name you want to change
  - **Measurement:** In a tool's measurement list, double-click the measurement name you want to change.
5. Type a new name.
6. Press the Tab or Enter key, or click outside the field.  
The name will be changed.

## Changing a Measurement ID

The measurement ID is used to uniquely identify a measurement in the Gocator protocol or in the SDK. The value **must** be unique among all measurements.

*To edit a measurement ID:*

1. Go to the **Scan** page by clicking on the **Scan** icon.
2. Choose Profile or Surface mode in the **Scan Mode** panel.  
If one of these modes is not selected, tools will not be available in the **Measure** panel.
3. Go to the **Measure** page by clicking on the **Measure** icon.
4. In the measurement list, select a measurement.



To select a measurement, it must be enabled. See *Enabling and Disabling Measurements* on page 180 for instructions on how to enable a measurement.

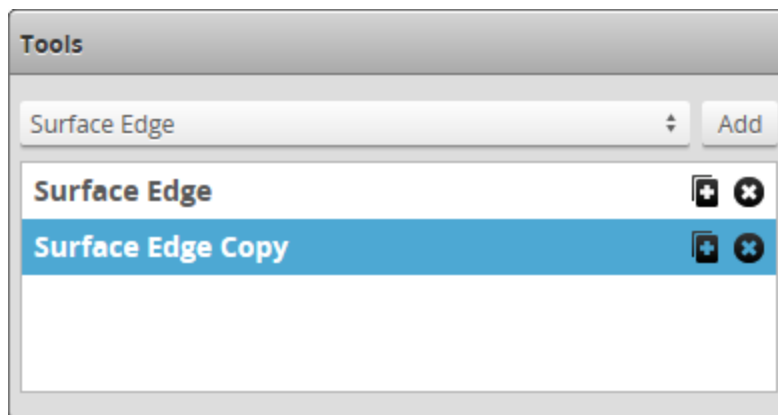
5. Click in the ID field.
6. Type a new ID number.  
The value must be unique among all measurements.
7. Press the Tab or Enter key, or click outside the ID field.  
The measurement ID will be changed.

## Duplicating a Tool

You can quickly create a copy of a previously added tool in Gocator. All settings of the original are copied. This is useful, for example, when you need almost identical tools with only minor variations, such as different Min and Max values.

*To duplicate a tool:*

1. Go to the **Scan** page by clicking on the **Scan** icon.
2. Choose Profile or Surface mode in the **Scan Mode** panel.  
If one of these modes is not selected, tools will not be available in the **Measure** panel.
3. Go to the **Measure** page by clicking on the **Measure** icon.
4. In the tool list, click on the Duplicate button (📄) of the tool you want to duplicate.  
A copy of the tool appears below the original.



5. Configure the copy as desired and rename it if necessary.  
For information on renaming a tool, see *Editing a Tool or Measurement Name* on the previous page.

## Removing a Tool

Removing a tool removes all of its associated measurements.

*To remove a tool:*

1. Go to the **Scan** page by clicking on the **Scan** icon.
2. Choose Profile or Surface mode in the **Scan Mode** panel.  
If is not selected, tools will not be available in the **Measure** panel.

3. Go to the **Measure** page by clicking on the **Measure** icon.
4. In the tool list, click on the Duplicate button () of the tool you want to duplicate.  
A copy of the tool appears below the original.

## Profile Measurement

This section describes the profile measurement tools available in Gocator sensors.

When Gocator is in Surface [mode](#) and you have defined a [section](#), a Stream option displays in Profile tools.

The following tools are available when **Uniform Spacing** is disabled:

- [Bridge Value](#)
- [Dimension](#)
- [Position](#)
- [Script](#)

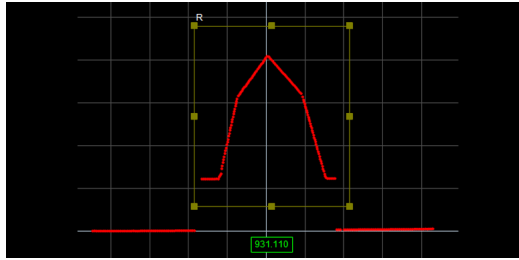
For more information on the **Uniform Spacing** setting and resampled data, see *Uniform Spacing (Data Resampling)* on page 53.

Profile measurement tools can be used on sections. For more information on sections, see *Sections* on page 155.

## Area

The Area tool determines the cross-sectional area within a region. Gocator compares the measurement value with the values in **Min** and **Max** to yield a decision. For more information on decisions, see *Decisions* on page 172.

See *Adding and Configuring a Tool* on page 163 for instructions on how to add measurement tools.



Parameters
Anchoring

Source: Top
Type: Object
Baseline: Line
☒ Region
Line: 1 Region

Measurements
Features

Area 931.110 ☒
Centroid X ☐
Centroid Z ☐

ID: 0

Output

Filters

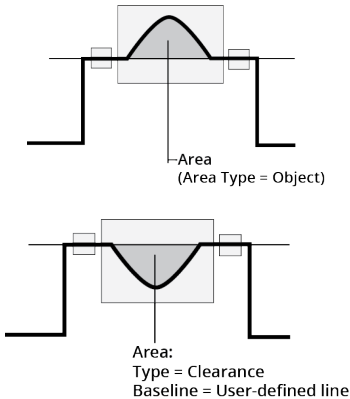
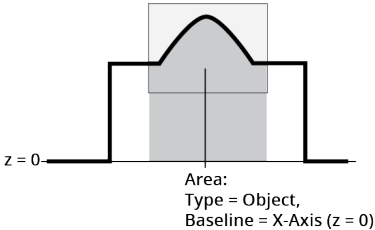
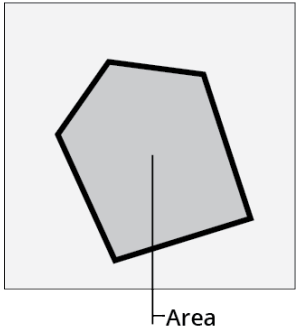
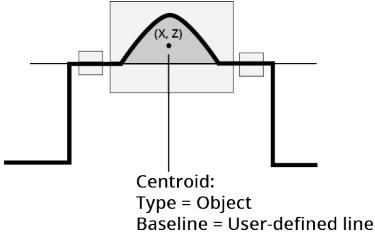
Decision

Min: 930 mm<sup>2</sup>
Max: 940 mm<sup>2</sup>

Areas are positive in regions where the profile is above the X axis. In contrast, areas are negative in regions where the profile is below the X axis.

Measurements, Features, and Settings

Measurements

| Measurement                                                                                                           | Illustration                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        |
|-----------------------------------------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <p><b>Area</b></p> <p>Measures the cross-sectional area within a region that is above or below a fitted baseline.</p> |  <p>Area<br/>(Area Type = Object)</p> <p>Area:<br/>Type = Clearance<br/>Baseline = User-defined line</p> <p>Standalone,<br/>or dual-sensor setup<br/>in Wide orientation</p>  <p>z = 0</p> <p>Area:<br/>Type = Object,<br/>Baseline = X-Axis (z = 0)</p> <p>Dual-sensor setup<br/>in Opposite orientation</p>  <p>Area</p> |
| <p><b>Centroid X</b></p> <p>Determines the X position of the centroid of the area.</p>                                |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     |
| <p><b>Centroid Z</b></p> <p>Determines the Z position of the centroid of the area.</p>                                |  <p>Centroid:<br/>Type = Object<br/>Baseline = User-defined line</p>                                                                                                                                                                                                                                                                                                                                                                                                                            |

Features

| Type         | Description                   |
|--------------|-------------------------------|
| Center Point | The center point of the area. |



For more information on geometric features, see *Geometric Features* on page 171.

## Parameters

| Parameter | Description                                                                                                                                                                                                                                                                                                                                                                                                                                |
|-----------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Type      | <p><b>Object</b> area type is for convex shapes above the baseline. Regions below the baseline are ignored.</p> <p><b>Clearance</b> area type is for concave shapes below the baseline. Regions above the baseline are ignored.</p>                                                                                                                                                                                                        |
| Baseline  | <p>Baseline is the fit line that represents the line above which (Object clearance type) or below which (Clearance area type) the cross-sectional area is measured.</p> <p>When this parameter is set to <b>Line</b>, you must define a line in the Line parameter. See <i>Fit Lines</i> on page 170 for more information on fit lines.</p> <p>When this parameter is set to <b>X-Axis</b>, the baseline is set to <math>z = 0</math>.</p> |
| Line      | <p>When Baseline is set to <b>Line</b>, you must set this parameter. See <i>Fit Lines</i> on page 170 for more information on fit lines.</p>                                                                                                                                                                                                                                                                                               |
| Decision  | See <i>Decisions</i> on page 172.                                                                                                                                                                                                                                                                                                                                                                                                          |
| Region    | See <i>Regions</i> on page 165.                                                                                                                                                                                                                                                                                                                                                                                                            |
| Filters   | See <i>Filters</i> on page 173.                                                                                                                                                                                                                                                                                                                                                                                                            |

## Bounding Box

The Bounding Box tool provides measurements related to the smallest box that contains the profile (for example, X position, Z position, width, etc.).

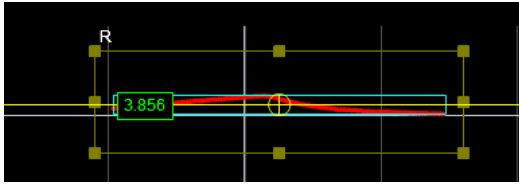
Gocator compares the measurement value with the values in **Min** and **Max** to yield a decision. For more information on decisions, see *Decisions* on page 172.

See *Adding and Configuring a Tool* on page 163 for instructions on how to add measurement tools.

The bounding box provides the absolute position from which the Position centroids tools are referenced.



When you use measurement tools on parts or sections, the coordinates returned are relative to the part or section. You can use the values returned by the Bounding Box tool's "Global" (see below) measurements as an offset in a Gocator script to convert the positional (X, Y, or Z) measurements of other measurement tools to [sensor](#) or [system](#) coordinates (depending on whether the sensor is aligned). For more information on Gocator scripts, see *Scripts* on page 278.



ParametersAnchoring

Source: Top

☒ Region

MeasurementsFeatures

X4.703☒  
Z☐  
Width☐  
Height☐  
Global X☐  
Global Y☐  
Global Angle☐

ID: 1

Output

Filters

Decision

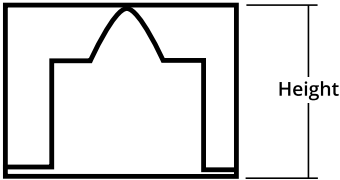
Min: 4 mm  
Max: 5 mm

Measurement Panel

Measurements, Features, and Settings

Measurements

| Measurement                                                                                                                                                                   | Illustration |
|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--------------|
| <p><b>X</b></p> <p>Determines the X position of the center of the bounding box that contains the profile.</p> <p>The value returned is relative to the profile.</p>           |              |
| <p><b>Z</b></p> <p>Determines the Z position of the center of the bounding box that contains the profile.</p> <p>The value returned is relative to the profile.</p>           |              |
| <p><b>Width</b></p> <p>Determines the width of the bounding box that contains the profile. The width reports the dimension of the box in the direction of the minor axis.</p> |              |

| Measurement                                                                                                                                                                                                                                                                                                                                                                        | Illustration                                                                       |
|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------------------------------------------------------------------------------|
| <b>Height</b><br>Determines the height (thickness) of the bounding box that contains the profile.                                                                                                                                                                                                                                                                                  |  |
| <b>Global X<sup>*</sup></b><br>Determines the X position of the center of the bounding box that contains the profile relative to the surface from which the profile is extracted.                                                                                                                                                                                                  |                                                                                    |
| <b>Global Y<sup>*</sup></b><br>Determines the Y position of the center of the bounding box that contains the profile relative to the surface from which the profile is extracted.                                                                                                                                                                                                  |                                                                                    |
| <b>Global Angle<sup>*</sup></b><br>Determines the angle around Z of the section used to create the profile, relative to the surface from which it is extracted, where a line parallel to the X axis is 0 degrees.<br><br>Angles of sections pointing to the bottom of the data viewer are positive.<br><br>Angles of sections pointing to the top of the data viewer are negative. |                                                                                    |



\*The Global X, Global Y, and Global Angle measurements are intended to be used with profiles extracted from a surface using a section.

When used with profiles not generated from a section, the Global X measurement returns the same value as the X measurement, and the Global Y and Global Angle measurements return 0.000.

## Features

| Type         | Description                                |
|--------------|--------------------------------------------|
| Center Point | The center point of the bounding box.      |
| Corner Point | The lower left corner of the bounding box. |



For more information on geometric features, see *Geometric Features* on page 171.

## Parameters

| Parameter | Description                       |
|-----------|-----------------------------------|
| Decision  | See <i>Decisions</i> on page 172. |
| Region    | See <i>Regions</i> on page 165.   |
| Filters   | See <i>Filters</i> on page 173.   |

## Bridge Value

The Bridge Value tool lets you calculate the "bridge value" and angle of a scanned surface. A bridge value is a single, processed range that is basically a filtered average of a laser line profile, representing a "roughness calculation." A bridge value is typically used to measure road roughness.

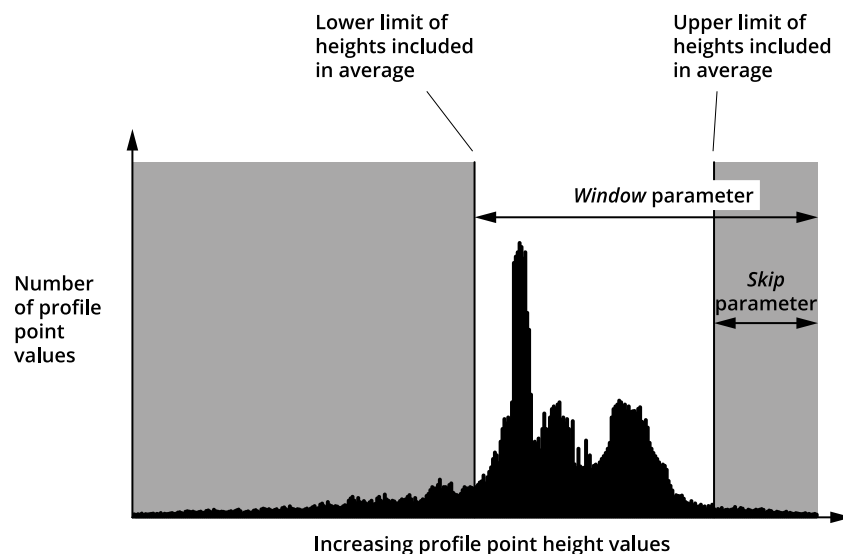


The Bridge value tool is *only* available when **Uniform Spacing** (in the **Scan Mode** panel on the **Scan** page) is unchecked, as the tool only works with unresampled data. For more information, see *Uniform Spacing (Data Resampling)* on page 53.



This measurement is only available on Gocator 2342 sensors.

The Bridge Value tool measurements use a histogram of the ranges that make up the profile, in which the ranges are ordered from lowest to highest. The **Window** and **Skip** parameters together determine what segment of the heights in the histogram is used to calculate the bridge value. The following diagram illustrates what points of the histogram would be included for calculating the bridge value where **Window** is roughly 50% and **Skip** is roughly 15% of the histogram.

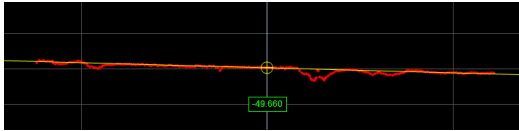


Profile point heights in the white area are included in the calculation of the average. Profile point heights in the grey area are excluded. By adjusting the **Window** and **Skip** parameters, you can choose profile point heights to remove unwanted features. In road roughness applications, you could exclude road features, such as rocks, cracks, tining valleys, and so on, to get an accurate representation of the tire-to-road interface. For more information on parameters, see the *Parameters* table below.

Gocator compares the measurement value with the values in **Min** and **Max** to yield a decision. For more information on decisions, see *Decisions* on page 172.

See *Adding and Configuring a Tool* on page 163 for instructions on how to add measurement tools.





Parameters
Anchoring

Source:
Top

Window:
50 %

Skip:
15 %

Max Invalid:
80 %

Max Differential:
No Limit mm

Normalize Tilt:
☒

Region

Bridge Value
-49.237

Angle
0.000

ID:
0

Output

Filters

Decision

Min:
-50 mm

Max:
-49 mm

Measurement Panel

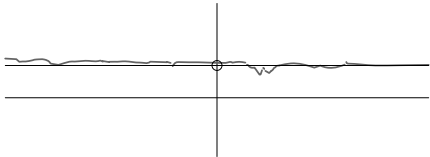
Measurements

Measurement

Illustration

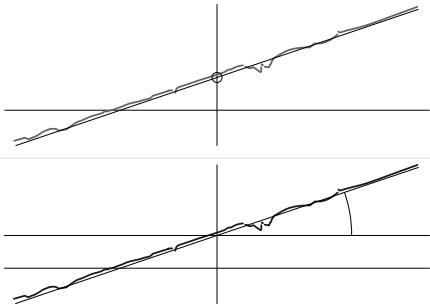
Bridge Value

Determines the bridge value of the profile.



Angle

Determines the angle of the line fitted to the profile.  
When Normalize Tilt is unchecked, the measurement always returns 0.



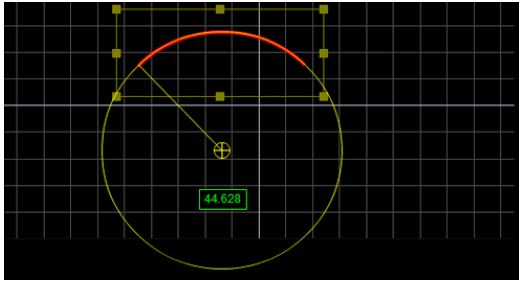
## Parameters

| Parameter        | Description                                                                                                                                                                                                                                                                                                                                                                                                                                                                      |
|------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Window           | <p>A percentage of the profile point heights in the histogram, starting from the highest point, to include in the average. For example, a setting of 50% would include the highest 50% of the heights. The <b>Skip</b> parameter then determines the actual portion of the profile point heights used to calculate the average.</p> <p>The <b>Window</b> setting in effect sets the lower limit of the portion of profile points in the histogram to be used in the average.</p> |
| Skip             | <p>A percentage of the profile point heights in the histogram, starting from the highest points, to exclude from the average.</p> <p>The percentage represents the portion of the entire profile, not the portion defined by <b>Window</b>.</p> <p>The <b>Skip</b> setting basically sets the upper limit of the portion of profile points in the histogram to be used in the average. If <b>Skip</b> is greater than <b>Window</b>, an invalid value is returned.</p>           |
| Max Invalid      | <p>The maximum percentage of invalid points allowed before an invalid result is returned.</p>                                                                                                                                                                                                                                                                                                                                                                                    |
| Max Differential | <p>The maximum difference between the maximum and minimum histogram values before an invalid measurement value is produced.</p>                                                                                                                                                                                                                                                                                                                                                  |
| Normalize Tilt   | <p>Fits a line to the profile and shears the points in the Z direction by the angle between the fitted line and the X axis. The <b>Window</b> and <b>Skip</b> settings are applied to the histogram of the transformed data.</p> <p>Useful for surfaces that are tilted.</p>                                                                                                                                                                                                     |
| Decision         | <p>See <i>Decisions</i> on page 172.</p>                                                                                                                                                                                                                                                                                                                                                                                                                                         |
| Region           | <p>See <i>Regions</i> on page 165.</p>                                                                                                                                                                                                                                                                                                                                                                                                                                           |
| Filters          | <p>See <i>Filters</i> on page 173.</p>                                                                                                                                                                                                                                                                                                                                                                                                                                           |

## Circle

The Circle tool provides measurements that find the best-fitted circle to the live profile and measure various characteristics of the circle. Gocator compares the measurement value with the values in **Min** and **Max** to yield a decision. For more information on decisions, see *Decisions* on page 172.

See *Adding and Configuring a Tool* on page 163 for instructions on how to add measurement tools.



ParametersAnchoring

Source:

Top

☒ Region

↺

⋮

MeasurementsFeatures

X

□

Z

□

Radius

44.628

☒

ID:

2

Output

Filters

⋮

Decision

Min:

44

mm

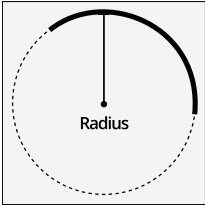
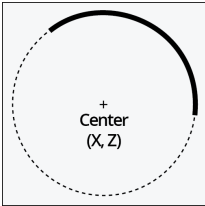
Max:

46

mm

# Measurements, Features, and Settings

## Measurements

| Measurement                                                 | Illustration                                                                          |
|-------------------------------------------------------------|---------------------------------------------------------------------------------------|
| <b>Radius</b><br>Measures the radius of the circle.         |   |
| <b>X</b><br>Finds the circle center position in the X axis. |  |
| <b>Z</b><br>Finds the circle center position in the Z axis. |                                                                                       |

## Features

| Type         | Description                            |
|--------------|----------------------------------------|
| Center Point | The center point of the fitted circle. |

📄

For more information on geometric features, see *Geometric Features* on page 171.

## Parameters

| Parameter | Description                       |
|-----------|-----------------------------------|
| Decision  | See <i>Decisions</i> on page 172. |
| Region    | See <i>Regions</i> on page 165.   |
| Filters   | See <i>Filters</i> on page 173.   |

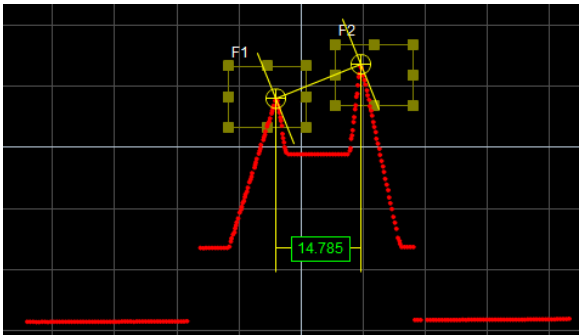
Dimension

The Dimension tool provides Width, Height, Distance, Center X, and Center Z measurements.



The Dimension tool can be used whether **Uniform Spacing** is enabled or not, that is, with either resampled or unresampled data. For more information on the **Uniform Spacing** setting and resampled data, see *Uniform Spacing (Data Resampling)* on page 53.

See *Adding and Configuring a Tool* on page 163 for instructions on how to add measurement tools.



ParametersAnchoring

Source:Top

Feature 1Max Z

Feature 2Max Z

Width

Height

Distance14.785

Center X

Center Z

Id:4

Output

Filters

Decision

Min:14 mm

Max:15 mm

The tool's measurements require two feature points. See *Feature Points* on page 168 for information on point types and how to configure them.

Measurements

Measurement

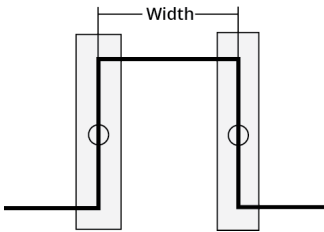
Illustration

Width

Determines the difference along the X axis between two feature points.

The difference can be calculated as an absolute or signed result. The difference is calculated by:

$Width = Feature\ 2_{X\ position} - Feature\ 1_{X\ position}$



## Measurement

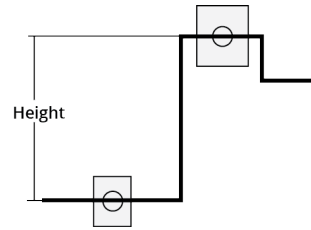
### Height

Determines the difference along the Z axis between two feature points.

The difference can be expressed as an absolute or signed result. The difference is calculated by:

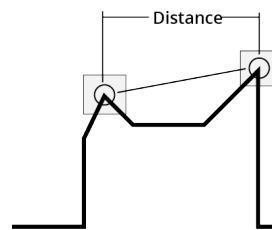
$$\text{Height} = \text{Feature 2}_{Z \text{ position}} - \text{Feature 1}_{Z \text{ position}}$$

## Illustration



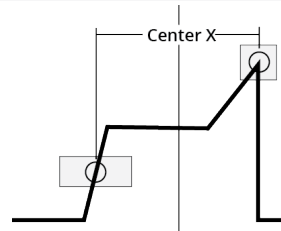
### Distance

Determines the direct, Euclidean distance between two feature points.



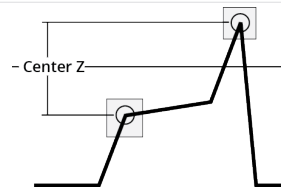
### Center X

Finds the average location of two features and measures the X axis position of the average location



### Center Z

Finds the average location of two features and measures the Z axis position of the average location.



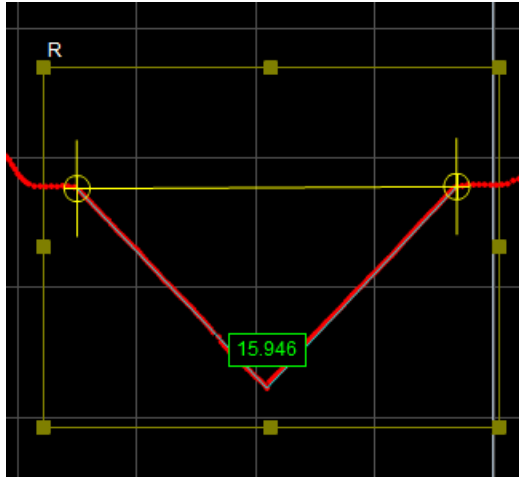
## Parameters

| Parameter                                        | Description                                                                  |
|--------------------------------------------------|------------------------------------------------------------------------------|
| Absolute<br>(Width and Height measurements only) | Determines if the result will be expressed as an absolute or a signed value. |
| Decision                                         | See <i>Decisions</i> on page 172.                                            |
| Region                                           | See <i>Regions</i> on page 165.                                              |
| Filters                                          | See <i>Filters</i> on page 173.                                              |

## Groove

The Groove tool provides measurements of V-shape, U-shape, or open-shape grooves. Gocator compares the measurement value with the values in **Min** and **Max** to yield a decision. For more information on decisions, see *Decisions* on page 172.

See *Adding and Configuring a Tool* on page 163 for instructions on how to add measurement tools.



ParameterAnchoring

Source:Top
Shape:U-Shape
Min Depth:0 mm
Min Width:0 mm
Max Width:0 mm
☒ Region

Width
Add

X
Z
Width15.946
Depth

Id:6

ParametersOutput

Select Type:Max Depth
Index:0

The Groove tool uses a complex feature-locating algorithm to find a groove and then return measurements. See "Groove Algorithm" in the *Gocator Measurement Tool Technical Manual* for a detailed explanation of the algorithm. The behavior of the algorithm can be adjusted by changing the parameters in the measurement panel.

The Groove tool lets you add multiple measurements of the same type to receive measurements and set decisions for multiple grooves. Multiple measurements are added by using the drop-down above the list of measurements and clicking on the **Add** button.

For example, if a target has three grooves, by adding two measurements, choosing **Index From The Left** in the **Select Type** setting of those measurements, and providing values of 0 and 2 in the **Index** setting of the measurements, respectively, the Groove tool will return measurements and decisions for the first and third grooves.

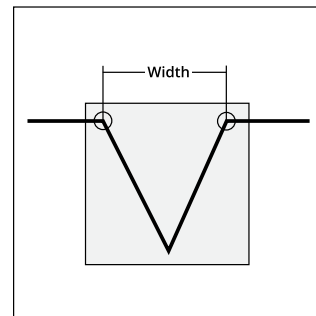
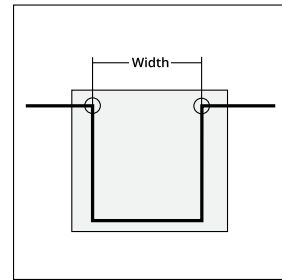
## Measurements

### Measurement

### Illustration

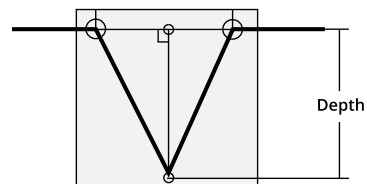
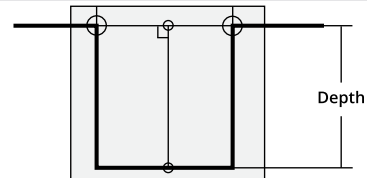
#### Width

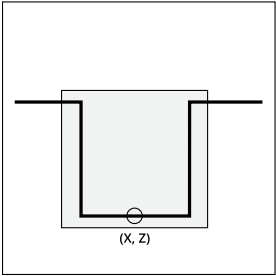
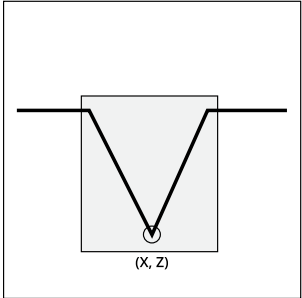
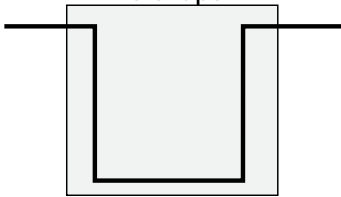
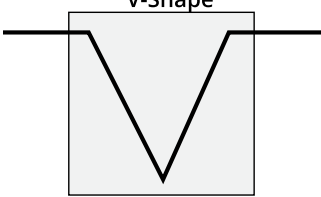
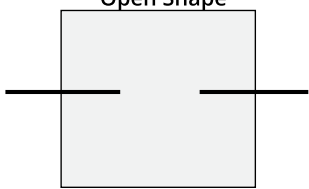
Measures the width of a groove.



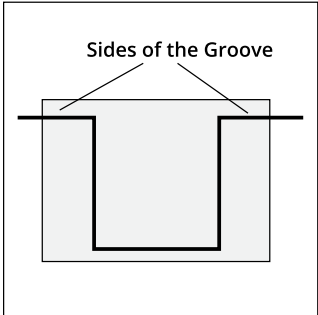
#### Depth

Measures the depth of a groove as the maximum perpendicular distance from a line connecting the edge points of the groove.



| Measurement                                                    | Illustration                                                                                                                                                                                                                                                                                                                                                                                          |
|----------------------------------------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <b>X</b><br>Measures the X position of the bottom of a groove. |                                                                                                                                                                                                                                                                                                                     |
| <b>Z</b><br>Measures the Z position of the bottom of a groove. |                                                                                                                                                                                                                                                                                                                     |
| <b>Parameters</b>                                              |                                                                                                                                                                                                                                                                                                                                                                                                       |
| Parameter                                                      | Description                                                                                                                                                                                                                                                                                                                                                                                           |
| Shape                                                          | Shape of the groove <div> <div>  U-Shape </div> <div>  V-Shape </div> <div>  Open Shape </div> </div>                                      |
| Location<br><i>(Groove X and Groove Z measurements only)</i>   | Specifies the location type to return<br><br>Bottom - Groove bottom. For a U-shape and open-shape groove, the X position is at the centroid of the groove. For a V-shape groove, the X position is at the intersection of lines fitted to the left and right sides of the groove. See algorithm section below for more details.<br><br>Left - Groove's left corner.<br>Right - Groove's right corner. |



| Parameter                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             | Description                                                                                                                                                                                                                                                                                                              |
|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Select Type                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           | <p>Specifies how a groove is selected when there are multiple grooves within the measurement area.</p> <p>Maximum Depth - Groove with maximum depth.</p> <p>Index from The Left - 0-based groove index, counting from left to right</p> <p>Index from the Right - 0-based groove index, counting from right to left.</p> |
| Index                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 | 0-based groove index.                                                                                                                                                                                                                                                                                                    |
| Minimum Depth                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         | Minimum depth for a groove to be considered valid.                                                                                                                                                                                                                                                                       |
| Minimum Width                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         | Minimum width for a groove to be considered valid. The width is the distance between the groove corners.                                                                                                                                                                                                                 |
| Maximum Width                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         | Maximum width of a groove to be considered valid. If set to 0, the maximum is set to the width of the measurement area.                                                                                                                                                                                                  |
| Decision                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              | See <i>Decisions</i> on page 172.                                                                                                                                                                                                                                                                                        |
| Region                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                | <p>The measurement region defines the region in which to search for the groove. For a stable measurement, the measurement region should be made large enough to cover some laser data on the left and right sides of the groove. See <i>Regions</i> on page 165.</p>                                                     |
|  <p>The diagram shows a cross-section of a groove. A large rectangle represents the measurement region. Inside this region, a smaller rectangle represents the groove. Two lines point from the text 'Sides of the Groove' to the vertical walls of the groove. The top surface of the groove is a horizontal line, and the bottom is a horizontal line. The region outside the groove but within the measurement region is shaded light gray.</p> |                                                                                                                                                                                                                                                                                                                          |
| Filters                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               | See <i>Filters</i> on page 173.                                                                                                                                                                                                                                                                                          |

## Intersect

The Intersect tool determines intersect points and angles. Gocator compares the measurement value with the values in **Min** and **Max** to yield a decision. For more information on decisions, see *Decisions* on page 172.

The Intersect tool's measurements require two fit lines, one of which is a reference line set to the X axis ( $z = 0$ ), the Z axis ( $x = 0$ ), or a user-defined line.

See *Adding and Configuring a Tool* on page 163 for instructions on how to add measurement tools.



ParametersAnchoring

Source:Top
Reference Type:Line
Line (L)2 Regions
Ref Line (RL)2 Regions

MeasurementsFeatures

X-0.291
Z
Angle

Output

Filters
Decision

Min:-3 mm
Max:-2 mm

## Measurements, Features, and Settings

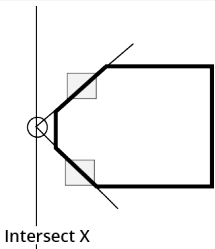
### Measurements

#### Measurement

#### Illustration

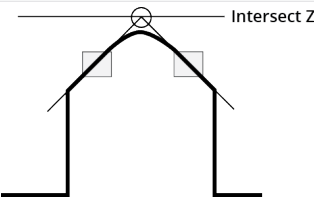
##### X

Finds the intersection between two fitted lines and measures the X axis position of the intersection point.



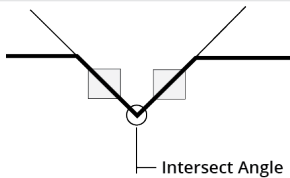
##### Z

Finds the intersection between two fitted lines and measures the Z axis position of the intersection point.



##### Angle

Finds the angle subtended by two fitted lines.



### Features

| Type            | Description                |
|-----------------|----------------------------|
| Intersect Point | The point of intersection. |
| Line            | The intersect line.        |
| Base Line       | The base line.             |



For more information on geometric features, see *Geometric Features* on page 171.

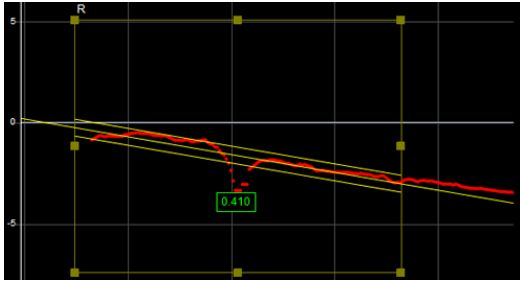
### Parameters

| Parameter                               | Description                                                                                                                                                                                                                                                                                                    |
|-----------------------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Reference Type                          | Determines the type of the reference line.<br><b>X-Axis:</b> The reference line is set to the X axis.<br><b>Z-Axis:</b> The reference line is set to the Z axis<br><b>Line:</b> The reference line is defined manually using the <b>Ref Line</b> parameter. One or two regions can be used to define the line. |
| Ref Line                                | Used to define the reference line when <b>Line</b> is selected in the <b>Reference Type</b> parameter.                                                                                                                                                                                                         |
| Line                                    | One or two fit areas can be used for each fit line.<br>See <i>Fit Lines</i> on page 170 for more information.                                                                                                                                                                                                  |
| Angle Range<br>(Angle measurement only) | Determines the angle range. The options are:<br><b>-90 – 90</b><br><b>0 – 180</b>                                                                                                                                                                                                                              |
| Decision                                | See <i>Decisions</i> on page 172.                                                                                                                                                                                                                                                                              |
| Region                                  | See <i>Regions</i> on page 165.                                                                                                                                                                                                                                                                                |
| Filters                                 | See <i>Filters</i> on page 173.                                                                                                                                                                                                                                                                                |

## Line

The Line tool fits a line to the live profile and measures the deviations from the best-fitted line. Gocator compares the measurement value with the values in **Min** and **Max** to yield a decision. For more information on decisions, see *Decisions* on page 172.

See *Adding and Configuring a Tool* on page 163 for instructions on how to add measurement tools.



ParametersAnchoring

Source: Top

☒ Region

X: -25.63 mm  
Z: -22.355 mm  
Width: 52.404 mm  
Height: 52.404 mm

☐ Fitting Regions All Data

MeasurementsFeatures

Standard Deviation 0.410 ☒  
Min Error ☐  
Max Error ☐  
Percentile ☐  
Offset ☐  
Angle ☐  
Min Error X ☐  
Min Error Z ☐  
Max Error X ☐  
Max Error Z ☐

ID: 4

Output

Filters

Decision

Min: 0 mm  
Max: 1 mm

# Measurements, Features, and Settings

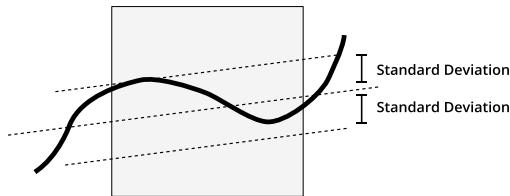
## Measurements

### Measurement

#### Standard Deviation

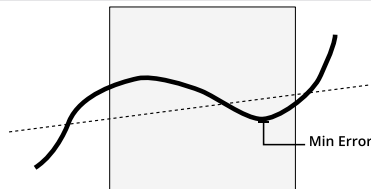
Finds the best-fitted line and measures the standard deviation of the laser points from the line.

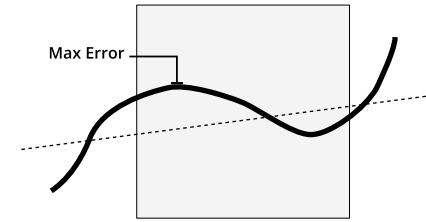
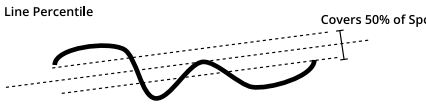
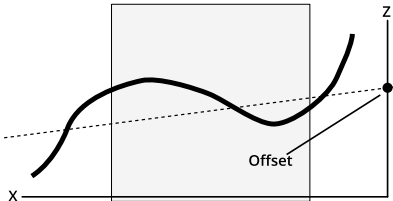
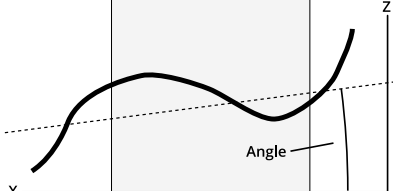
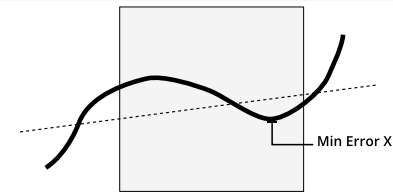
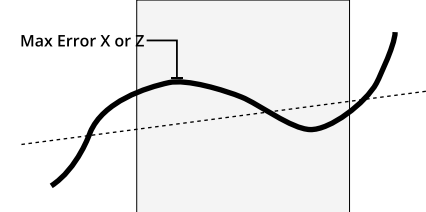
### Illustration



#### Min Error

Finds the best-fitted line and measures the minimum error from the line (the maximum distance below the line).



| Measurement                                                                                                                                                                                     | Illustration                                                                         |
|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--------------------------------------------------------------------------------------|
| <p><b>Max Error</b></p> <p>Finds the best-fitted line and measures the maximum error from the line (the maximum distance above the line).</p>                                                   |    |
| <p><b>Percentile</b></p> <p>Finds the best-fitted line and measures the range (in Z) that covers a percentage of points around the line.</p>                                                    |    |
| <p><b>Offset</b></p> <p>Finds the best-fitted line and returns the intersection point between that line and the Z axis.</p>                                                                     |    |
| <p><b>Angle</b></p> <p>Finds the best-fitted line and returns the angle relative to the X axis.</p>                                                                                             |   |
| <p><b>Min Error X</b></p> <p><b>Min Error Z</b></p> <p>Finds the best-fitted line and returns the X or Z position of the minimum error from the line (the maximum distance below the line).</p> |  |
| <p><b>Max Error X</b></p> <p><b>Max Error Z</b></p> <p>Finds the best-fitted line and returns the X or Z position of the maximum error from the line (the maximum distance above the line).</p> |  |
| Features                                                                                                                                                                                        |                                                                                      |
| Type                                                                                                                                                                                            | Description                                                                          |
| Line                                                                                                                                                                                            | The fitted line.                                                                     |
| Error Min Point                                                                                                                                                                                 | The point of minimum error.                                                          |
| Error Max Point                                                                                                                                                                                 | The point of maximum error.                                                          |


For more information on geometric features, see *Geometric Features* on page 171.

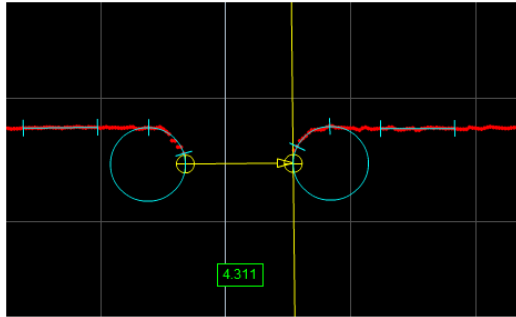
## Parameters

| Parameter                                | Description                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               |
|------------------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Percent<br>(Percentile measurement only) | The specified percentage of points around the best-fitted line.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           |
| Fitting Regions                          | <p>Determines which data Gocator uses to <i>fit the line</i> over the profile.</p> <p>When <b>Fitting Regions</b> is enabled, Gocator uses the data indicated by one of the following options:</p> <ul style="list-style-type: none"><li>• All Data: All of the data in the profile is used to fit the line.</li><li>• 1 Region: Data from a fitting region you define in the data viewer is used to fit the line.</li><li>• 2 Regions: Data from two fitting regions you define is used to fit the line.</li></ul> <p>When <b>Fitting Regions</b> is disabled, to fit the line, Gocator uses the measurement region if <b>Region</b> is enabled, or the entire profile if <b>Region</b> is disabled.</p> |
| Decision                                 | See <i>Decisions</i> on page 172.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         |
| Region                                   | See <i>Regions</i> on page 165.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           |
| Filters                                  | See <i>Filters</i> on page 173.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           |

## Panel

The Panel tool provides Gap and Flush measurements. Gocator compares the measurement value with the values in **Min** and **Max** to yield a decision. For more information on decisions, see *Decisions* on page 172.

See *Adding and Configuring a Tool* on page 163 for instructions on how to add measurement tools.



ParametersAnchoring

Source:Top
Reference Side:Left
Max Gap Width:0 mm
Left
Right

Gap4.311

Flush
Left Gap X
Left Gap Z
Left Flush X
Left Flush Z
Left Surface Angle
Right Gap X
Right Gap Z
Right Flush X
Right Flush Z
Right Surface Angle

ID:0

ParametersOutput

Measurement AxisEdge

The Panel tool uses a complex feature-locating algorithm to find the gap or calculate flushness and return measurements. The behavior of the algorithm can be adjusted by changing the parameters in the measurement panel. See "Gap and Flush Algorithm" in the *Gocator Measurement Tool Technical Manual* for a detailed explanation of the algorithm.



You must make sure that there are enough data points to define the edge in the profile, by properly setting up exposure, etc. If not, the algorithm will not function.

## Measurements

| Measurement                                                                                               | Illustration |
|-----------------------------------------------------------------------------------------------------------|--------------|
| <b>Gap</b><br>Measures the distance between two surfaces. The surface edges can be curved or sharp.       |              |
| <b>Flush</b><br>Measures the flushness between two surfaces. The surface edges can be curved or sharp.    |              |
| <b>Left Gap X</b><br>Returns the X position of the edge feature on the left side used to measure the gap. |              |
| <b>Left Gap Z</b><br>Returns the Z position of the edge feature on the left side used to measure the gap. |              |
| <b>Left Flush X</b><br>Returns the X position of the feature on the left side used to measure flushness.  |              |
| <b>Left Flush Z</b><br>Returns the Z position of the feature on the left side used to measure flushness.  |              |
| <b>Left Surface Angle</b><br>The angle of the left side surface relative to the X axis.                   |              |



| Measurement                                                                                                 | Illustration |
|-------------------------------------------------------------------------------------------------------------|--------------|
| <b>Right Gap X</b><br>Returns the X position of the edge feature on the right side used to measure the gap. |              |
| <b>Right Gap Z</b><br>Returns the Z position of the edge feature on the right side used to measure the gap. |              |
| <b>Right Flush X</b><br>Returns the X position of the feature on the right side used to measure flushness.  |              |
| <b>Right Flush Z</b><br>Returns the Z position of the feature on the right side used to measure flushness.  |              |
| <b>Right Surface Angle</b><br>The angle of the right side surface relative to the X axis.                   |              |

#### Parameters

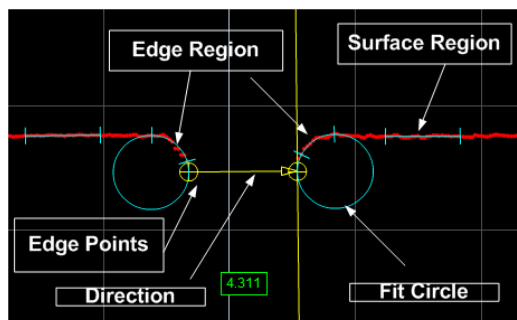
| Parameter                                       | Description                                                                                                                                                                                                                                                                                                                                                  |
|-------------------------------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Max Gap Width                                   | The maximum width of the gap. Allows the tool to filter gaps greater than the expected width. This can be used to single out the correct gap when there are multiple gaps in the field of view.                                                                                                                                                              |
| Reference Side                                  | Defines the side used to calculate the measurement axis (see below).                                                                                                                                                                                                                                                                                         |
| Measurement Axis<br><i>Gap measurement only</i> | Defines the direction that the gap is calculated, in relation to the reference side (see above).<br><b>Surface:</b> In the direction of the fitted surface line of the reference surface.<br><b>Edge:</b> In the direction perpendicular to the edge of the reference surface.<br><b>Distance:</b> The Cartesian distance between the two feature locations. |
| Absolute<br><i>Flush measurement only</i>       | When enabled, returns an absolute value rather than a signed value.                                                                                                                                                                                                                                                                                          |
| Decision                                        | See <i>Decisions</i> on page 172.                                                                                                                                                                                                                                                                                                                            |
| Region                                          | See <i>Regions</i> on page 165.                                                                                                                                                                                                                                                                                                                              |
| Output                                          | See <i>Filters</i> on page 173.                                                                                                                                                                                                                                                                                                                              |

#### Left/Right SideParameters

| Parameter      | Description                                                                                                                                                     |
|----------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Max Void Width | The maximum allowed width of missing data caused by occlusion or data dropout.                                                                                  |
| Min Depth      | Defines the minimum depth before an opening could be considered to have a potential edge. The depth is the perpendicular distance from the fitted surface line. |

| Parameter      | Description                                                                                                                                                                                                                                                                                                                                                                         |
|----------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Surface Width  | The width of the surface area in which laser data is used to form the fitted surface line. This value should be as large as the surface allows.                                                                                                                                                                                                                                     |
| Surface Offset | The distance between the edge region and the surface region.<br><br>Setting a small value allows the edge within a tighter region to be detected. However, the measurement repeatability could be affected if the data from the edge are considered as part of the surface region (or vice versa). A rule of thumb is to set <b>Surface Offset</b> equal to <b>Nominal Radius</b> . |
| Nominal Radius | The radius of the curve edge that the tool uses to locate the edge region.                                                                                                                                                                                                                                                                                                          |
| Edge Angle     | A point on the best fit circle to be used to calculate the feature point. The selected point is on the circumference at the specified angle from the start of the edge region.<br><br>The angle is measured from the axis perpendicular to the fitted surface line.                                                                                                                 |
| Edge Type      | Defines the type of feature point to use for the edge (Corner or Tangent).<br><br>A tangent edge point is the point selected based on the defined Edge Angle. A corner edge point is the intersect point between the fitted surface line and a edge line formed by interpolating the points at and after the tangent within the edge region.                                        |

The Data Viewer displays the gap measurement in real time. It also displays the results from the intermediate steps in the algorithm.



## Position

The Position tool finds the X or Z axis position of a feature point. The feature type must be specified and is one of the following: Max Z, Min Z, Max X, Min X, Corner, Average (the mean X and Z of the data points), Rising Edge, Falling Edge, Any Edge, Top Corner, Bottom Corner, Left Corner, Right Corner, or Median (median X and Z of the data points). Gocator compares the measurement value with the values in **Min** and **Max** to yield a decision. For more information on decisions, see *Decisions* on page 172.



The Position tool can be used whether **Uniform Spacing** is enabled or not, that is, with either resampled or unresampled data. For more information on the **Uniform Spacing** setting and resampled data, see *Uniform Spacing (Data Resampling)* on page 53.

See *Adding and Configuring a Tool* on page 163 for instructions on how to add measurement tools.



ParametersAnchoring

Source:Top
Feature:Max Z

MeasurementsFeatures

X0.357
Z

ID:5

Output

Filters

Decision

Min:0 mm
Max:1 mm

### Measurements, Features, and Settings

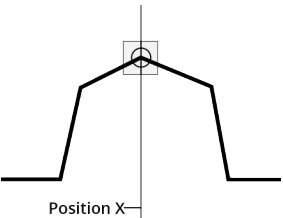
#### Measurements

##### Measurement

##### Illustration

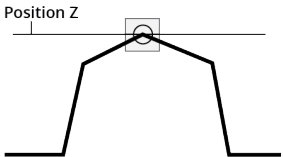
##### X

Finds the position of a feature on the X axis.



##### Z

Finds the position of a feature on the Z axis.



#### Features

##### Type

##### Description

Point

The returned position.



For more information on geometric features, see *Geometric Features* on page 171.

#### Parameters

##### Parameter

##### Description

Feature Type

Choose Max Z, Min Z, Max X, Min X, Corner, Average, Rising Edge, Falling Edge, Any Edge, Top Corner, Bottom Corner, Left Corner, Right Corner, or Median.

Decision

See *Decisions* on page 172.

Region

See *Regions* on page 165.

Output

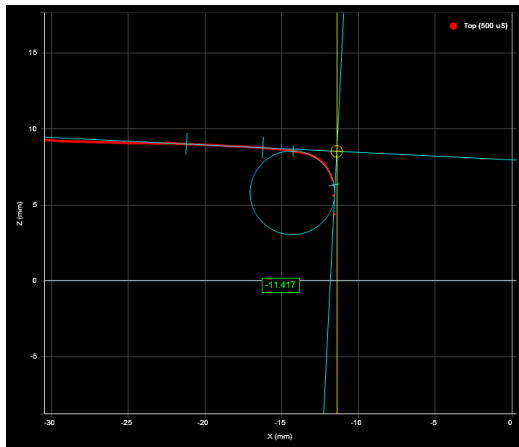
See *Filters* on page 173.

## Round Corner

The Round Corner tool measures corners with a radius, returning the position of the edge of the corner and the angle of adjacent surface with respect to the X axis.

Gocator compares the measurement value with the values in **Min** and **Max** to yield a decision. For more information on decisions, see *Decisions* on page 172.

See *Adding and Configuring a Tool* on page 163 for instructions on how to add measurement tools.



Parameters Anchoring

Source: Top

Reference Direction: From the Left

Edge

Max Void Width: 0 mm

Min Depth: 0 mm

Surface Width: 5 mm

Surface Offset: 2 mm

Nominal Radius: 2.75 mm

Edge Angle: 90 °

Edge Type: Corner

Region

X -11.417

Z 8.529

Angle -2.813

ID: 6

Output

Filters

Decision

Min: -20 mm

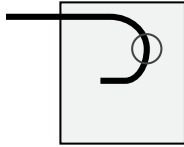
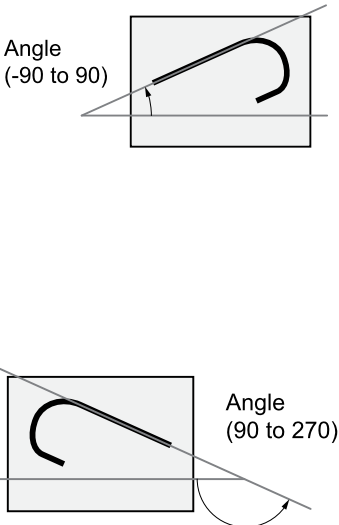
Max: 20 mm

The Round Corner tool uses a complex feature-locating algorithm to find the edge and return measurements. The behavior of the algorithm can be adjusted by changing the parameters in the measurement panel. See "Gap and Flush Algorithm" in the *Gocator Measurement Tool Technical Manual* for a detailed explanation of the algorithm.



You must make sure that there are enough data points to define the edge (proper exposure, etc.). If not, the algorithm will not function.

## Measurements

| Measurement                                                                                                                                                                                                                                   | Illustration                                                                        |
|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------|
| <p><b>X</b></p> <p>Measures the X position of the location where the tangent touches the edge, or intersect of the tangent and the line fitted to the surface used by the measurement (see <b>Reference Side</b>, below).</p>                 |  |
| <p><b>Z</b></p> <p>Measures the Z position of the location where the tangent touches the edge, or intersect of the tangent and the line fitted to the surface used by the measurement (see <b>Reference Side</b>, below).</p>                 |                                                                                     |
| <p><b>Angle</b></p> <p>Measures the angle of the line fitted to the surface next to the corner (see <b>Reference Side</b>, below), with respect to the x-axis. Left edge angles are from -90 to 90. Right edge angles are from 90 to 270.</p> |  |

## Parameters

| Parameter           | Description                                                                                                                                                                                     |
|---------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Max Gap Width       | The maximum width of the gap. Allows the tool to filter gaps greater than the expected width. This can be used to single out the correct gap when there are multiple gaps in the field of view. |
| Reference Direction | Defines the side used to calculate the rounded corner.                                                                                                                                          |
| Decision            | See <i>Decisions</i> on page 172.                                                                                                                                                               |
| Region              | See <i>Regions</i> on page 165.                                                                                                                                                                 |
| Output              | See <i>Filters</i> on page 173.                                                                                                                                                                 |

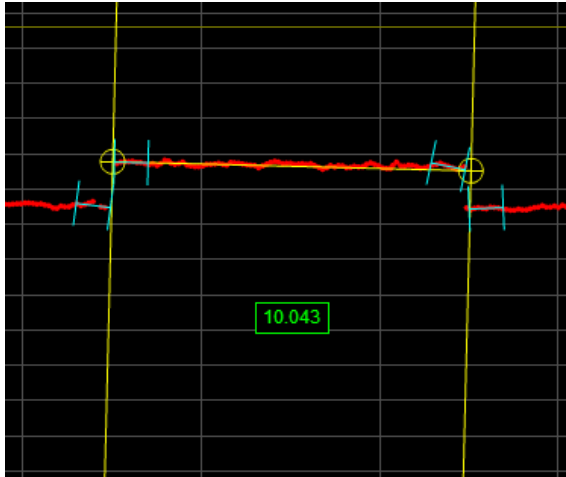
### Edge Parameters

| Parameter      | Description                                                                                                                                                                                                                                                                                                                                                                               |
|----------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Max Void Width | The maximum allowed width of missing data caused by occlusion or data dropout.                                                                                                                                                                                                                                                                                                            |
| Min Depth      | Defines the minimum depth before an opening could be considered to have a potential edge. The depth is the perpendicular distance from the fitted surface line.                                                                                                                                                                                                                           |
| Surface Width  | The width of the surface area in which laser data is used to form the fitted surface line. This value should be as large as the surface allows.                                                                                                                                                                                                                                           |
| Surface Offset | <p>The distance between the edge region and the surface region.</p> <p>Setting a small value allows the edge within a tighter region to be detected. However, the measurement repeatability could be affected if the data from the edge are considered as part of the surface region (or vice versa). A rule of thumb is to set <b>Surface Offset</b> equal to <b>Nominal Radius</b>.</p> |
| Nominal Radius | The radius of the curve edge that the tool uses to locate the edge region.                                                                                                                                                                                                                                                                                                                |
| Edge Angle     | <p>A point on the best fit circle to be used to calculate the feature point. The selected point is on the circumference at the specified angle from the start of the edge region.</p> <p>The angle is measured from the axis perpendicular to the fitted surface line.</p>                                                                                                                |
| Edge Type      | <p>Defines the type of feature point to use for the edge (Corner or Tangent).</p> <p>A tangent edge point is the point selected based on the defined Edge Angle. A corner edge point is the intersect point between the fitted surface line and a edge line formed by interpolating the points at and after the tangent within the edge region.</p>                                       |

### Strip

The Strip tool measures the width of a strip. Gocator compares the measurement value with the values in **Min** and **Max** to yield a decision. For more information on decisions, see *Decisions* on page 172.

See *Adding and Configuring a Tool* on page 163 for instructions on how to add measurement tools.



Parameters

Anchoring

Source: Top
Base Type: Flat

Left Edge

☒ Rising
☒ Data End
☒ Falling
☒ Void

Right Edge

Tilt Enabled: ☒
Support Width: 5 mm
Transition Width: 0 mm
Min Width: 0 mm
Min Height: 2 mm
Max Void Width: 0 mm

☒ Region

X
Add

X
Z
Width 10.043
Height

Id: 12

Parameters

Output

Select Type: Index Left
Index: 0

The Strip tool uses a complex feature-locating algorithm to find a strip and then return measurements. See "Strip Algorithm" in the *Gocator Measurement Tool Technical Manual* for a detailed explanation of the algorithm. The behavior of the algorithm can be adjusted by changing the parameters in the measurement panel.

The Strip tool lets you add multiple measurements of the same type to receive measurements and set decisions for multiple strips. Multiple measurements are added by using the drop-down above the list of measurements and clicking on the **Add** button.

For example, if a target has three strips, by adding two measurements, choosing **Index From The Left** in the **Select Type** setting, and providing values of 1 and 3 in the **Index** of field of the measurements, respectively, the Strip tool will return measurements and decisions for the first and third strip.

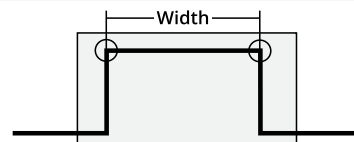
## Measurements

### Measurement

#### Width

Measures the width of a strip.

### Illustration



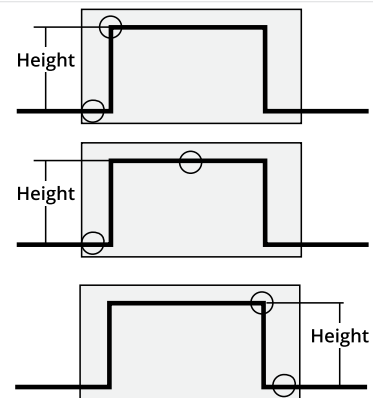
---

**Measurement****Illustration**

---

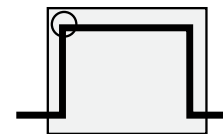
**Height**

Measures the height of a strip.

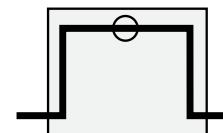
**X**

Measures the X position of a strip.

(X, Z)

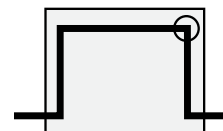


(X, Z)

**Z**

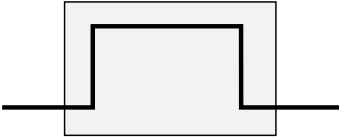
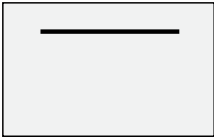
Measures the Z position of a strip.

(X, Z)





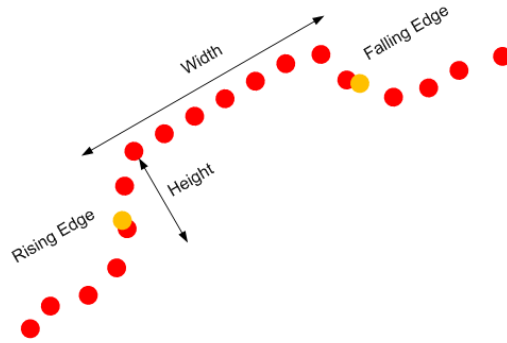
## Parameters

| Parameter                                                                 | Description                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       |
|---------------------------------------------------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Base Type                                                                 | <p>Affects detection of rising and falling edges.</p> <div style="text-align: center;"> <p><b>Base Type = Flat</b></p>  <p><b>Base Type = None</b></p>  </div> <p>When <b>Base Type</b> is set to <b>Flat</b>, both strip (raised area) and base support regions are needed. When set to <b>None</b>, only a point that deviates from a smooth strip support region is needed to find a rising or falling edge.</p>                                                                                                                           |
| Location<br><i>(Strip Height, Strip X, and Strip Z measurements only)</i> | <p>Specifies the strip position from which the measurements are performed.</p> <p><b>Left</b> - Left edge of the strip.</p> <p><b>Right</b> - Right edge of the strip.</p> <p><b>Center</b> - Center of the strip.</p>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            |
| Left Edge<br>Right Edge                                                   | <p>Specifies the features that will be considered as the strip's left and right edges. You can select more than one condition.</p> <p><b>Rising</b> - Rising edge detected based on the strip edge parameters.</p> <p><b>Falling</b> - Falling edge detected based on the strip edge parameters.</p> <p><b>Data end</b> - First valid profile data point in the measurement region.</p> <p><b>Void</b> - Gap in the data that is larger than the maximum void threshold. Gaps connected to the measurement region's boundary are not considered as a void.</p> <p>See "Strip Start and Terminate Conditions" in the <i>Gocator Measurement Tool Technical Manual</i> for the definitions of these conditions.</p> |
| Select Type                                                               | <p>Specifies how a strip is selected when there are multiple strips within the measurement area.</p> <p><b>Best</b> - The widest strip.</p> <p><b>Index Left</b> - 0-based strip index, counting from left to right.</p> <p><b>Index Right</b> - 0-based strip index, counting from right to left.</p>                                                                                                                                                                                                                                                                                                                                                                                                            |
| Index                                                                     | 0-based strip index.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              |
| Min Height                                                                | <p>Specifies the minimum deviation from the strip base. See "Strip Step Edge Definitions" in the <i>Gocator Measurement Tool Technical Manual</i> on how this parameter is used for different base types.</p>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     |

| Parameter        | Description                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    |
|------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Support Width    | Specifies the width of the region around the edges from which the data is used to calculate the step change. See "Strip Step Edge Definitions" in the <i>Gocator Measurement Tool Technical Manual</i> on how this parameter is used by different base types.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  |
| Transition Width | Specifies the nominal width needed to make the transition from the base to the strip. See "Strip Step Edge Definitions" in the <i>Gocator Measurement Tool Technical Manual</i> on how this parameter is used by different base types.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         |
| Max Void Width   | <p>The maximum width of missing data allowed for the data to be considered as part of a strip when <b>Void</b> is selected in the <b>Left</b> or <b>Right</b> parameter. This value must be smaller than the edge <b>Support Width</b>.</p> <div> <p>The diagram shows a horizontal sequence of red dots. A gap between two dots is highlighted with a double-headed arrow and labeled 'Gap &gt; Maximum void'. The dots are grouped into 'Strip 0' and 'Strip 1'. A double-headed arrow below the dots indicates the 'Measurement region'.</p> </div> <p>When occlusion and exposure causes data drops, users should use the gap filling function to fill the gaps. See <i>Gap Filling</i> on page 116 for information.</p> |
| Min Width        | Specifies the minimum width for a strip to be considered valid.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                |
| Tilt Enabled     | Enables/disables tile correction.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              |
| Decision         | See <i>Decisions</i> on page 172.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              |
| Region           | <p>The measurement region defines the region in which to search for the strip. If possible, the region should be made large enough to cover the base on the left and right sides of the strip.</p> <div> <p>The diagram shows a gray rectangular area representing the measurement region. A black line represents the strip, and the sides of the strip are labeled 'Sides of the Strip'.</p> </div> <p>See <i>Regions</i> on page 165 for more information.</p>                                                                                                                                                                                                                                                          |
| Output           | See <i>Filters</i> on page 173.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                |

## Tilt

The strip may be tilted with respect to the sensor's coordinate X axis. This could be caused by conveyor vibration. If the Tilt option is enabled, the tool will report the width and height measurements following the tilt angle of the strip.



## Script

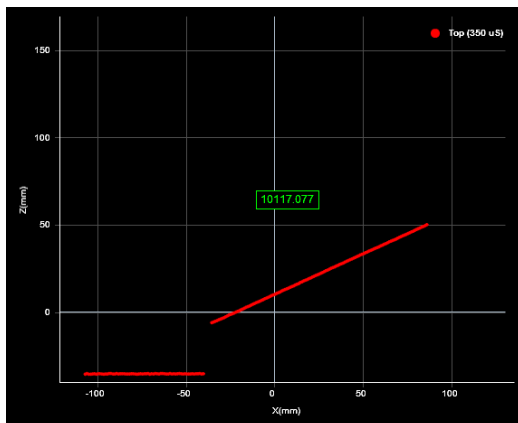
A Script measurement can be used to program a custom measurement using a simplified C-based syntax. A script measurement can produce multiple measurement values and decisions for the output.



The Script tool can be used whether **Uniform Spacing** is enabled or not, that is, with either resampled or unresampled data. For more information on the **Uniform Spacing** setting and resampled data, see *Uniform Spacing (Data Resampling)* on page 53.

See *Adding and Configuring a Tool* on page 163 for instructions on how to add measurement tools.

See *Scripts* on page 278 for more information on scripts.



Code

```

1 double DimensionDistance = Measurement_Value(2);
2
3 if (Measurement_Valid(2))
4 {
5     Output_Set(DimensionDistance + 10000, 1);
6 }
7 else
8 {
9     Output_SetAt(0, 0);
10 }

```

\*Press save button or 'Ctrl+S' to apply change.  
Press 'Esc' to exit full screen.

Output:

Add

Output 0

10117.077

✕

Id:

0

See *Scripts* on page 278 for more information on the script syntax.

*To create or edit a Script measurement:*

1. Add a new Script tool or select an existing Script measurement.
2. Edit the script code.
3. Add script outputs using the **Add** button.

For each script output that is added, an index will be added to the **Output** drop-down and a unique ID will be generated.

To remove a script output, click on the  button next to it.

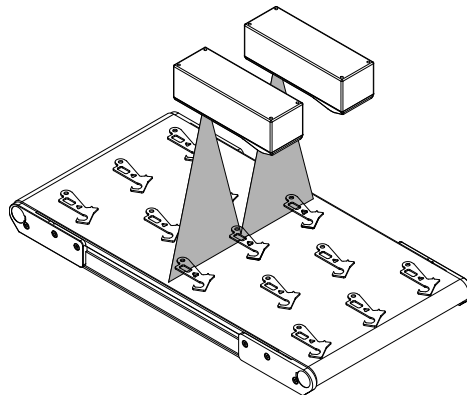
4. Click the **Save** button  to save the script code.

If there is a mistake in the script syntax, the result will be shown as a "Invalid" with a red border in the data viewer when you run the sensor.

Outputs from multiple measurement tools can be used as inputs to the script. A typical script would take results from other measurement tools using the value and decision function, and output the result using the output function. Stamp information, such as time and encoder stamps, are available in the script, whereas the actual profile data is not. (The script engine is not powerful enough to process the data itself.) Only one script can be created.

## Surface Measurement

Surface measurement involves capturing a sequence of laser profiles, optionally identifying discrete objects, and measuring properties of the surface or the objects, such as the volume of the object or the height at a certain position of the object. All volumetric tools have the ability to operate either on the entire surface or the full object, or within a region of interest at a certain position in relation to the surface or an object.



Multiple measurements can be performed on the entire surface or each discrete object, limited only by the available CPU resources.

The frame of reference for the coordinate system of the detected object can be set to **Sensor** or **Part** in the **Part Detection** panel (*Part Detection* on page 123). This setting determines what coordinate system the region of interest for a measurement is positioned in, as well as the coordinate reference used to output measurement values.

For example, if you need to measure the average height in a certain location relative to the sensor's field of view regardless of the objects passing under the sensor, the frame of reference should be set to **Sensor**. This is typical in applications where a wide web of material is continuously scanned, such as paper, rubber, fabrics, etc. If on the other hand you need to measure the average height in a certain location of a scanned object, the frame of reference should be set to **Part**. This is typical in applications where discrete objects pass under the sensor and specific locations on the objects need to be inspected.

## Bounding Box

The Bounding Box tool provides measurements related to the smallest box that contains the part (for example, X position, Y position, width, length, etc.).

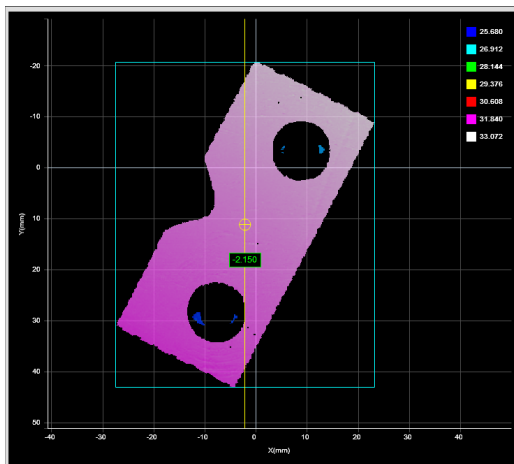
Gocator compares the measurement value with the values in **Min** and **Max** to yield a decision. For more information on decisions, see *Decisions* on page 172.

See *Adding and Configuring a Tool* on page 163 for instructions on how to add measurement tools.

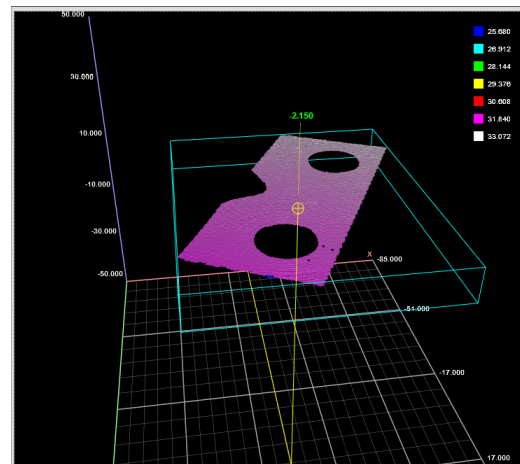
A bounding box can be vertical or rotated. A vertical bounding box provides the absolute position from which the Position centroids tools are referenced.



The vertical bounding box X and Y correspond to the part frame of reference origin. For this reason all X and Y measurements (except Bounding Box Global X and Global Y) are referenced to this point when **Frame of Reference** on the **Part Detection** panel is set to **Part**. See *Part Detection* on page 123 for more information.



2D View



3D View

Parameters

Anchoring

Source:

Top

Rotation:

☒ Region

↺ ⋮

Measurements

Features

X

-2.150

☒

Y

☐

Z

☐

Width

☐

Length

☐

Height

☐

Z Angle

☐

Global X

☐

Global Y

☐

Global Z Angle

☐

ID:

0

Output

Filters

⋮

Decision

Min:

-3 mm

Max:

-2 mm

Measurement Panel

## Measurements, Features, and Settings

### Measurements

| Measurement                                                                                                                                            | Illustration |
|--------------------------------------------------------------------------------------------------------------------------------------------------------|--------------|
| <b>X</b><br>Determines the X position of the center of the bounding box that contains the part.<br>The value returned is relative to the <i>part</i> . |              |
| <b>Y</b><br>Determines the Y position of the center of the bounding box that contains the part.<br>The value returned is relative to the <i>part</i> . |              |

---

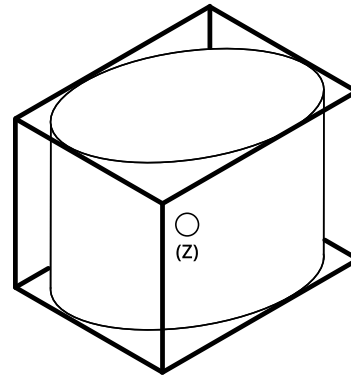
**Measurement****Illustration**

---

**Z**

Determines the Z position of the center of the bounding box that contains the part.

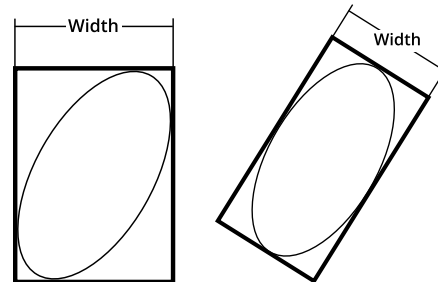
The value returned is relative to the *part*.

**Width**

Determines the width of the bounding box that contains the part.

When the **Rotation** setting is disabled, the bounding box is the smallest rectangle whose sides are parallel to the X and Y axes. Width is on the X axis.

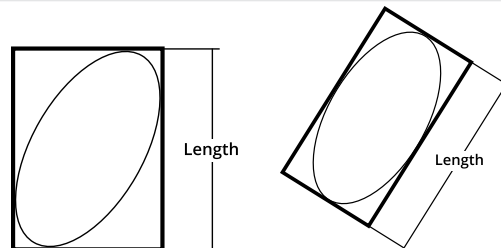
When **Rotation** is enabled, the width is the smaller side dimension.

**Length**

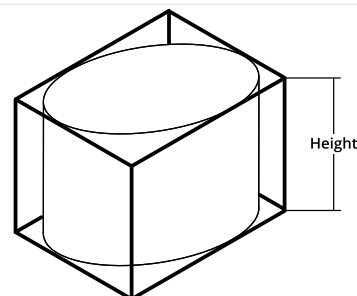
Determines the length of the bounding box that contains the part.

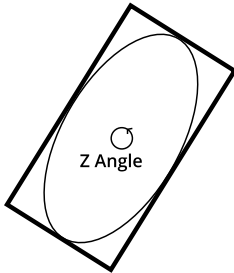
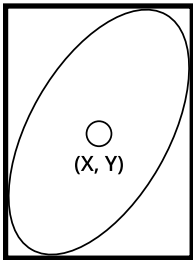
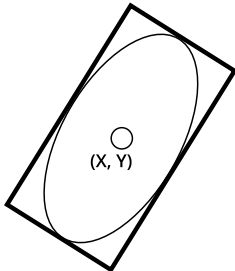
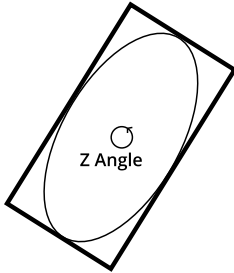
When the **Rotation** setting is disabled, the bounding box is the smallest rectangle whose sides are parallel to the X and Y axes. Length is on the Y axis.

When **Rotation** is enabled, the length is the longer side dimension.

**Height**

Determines the height of the bounding box that contains the part.



| Measurement                                                                                                                                                                                                                                                                                                                                                                                                          | Illustration                                                                        |
|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------|
| <p><b>Z Angle</b></p> <p>Determines the rotation around the Z axis and the angle of the longer side of the bounding box relative to the X axis.</p> <p>If <b>Rotation</b> is not enabled, the measurement returns 90.000 degrees.</p> <p>In order to use this measurement for angle anchoring, you must enable <b>Rotation</b>; for more information on anchoring, see <i>Measurement Anchoring</i> on page 175.</p> |   |
| <p><b>Global X*</b></p> <p>Determines the X position of the center of the bounding box that contains the part <i>on the surface from which the part was extracted</i>.</p>                                                                                                                                                                                                                                           |   |
| <p><b>Global Y*</b></p> <p>Determines the Y position of the center of the bounding box that contains the part <i>on the surface from which the part was extracted</i>.</p> <p>If the part is extracted from a <a href="#">continuous surface</a>, the Y origin of that surface is at the encoder starting position.</p>                                                                                              |  |
| <p><b>Global Z Angle*</b></p> <p>Determines the rotation of the longer side of the bounding box around the Z axis <i>on the surface from which the part was extracted</i>.</p> <p>If <a href="#">part matching</a> is enabled, the returned value represents the rotation of the part <i>before</i> part matching rotates it.</p> <p>If <b>Rotation</b> is not enabled, the measurement returns 90.000 degrees.</p>  |  |
| <div>  <p>*These measurements are mostly useful with parts extracted from a surface. For more information on parts, see <i>Part Detection</i> on page 123.</p> </div>                                                                                                                                                             |                                                                                     |

## Features

| Type                                                                                                                                                                                            | Description                           |
|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---------------------------------------|
| Center Point                                                                                                                                                                                    | The center point of the bounding box. |
| <div>  <p>For more information on geometric features, see <i>Geometric Features</i> on page 171..</p> </div> |                                       |



## Parameters

| Parameter           | Description                                                                                                                                                                                                                                     |
|---------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Rotation            | A bounding box can be vertical or rotated. A vertical bounding box provides the absolute position from which the part's Position centroid measurements are referenced.<br><br>Check the <b>Rotation</b> setting to select rotated bounding box. |
| Asymmetry Detection | Resolves the orientation of an object over 360 degrees. The possible values are:<br><br>0 – None<br>1 – Along Major Axis<br>2 – Along Minor Axis<br><br>This setting is only visible if <b>Rotation</b> is checked.                             |
| Decision            | See <i>Decisions</i> on page 172.                                                                                                                                                                                                               |
| Region              | See <i>Regions</i> on page 165.                                                                                                                                                                                                                 |
| Output              | See <i>Filters</i> on page 173.                                                                                                                                                                                                                 |

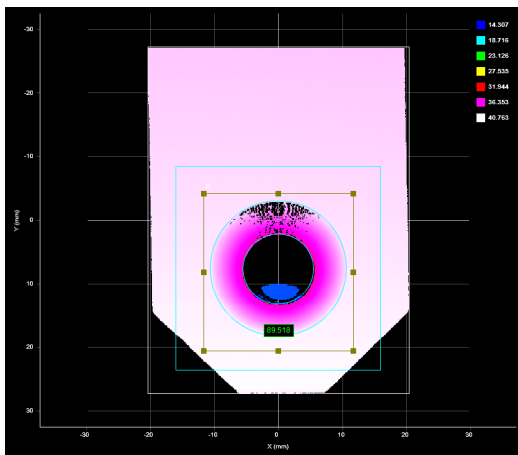
## Countersunk Hole

The Countersunk Hole tool locates a countersunk circular opening within a region of interest on the surface and provides measurements to evaluate characteristics of countersunk holes, including the position (X, Y, and Z) of the center of the hole, outside radius of the hole, hole bevel angle, and the depth of the hole. The countersunk hole can be on a surface at an angle to the sensor. The tool also supports measuring holes drilled at an angle relative to the surrounding surface.

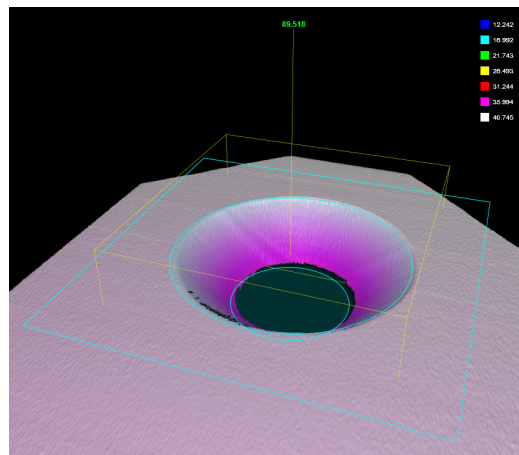


The Countersunk Hole tool does not search for or detect a hole. The tool expects that a hole conforming reasonably well to the defined parameters is present and that it is on a sufficiently uniform background.

See *Adding and Configuring a Tool* on page 163 for instructions on how to add measurement tools.



2D View



3D View

ParametersAdvancedAnchoring

Source:Top

Shape:Cone

Nominal Bevel Angle:100°

Nominal Outer Radius:10 mm

Nominal Inner Radius:4 mm

Bevel Radius Offset:4 mm

Partial Detection:

Plane Fit Range:0 mm

☒ Region

↺⋮

MeasurementsFeatures

|                   |        |                                     |
|-------------------|--------|-------------------------------------|
| X                 | 89.518 | <input checked="" type="checkbox"/> |
| Y                 |        | <input type="checkbox"/>            |
| Z                 |        | <input type="checkbox"/>            |
| Outer Radius      |        | <input type="checkbox"/>            |
| Depth             |        | <input type="checkbox"/>            |
| Bevel Radius      |        | <input type="checkbox"/>            |
| Bevel Angle       |        | <input type="checkbox"/>            |
| X Angle           |        | <input type="checkbox"/>            |
| Y Angle           |        | <input type="checkbox"/>            |
| Counterbore Depth |        | <input type="checkbox"/>            |
| Axis Tilt         |        | <input type="checkbox"/>            |
| Axis Orientation  |        | <input type="checkbox"/>            |

ID:1

Output

Filters⋮

Decision

Min:89 mm

Max:90 mm

Parameters
Advanced
Anchoring

☐ Curved Surface

☐ Reference Region
Auto Set

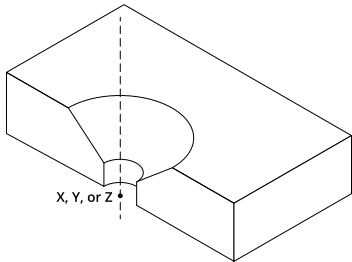
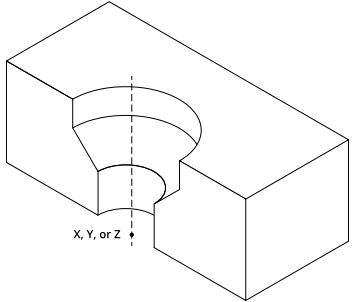
Tilt Correction
Auto Set

|                   |        |                                     |
|-------------------|--------|-------------------------------------|
| X                 | 89.518 | <input checked="" type="checkbox"/> |
| Y                 |        | <input type="checkbox"/>            |
| Z                 |        | <input type="checkbox"/>            |
| Outer Radius      |        | <input type="checkbox"/>            |
| Depth             |        | <input type="checkbox"/>            |
| Bevel Radius      |        | <input type="checkbox"/>            |
| Bevel Angle       |        | <input type="checkbox"/>            |
| X Angle           |        | <input type="checkbox"/>            |
| Y Angle           |        | <input type="checkbox"/>            |
| Counterbore Depth |        | <input type="checkbox"/>            |
| Axis Tilt         |        | <input type="checkbox"/>            |
| Axis Orientation  |        | <input type="checkbox"/>            |

Measurement Panel

## Measurements, Features, and Settings

### Measurements

| Measurement                                                                  | Illustration                                                                         |
|------------------------------------------------------------------------------|--------------------------------------------------------------------------------------|
| <b>X</b><br>Determines the X position of the center of the countersunk hole. |  |
| <b>Y</b><br>Determines the Y position of the center of the countersunk hole. |                                                                                      |
| <b>Z</b><br>Determines the Z position of the center of the countersunk hole. |  |

## Measurement

## Illustration

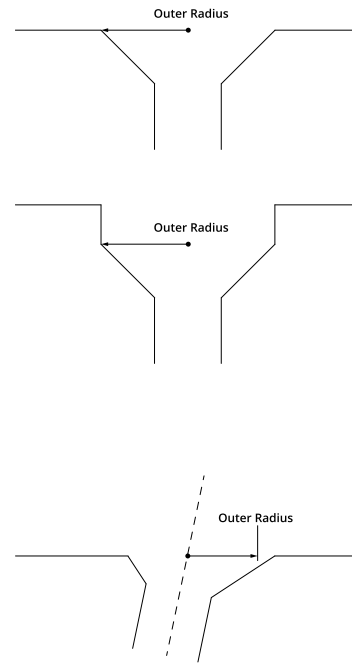
### Outer Radius

Determines the outer radius of the countersunk hole.

When a hole is cut at an angle relative to the surrounding surface, the outer radius is calculated as if the hole were not cut at an angle.

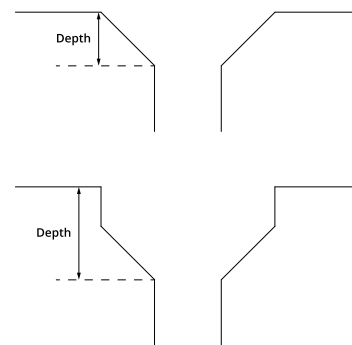


To convert the radius to a diameter, set the **Scale** setting in the **Output** panel (displayed after expanding the **Filters** section) to 2.



### Depth

Determines the depth of the countersunk hole relative to the surface that the countersunk hole is on.



## Measurement

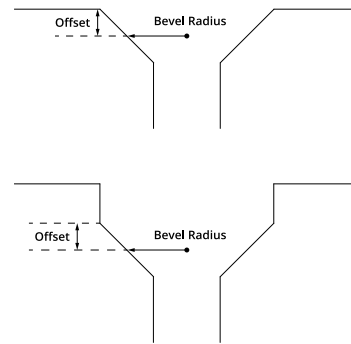
## Illustration

### Bevel Radius

Determines the radius at a user-defined offset (**Offset** setting) relative to the surface that the countersunk hole is on.

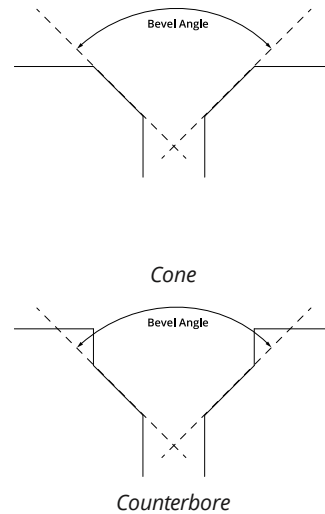


To convert the radius to a diameter, set the **Scale** setting in the **Output** panel (displayed after expanding the **Filters** section) to 2.



### Bevel Angle

Determines the angle of the hole's bevel.

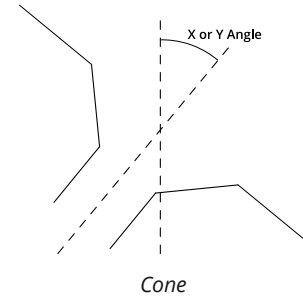


## Measurement

## Illustration

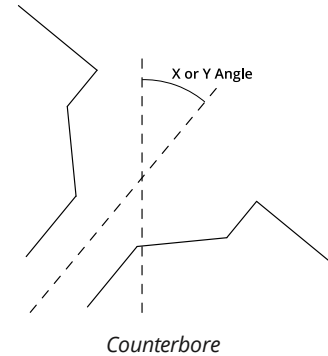
### X Angle

Determines the angle the hole relative to the X axis.



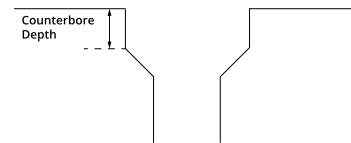
### Y Angle

Determines the angle of the hole relative to the Y axis.



### Counterbore Depth

Determines the depth of a counterbore.

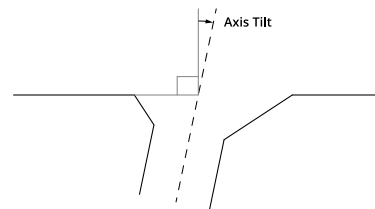


### Axis Tilt

Measures the tilt of the axis of the hole relative to the surface surrounding the hole.



This measurement is not supported when **Shape** is set to **Counterbore**.

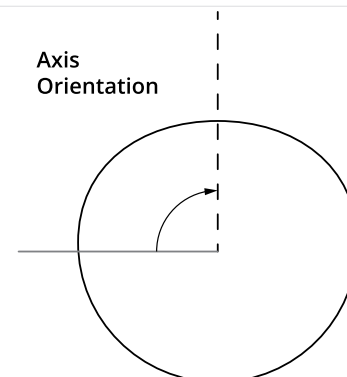


### Axis Orientation

Measures the angle of the axis of the hole around the normal of the surface surrounding the hole, relative to the X axis.



This measurement is not supported when **Shape** is set to **Counterbore**.



## Features

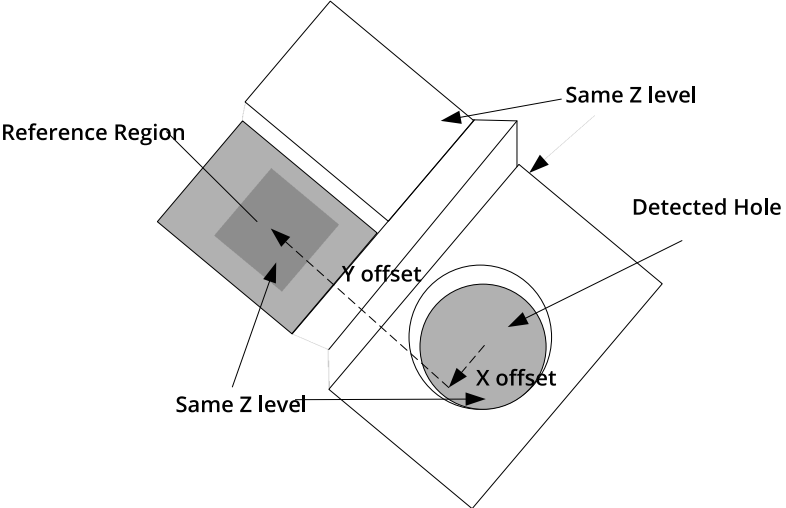
| Type         | Description                                                                                                                   |
|--------------|-------------------------------------------------------------------------------------------------------------------------------|
| Center Point | The center point of the countersunk hole. The Z position of the center point is at the Z position of the surrounding surface. |



For more information on geometric features, see *Geometric Features* on page 171.

## Parameters

| Parameter            | Description                                                                                                                                                                               |
|----------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Shape                | The shape of the countersunk hole. (See illustrations above.)<br>0 – Cone<br>1 – Counterbore                                                                                              |
| Nominal Bevel Angle  | The expected bevel angle of the countersunk hole.                                                                                                                                         |
| Nominal Outer Radius | The expected outer radius of the countersunk hole.                                                                                                                                        |
| Nominal Inner Radius | The expected inner radius of the countersunk hole.                                                                                                                                        |
| Bevel Radius Offset  | The offset, relative to the surface that the countersunk hole is on, at which the bevel radius will be measured.                                                                          |
| Curved Surface       | Whether the surface that the countersunk hole is on is curved. When this setting is enabled, specify the orientation of the curvature in degrees in the <b>Curve Orientation</b> setting. |

| Parameter         | Description                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             |
|-------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Reference Regions | <p>The algorithm uses the Reference Regions option to calculate the Z position of the hole. It is typically used in cases where the surface around the hole is not flat.</p>  <p>When this option is set to Autoset, the algorithm automatically determines the reference region. When the option is not set to Autoset, the user manually specifies the reference region. The location of the reference region is relative to the detected center of the hole and positioned on the nominal surface plane.</p> <p>When the Reference Regions option is disabled, the tool measures the hole's Z position using all the data in the measurement region, except for a bounding rectangular region around the hole.</p> |
| Tilt Correction   | <p>Tilt of the target with respect to the alignment plane.</p> <p>When this option is set to Autoset, the tool automatically detects the tilt. Otherwise, the user must enter the angles manually. Autoset requires the measurement region to cover more areas on the surface plane than other planes.</p> <p>The results from the Plane X and Y tool can be used for angles X and Y parameters.</p>                                                                                                                                                                                                                                                                                                                                                                                                    |
| Partial Detection | <p>Enable if only part of the hole is within the measurement region. If disabled, the hole must be completely in the region of interest for results to be valid.</p>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    |
| Plane Fit Range   | <p>Excludes data beyond the specified distance from the plane surrounding the hole. You can use this setting to exclude surfaces close to the countersunk hole that step down from the plane surrounding the hole that could make measurement of the hole less reliable.</p>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            |



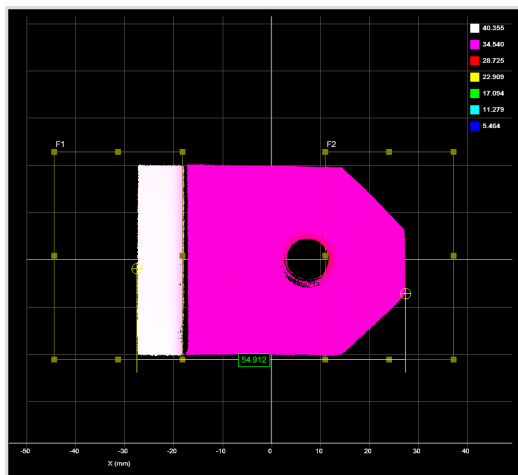
| Parameter | Description                       |
|-----------|-----------------------------------|
| Decision  | See <i>Decisions</i> on page 172. |
| Region    | See <i>Regions</i> on page 165.   |
| Output    | See <i>Filters</i> on page 173.   |

## Dimension

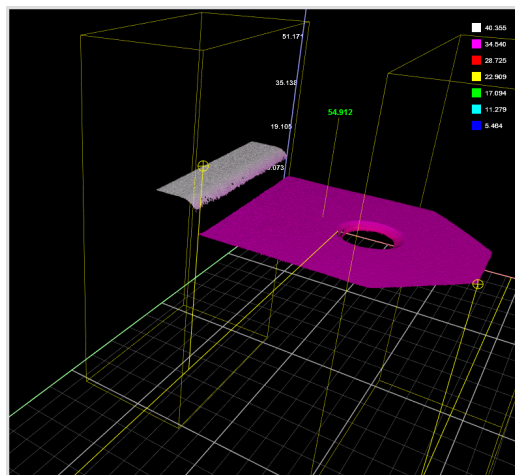
The Dimension tool returns various dimensional measurements of a part. You must specify two feature types (see below).

Gocator compares the measurement value with the values in **Min** and **Max** to yield a decision. For more information on decisions, see *Decisions* on page 172.

See *Adding and Configuring a Tool* on page 163 for instructions on how to add measurement tools.



2D View



3D View

ParametersAnchoring

Source:

Top

Feature 1

Min X

Feature 2

Max X

Width

54.912

☒

Length

☐

Height

☐

Distance

☐

Plane Distance

☐

Center X

☐

Center Y

☐

Center Z

☐

ID:

0

ParametersOutput

Filters

☐

Decision

Min:

54.9

mm

Max:

55

mm

Measurement Panel

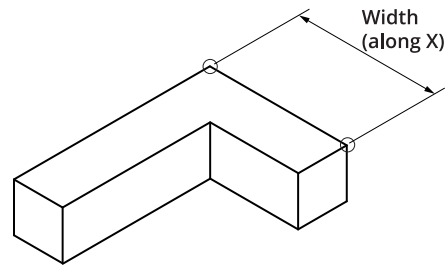
## Measurements

### Measurement

### Illustration

#### Width

Determines the distance between the selected features along the X axis.



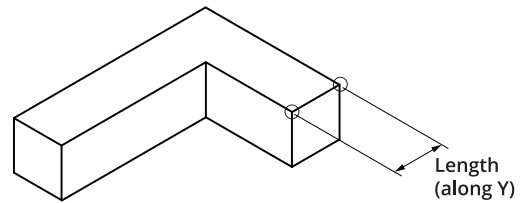
---

**Measurement****Illustration**

---

**Length**

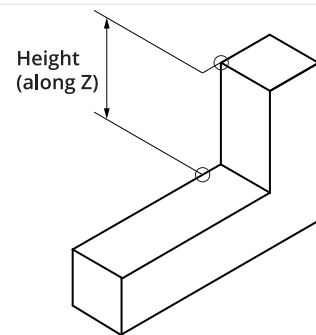
Determines the distance between the selected features along the Y axis.



---

**Height**

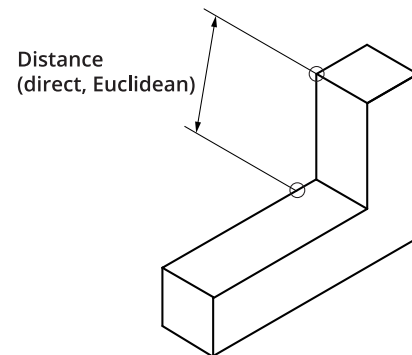
Determines the distance between the selected features along the Z axis.

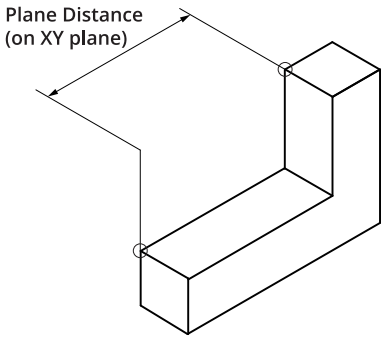
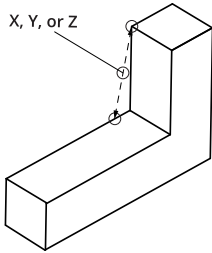


---

**Distance**

Determines the direct, Euclidean distance between the selected features.



| Measurement                                                                                                                                                                              | Illustration                                                                       |
|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------------------------------------------------------------------------------|
| <b>Plane Distance</b><br>Determines the distance between the selected features.<br>The position of the lowest feature point is projected onto the XY plane of the highest feature point. |  |
| <b>Center X</b><br>Determines the X position of the center point between the selected features.                                                                                          |  |
| <b>Center Y</b><br>Determines the Y position of the center point between the selected features.                                                                                          |                                                                                    |
| <b>Center Z</b><br>Determines the Z position of the center point between the selected features.                                                                                          |                                                                                    |

#### Parameters

| Parameter | Description                                                                                                                                                                                                                                                                                                                                                                                                    |
|-----------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Feature 1 | One of the following: <ul style="list-style-type: none"> <li>• Average (the mean X, Y, and Z of the data points)</li> <li>• Median (median X, Y, and Z of the data points)</li> <li>• Centroid (the centroid of the data considered as a volume with respect to the <math>z = 0</math> plane)</li> <li>• Min X</li> <li>• Max X</li> <li>• Min Y</li> <li>• Max Y</li> <li>• Min Z</li> <li>• Max Z</li> </ul> |
| Feature 2 |                                                                                                                                                                                                                                                                                                                                                                                                                |
| Decision  | See <i>Decisions</i> on page 172.                                                                                                                                                                                                                                                                                                                                                                              |
| Region    | See <i>Regions</i> on page 165.                                                                                                                                                                                                                                                                                                                                                                                |
| Output    | See <i>Filters</i> on page 173.                                                                                                                                                                                                                                                                                                                                                                                |

## Edge

The Edge tool fits a line to a straight edge in the scan data, using either height map or intensity data. After the tool locates an edge, the position (X, Y, and Z) of the center of the edge line, as well as its angle

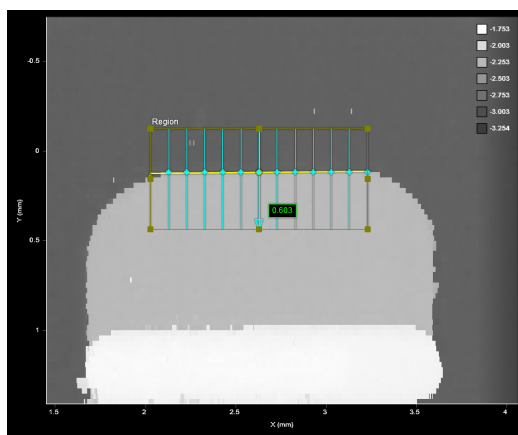
around the Z axis and the step height between the upper and lower surfaces adjacent to the edge, can be returned as measurements.

You can use the Z Angle measurement of the edge line with some tools to perform angle anchoring, compensating for minor part rotations around the Z axis, greatly increasing repeatability between part scans; for more information see *Measurement Anchoring* on page 175.

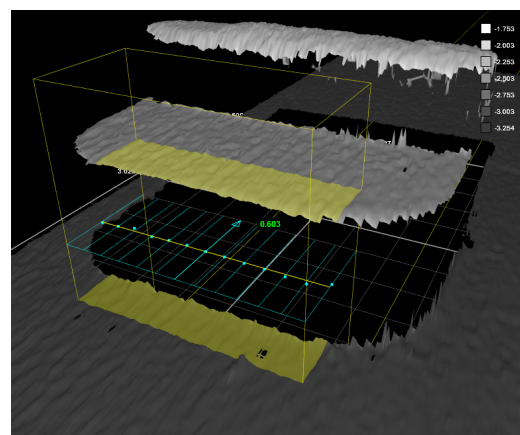
The tool can also generate edge line and center point geometric features that Feature tools can take as input for measurement. For more information on Feature tools, see *Feature Measurement* on page 271.

Gocator compares the measurement value with the values in **Min** and **Max** to yield a decision. For more information on decisions, see *Decisions* on page 172.

See *Adding and Configuring a Tool* on page 163 for instructions on how to add measurement tools.



2D View



3D View

Parameters
Anchoring

Source:
Top

☒ Use Intensity

Region

Search Direction
90 degrees

Path Spacing
0.1 mm

Path Width
0 mm

Selection Type
Best

Step Direction
Rising

Intensity Threshold
0

Step Smoothing
0 mm

Step Width
0 mm

Max Gap
0 mm

☒ Include Null Edges

Null Fill Value
0 mm

Intensity Null Fill Value
0

☒ Show Detail

Measurements
Features

X
☐

Y
☐

Z
☐

Z Angle
☐

Step Height
0.603
☒

ID:
1

Parameters
Output

Filters

Decision

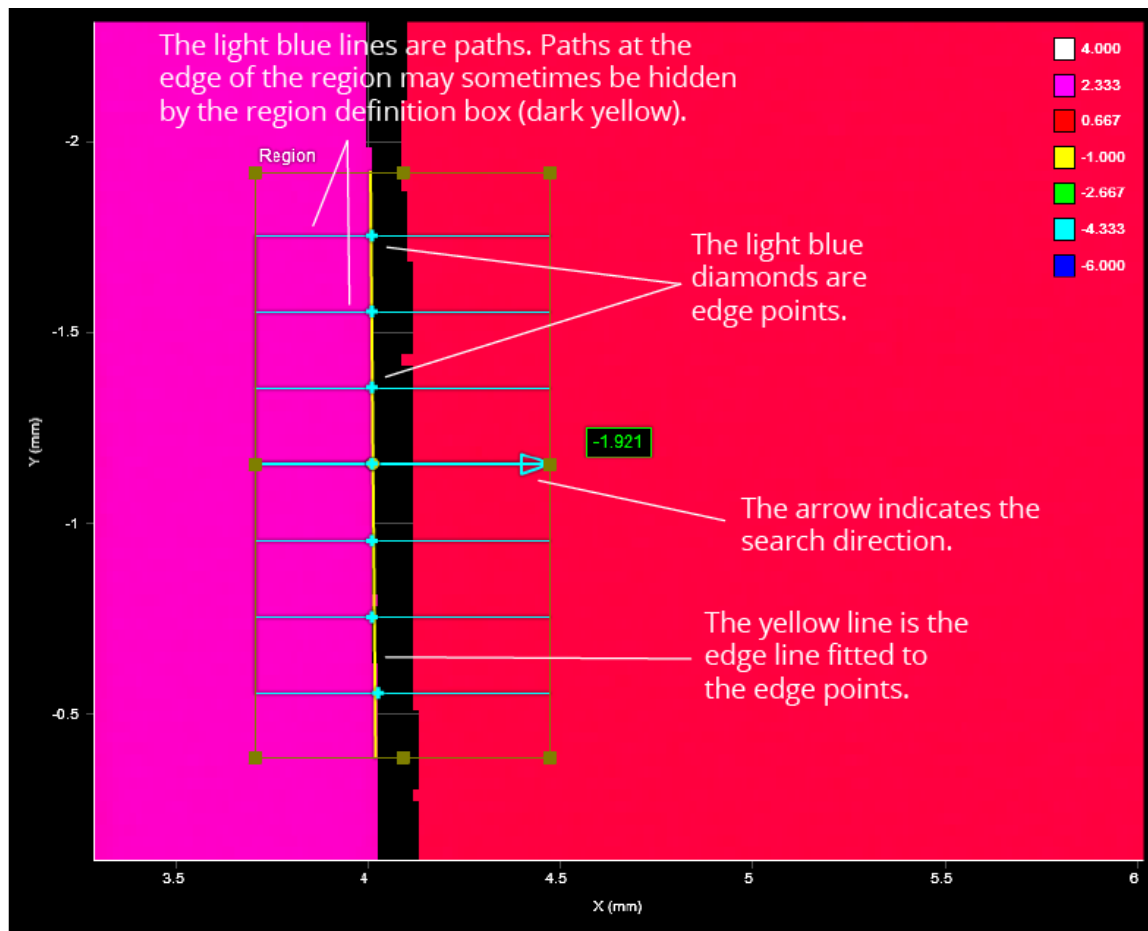
Min:
0.595 mm

Max:
0.605 mm

Measurement Panel

## Paths and Path Profiles

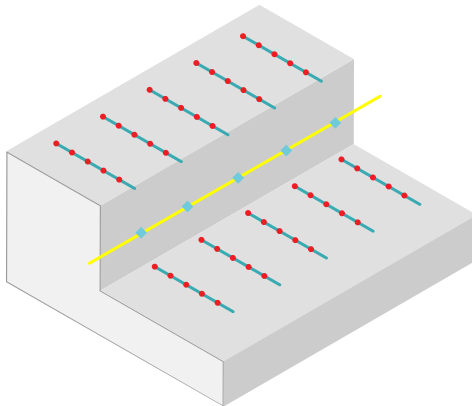
To fit an edge line to the scan data, the Surface Edge tool overlays evenly spaced, parallel *paths* (light blue lines in the interface; see below) in the defined region of interest.



For each path, a profile is generated internally from the height map's data points that fall under or, optionally, near the path. The tool then examines each path profile for steps (changes in height) that meet the criteria set by the tool's settings, such as minimum height, direction (whether it is rising or falling), and so on.

Red dots are data points from the scan data that fall under paths (light blue lines).

A single path profile extracted from a path.



For the step on each path profile that matches the settings, the tool places an edge point between the upper and lower area (light blue diamonds in the interface). The tool then fits a line to those edge points (yellow line in the interface). You can choose the orientation of the paths around the Z axis to accommodate different edge orientations.

## Measurements, Features, and Settings

### Measurements

#### Measurement

##### X

Returns the X position of the center point of the fitted edge line.

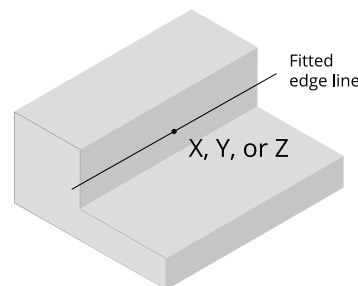
##### Y

Returns the Y position of the center point of the fitted edge line.

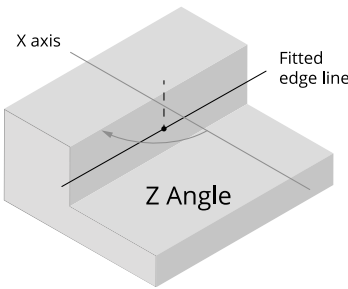
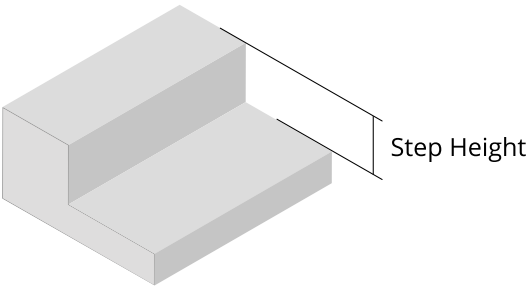
##### Z

Returns the Z position of the center point of the fitted edge line.

#### Illustration

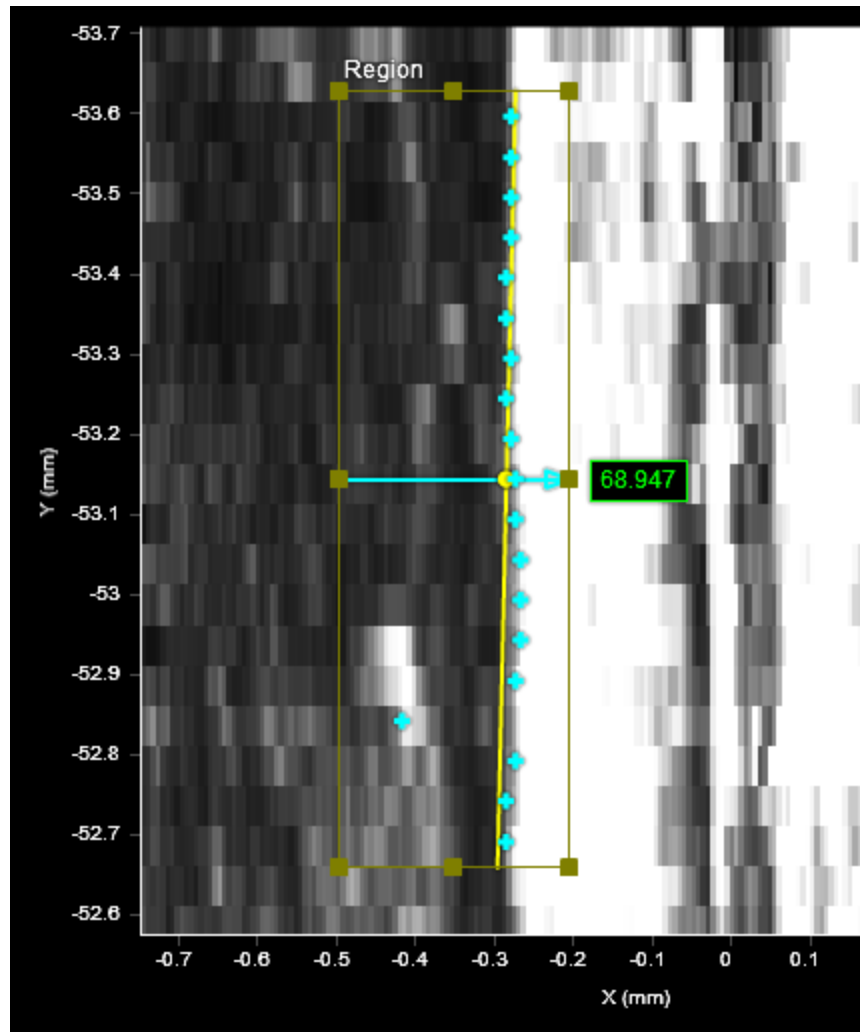




| Measurement                                                                                                                                                                                                                                                                                                                                                                                            | Illustration                                                                                                  |
|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---------------------------------------------------------------------------------------------------------------|
| <p><b>Z Angle</b></p> <p>Returns the rotation, around the Z axis, of the fitted edge line. Rotating the measurement region has no impact on the angle that is returned unless a different edge is detected.</p> <p>Useful for using minor variations in the rotation of an edge on target as an anchor for other measurements. For more information, see <i>Measurement Anchoring</i> on page 175.</p> |                             |
| <p><b>Step Height</b></p> <p>Returns the height of the step, calculated by averaging the step heights of all of the path profiles.</p> <p>(When <b>Use Intensity</b> is enabled, the value returned is the difference in intensity.)</p>                                                                                                                                                               |                             |
| Features                                                                                                                                                                                                                                                                                                                                                                                               |                                                                                                               |
| Type                                                                                                                                                                                                                                                                                                                                                                                                   | Description                                                                                                   |
| Edge line                                                                                                                                                                                                                                                                                                                                                                                              | The fitted edge line.                                                                                         |
| Center Point                                                                                                                                                                                                                                                                                                                                                                                           | The intersection point of the fitted edge line and a line through the center of the region at the path angle. |
| <div>  For more information on geometric features, see <i>Geometric Features</i> on page 171. </div>                                                                                                                                                                                                                |                                                                                                               |

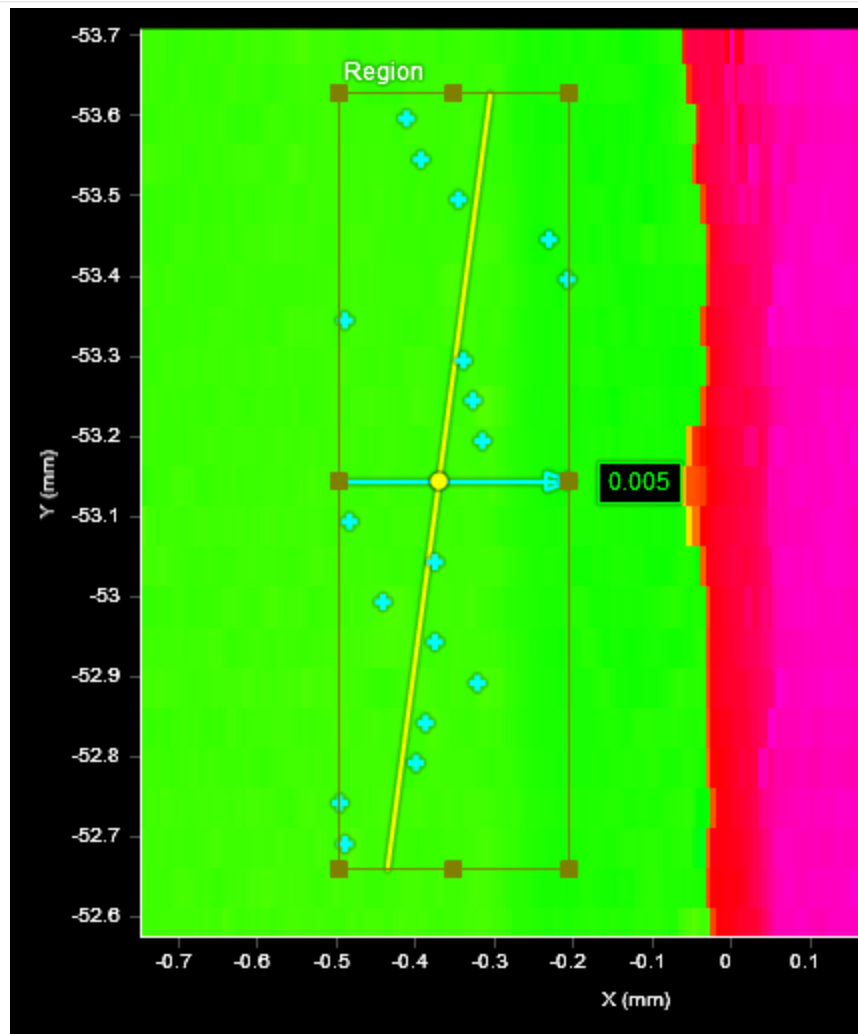
## Parameters

| Parameter     | Description                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               |
|---------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Use Intensity | <p>(This setting is only available when <b>Acquire Intensity</b> is enabled in the <b>Scan Mode</b> panel; for more information, see <i>Scan Modes</i> on page 92.)</p> <p>Uses intensity data rather than height data to find an edge. Useful when color differences on a flat area of a target, which would not be detected using height map data, are distinct, letting you use the detected "line" as an <a href="#">anchor source</a> or perform <a href="#">geometric feature measurements</a>.</p> |



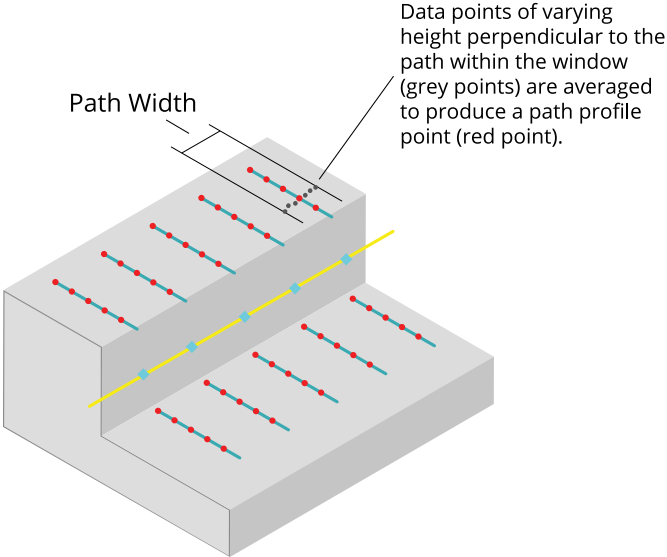
*Use Intensity* enabled (intensity view): Surface Edge tool finds the edge using intensity data.

| Parameter | Description |
|-----------|-------------|
|-----------|-------------|

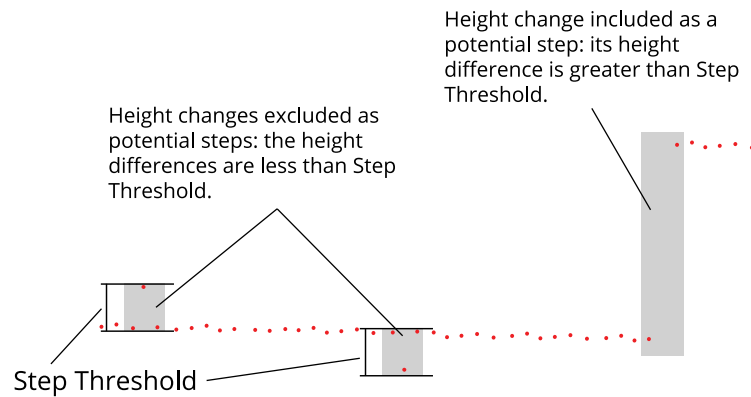


*Use Intensity disabled (heightmap view of the same area): Surface Edge tool unable to find edge using height data.*

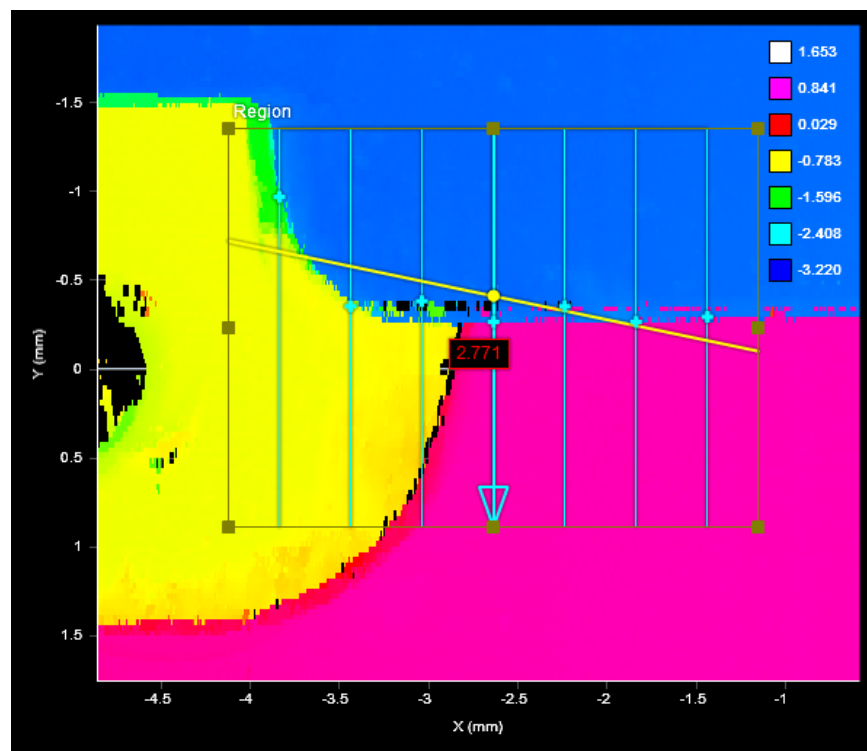
|                  |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            |
|------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Search Direction | <p>The search direction for steps, specified as an orientation around the Z axis, relative to the X axis. Can be 0, 90, 180, or 270 degrees. Choose a value that is roughly perpendicular to the edge on the target.</p> <p>The direction is indicated by a light blue arrow in the data viewer.</p>                                                                                                                                                                                                       |
| Path Spacing     | <p>Sets the spacing between paths in the measurement region used to extract the profiles that determine the edge. A higher number of paths results in a higher number of edge points, which makes the fitting of the edge line more accurate. However, a higher number of edge points results in a greater tool execution time.</p> <p>When <b>Path Spacing</b> is set to 0, the resolution of the scan data is used as the basis for spacing. No paths are displayed in the data viewer in this case.</p> |

| Parameter      | Description                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        |
|----------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Path Width     | <p>The size of the windows perpendicular to the path used to calculate an average for each data point on a path profile. Useful to average out noise along the path caused by reflections, and so on.</p>  <p>Data points of varying height perpendicular to the path within the window (grey points) are averaged to produce a path profile point (red point).</p> <p>If <b>Path Width</b> is set to 0, no averaging is performed (only the data point under the path is used).</p> <p>For averaging along the path, use <b>Step Smoothing</b> (see below).</p> |
| Selection Type | <p>Determines which step the tool uses on each path profile when there are multiple steps in the profile. An edge point is placed on each chosen step. Steps must pass the criteria of the tool's <b>Step Threshold</b> and <b>Step Direction</b> settings.</p> <p><b>Best:</b> Selects the greatest on each path profile.</p> <p><b>First:</b> Selects the first step on each path profile.</p> <p><b>Last:</b> Selects the last step on each path profile.</p>                                                                                                                                                                                   |
| Step Direction | <p>Determines whether the expected step rises or falls along the path. Either <b>Rising</b>, <b>Falling</b>, or <b>Rising or Falling</b>.</p>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      |

| Parameter                                   | Description                                                                                                                                                                                                                                                                                          |
|---------------------------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Step Threshold<br>or<br>Intensity Threshold | When <b>Use Intensity</b> is disabled, the setting specifies the minimum height difference between points on a path profile to be considered a step. Useful to exclude small height differences caused by noise, but also to exclude smaller steps on a part that should not be considered as steps. |

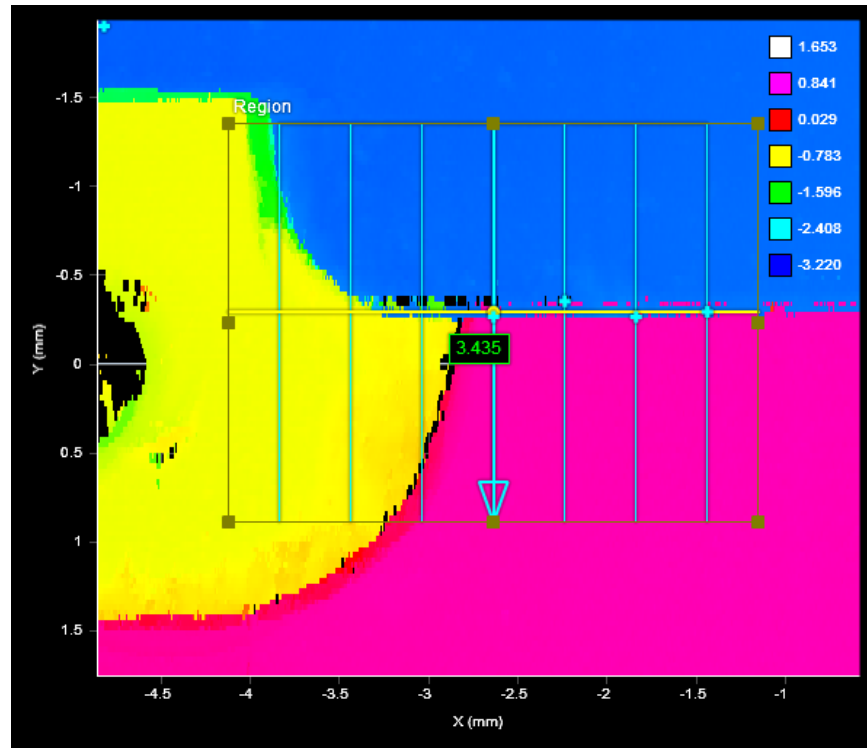


In the image below, when **Step Threshold** is left at the default of 0, all steps are included as possible candidates for an edge, and will be used to fit an edge line. The resulting edge line is angled upward to the left.

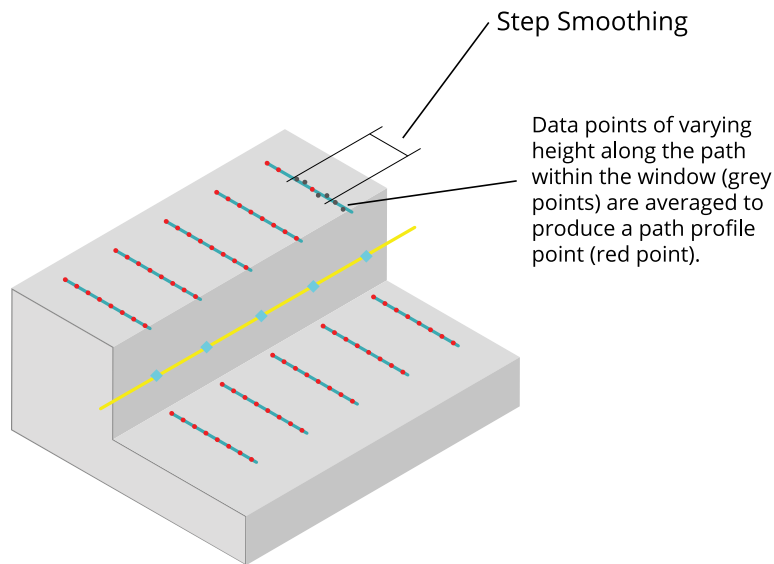
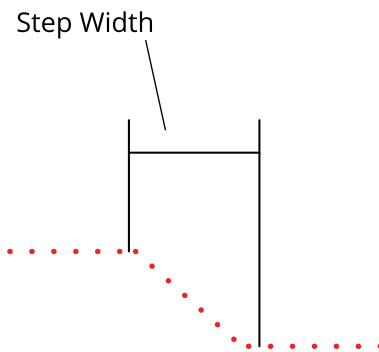


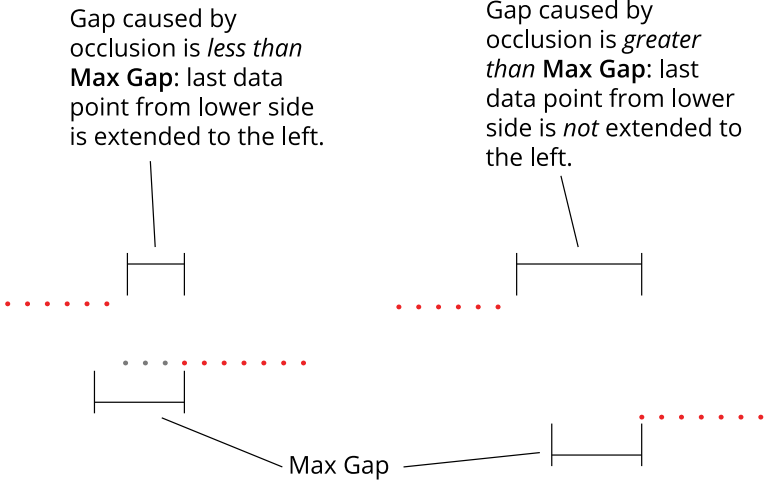
When **Step Threshold** is set to 3 with the same data (see image below), steps going from the yellow to pink regions (roughly 1.37 mm) and from the blue to yellow regions (roughly 2 mm) are excluded. Only steps from the blue to pink regions (roughly 3 mm) are included.

| Parameter | Description |
|-----------|-------------|
|-----------|-------------|



When **Use Intensity** is enabled, this setting is labeled **Intensity Threshold** and differences in intensity are examined for step thresholding.

| Parameter      | Description                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              |
|----------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Step Smoothing | <p>The size of the windows along the path used to calculate an average for each data point on a path profile. The setting is useful for averaging out noise.</p> <div>  </div> <p>If <b>Step Smoothing</b> is set to 0, no averaging is performed (only the data point under the path is used).</p> <p>For averaging perpendicular to the path, use <b>Path Width</b> (see above).</p>                                                                                                                                                                                                                                                                                                                                                                                 |
| Step Width     | <p>The distance, along a path profile, separating the points used to find steps on a path profile.</p> <div>  </div> <p>The setting is useful when you must detect a slope as an edge, rather than a sharply defined edge: setting <b>Step Width</b> to a value greater than the width of the edge ensures that the tool measures the height difference between the flat regions on either side of the edge. As a result, the height of the step is accurately measured, and the edge is correctly located.</p> <div> <p> Setting <b>Step Width</b> wider than necessary can reduce the precision of edge location.</p> </div> |

| Parameter                 | Description                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         |
|---------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Max Gap                   | <p>Fills in regions of missing data caused by an occlusion near the desired edge. Use this setting when continuity on the target is expected. When <b>Max Gap</b> is set to a non-zero value, the tool holds and extends the last data point on the low side next to an edge across a gap of null points, up to the distance specified in <b>Max Gap</b>.</p>  <p>Gap caused by occlusion is <i>less than</i> <b>Max Gap</b>: last data point from lower side is extended to the left.</p> <p>Gap caused by occlusion is <i>greater than</i> <b>Max Gap</b>: last data point from lower side is <i>not</i> extended to the left.</p> <p>Max Gap</p>                                                                                                                                                                                                                                                                               |
| Include Null Edges        | <p>Indicates whether null points (points where no height or intensity value is available, due to dropouts or regions outside of the measurement range) are filled with the value in <b>Null Fill Value</b> as a general “background level.” If <b>Use Intensity</b> (see above) is enabled, the intensity value in <b>Intensity Null Fill Value</b> is also used.</p> <p>A typical example is a discrete part produced by <a href="#">part detection</a> of an object sitting on a flat background. The background is not visible in the part, so the tool assumes that any null region are at the background level.</p> <div style="border: 1px solid black; padding: 10px; margin-top: 10px;"> <p>To find edges along a region of null points, you must use either this option and an appropriate value in <b>Null Fill Value</b> (and <b>Intensity Null Fill Value</b> if <b>Use Intensity</b> is enabled) or <b>Max Gap</b>. Otherwise, only edges within areas of contiguous data will be detected.</p> </div> |
| Null Fill Value           | The height value (in mm) used to replace null points not filled by <b>Max Gap</b> when <b>Include Null Edges</b> is enabled.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        |
| Intensity Null Fill Value | The intensity value (0-255) used to replace null points when <b>Include Null Edges</b> and <b>Use Intensity</b> are enabled.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        |
| Show Detail               | When disabled, hides the light blue path lines and edge points.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     |
| Decision                  | See <i>Decisions</i> on page 172.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   |
| Region                    | See <i>Regions</i> on page 165.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     |
| Output                    | See <i>Filters</i> on page 173.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     |

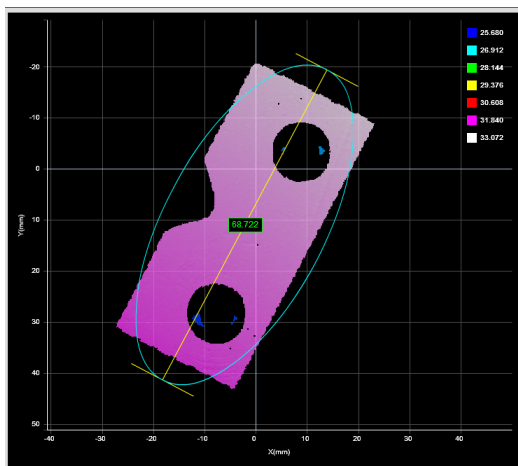
## Ellipse

The Ellipse tool provides measurements for the major and minor axis lengths of an ellipse fitted to the part's shape in the XY plane, and also for the ratio of the major and minor axis lengths and for the

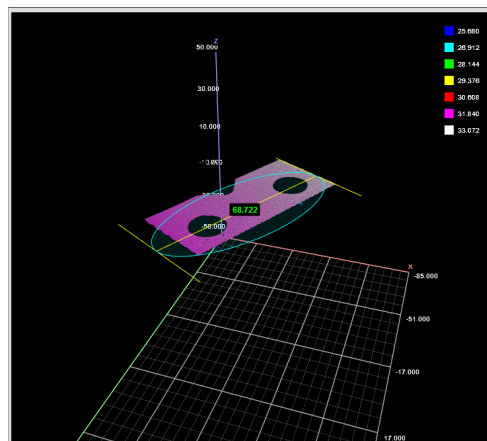


orientation angle of the ellipse. Gocator compares the measurement value with the values in **Min** and **Max** to yield a decision. For more information on decisions, see *Decisions* on page 172.

See *Adding and Configuring a Tool* on page 163 for instructions on how to add measurement tools.



2D View



3D View

ParametersAnchoring

Source:Top
Asymmetry Detection:None
☒ Region

MeasurementsFeatures

Major68.722☒
Minor☐
Ratio☐
Z Angle☐

ID:2

Output

Filters

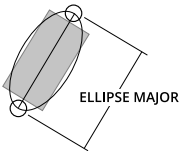
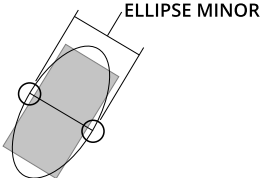
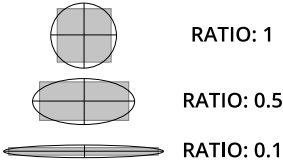
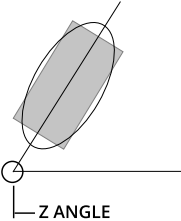
Decision

Min:68 mm
Max:69 mm

Measurement Panel

Measurements, Features, and Settings

Measurements

| Measurement                                                                                                        | Illustration                                                                          |
|--------------------------------------------------------------------------------------------------------------------|---------------------------------------------------------------------------------------|
| <b>Major</b><br><br>Determines the major axis length of an ellipse fitted to the part's area in the XY plane.      |    |
| <b>Minor</b><br><br>Determines the minor axis length of an ellipse fitted to the part's area in the XY plane.      |    |
| <b>Ratio</b><br><br>Determines the minor/major axis ratio of an ellipse fitted to the part's area in the XY plane. |     |
| <b>Z Angle</b><br><br>Determines the orientation angle of an ellipse fitted to the part's area in the XY plane.    |  |

Features

| Type         | Description                                               |
|--------------|-----------------------------------------------------------|
| Center Point | The center point of the fitted ellipse.                   |
| Major Axis   | A line representing the major axis of the fitted ellipse. |
| Minor Axis   | A line representing the minor axis of the fitted ellipse. |

 For more information on geometric features, see *Geometric Features* on page 171.

## Parameters

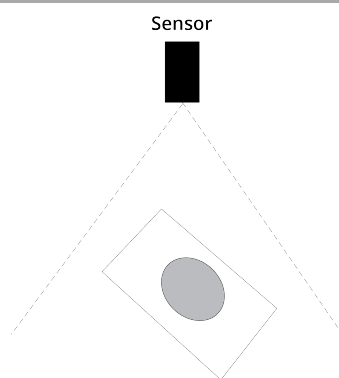
| Parameter           | Description                                                                                                                                      |
|---------------------|--------------------------------------------------------------------------------------------------------------------------------------------------|
| Asymmetry Detection | Resolves the orientation of an object over 360 degrees. The possible values are:<br><br>0 – None<br>1 – Along Major Axis<br>2 – Along Minor Axis |
| Decision            | See <i>Decisions</i> on page 172.                                                                                                                |
| Region              | See <i>Regions</i> on page 165.                                                                                                                  |
| Output              | See <i>Filters</i> on page 173.                                                                                                                  |

## Hole

The Hole tool measures a circular opening within a region of interest on the surface and returns its position and radius.



The Hole tool does not search for or detect a hole. The tool expects that a hole conforming reasonably well to the defined parameters is present and that it is on a sufficiently uniform background.

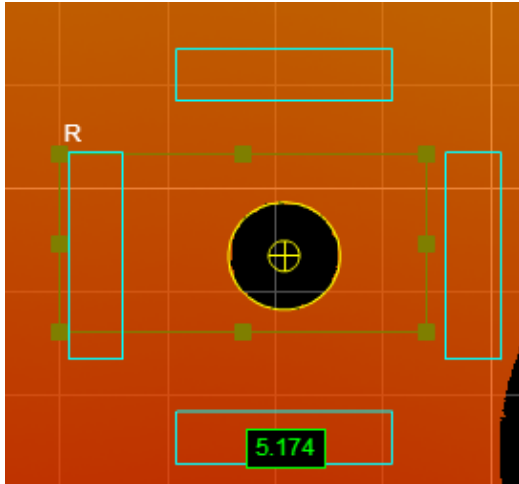


See *Adding and Configuring a Tool* on page 163 for instructions on how to add measurement tools.

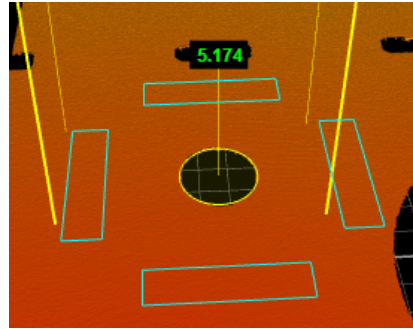
The hole can be on a surface at an angle to the sensor.

The tool uses a complex feature-locating algorithm to find a hold and then return measurements. See "Hole Algorithm" in the *Gocator Measurement Tool Technical Manual* for a detailed explanation of the algorithm. The behavior of the algorithm can be adjusted by changing the parameters in the measurement panel.

Gocator compares the measurement value with the values in **Min** and **Max** to yield a decision. For more information on decisions, see *Decisions* on page 172.



2D View



3D View

Parameters
Advanced
Anchoring

Source: Top
Nominal Radius: 10 mm
Radius Tolerance: 5 mm
Partial Detection:
Depth Limit: 5 mm
☒ Region

Measurements
Features

|        |       |                                     |
|--------|-------|-------------------------------------|
| X      | 5.174 | <input checked="" type="checkbox"/> |
| Y      |       | <input type="checkbox"/>            |
| Z      |       | <input type="checkbox"/>            |
| Radius |       | <input type="checkbox"/>            |

ID: 3

Output

Filters
Decision

Min: 5 mm
Max: 5.2 mm

ParameterAdvancedAnchoring

☒ Reference Region

Auto Set

Tilt Correction

Auto Set

X

Y

Z

Radius

5.174

☒

Id:

10

Output

Filters

Decision

Min:

3 mm

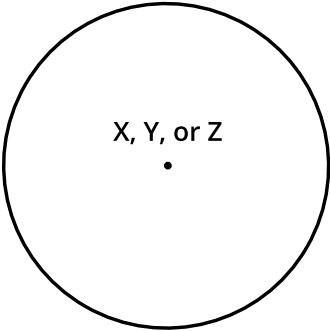
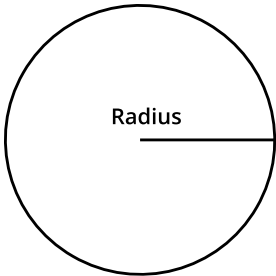
Max:

8 mm

Measurement Panel

Measurements, Features, and Settings

Measurements

| Measurement                                               | Illustration                                                                         |
|-----------------------------------------------------------|--------------------------------------------------------------------------------------|
| <b>X</b><br>Determines the X position of the hole center. |  |
| <b>Y</b><br>Determines the Y position of the hole center. |                                                                                      |
| <b>Z</b><br>Determines the Z position of the hole center. |                                                                                      |
| <b>Radius</b><br>Determines the radius of the hole.       |  |

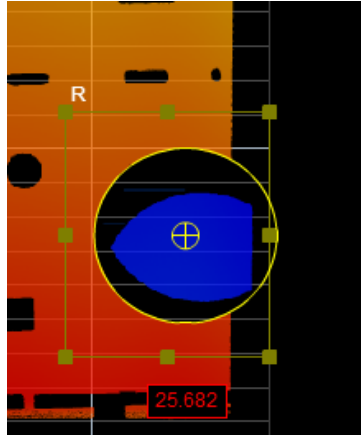
Features

| Type         | Description                                                                                                       |
|--------------|-------------------------------------------------------------------------------------------------------------------|
| Center Point | The center point of the hole. The Z position of the center point is at the Z position of the surrounding surface. |

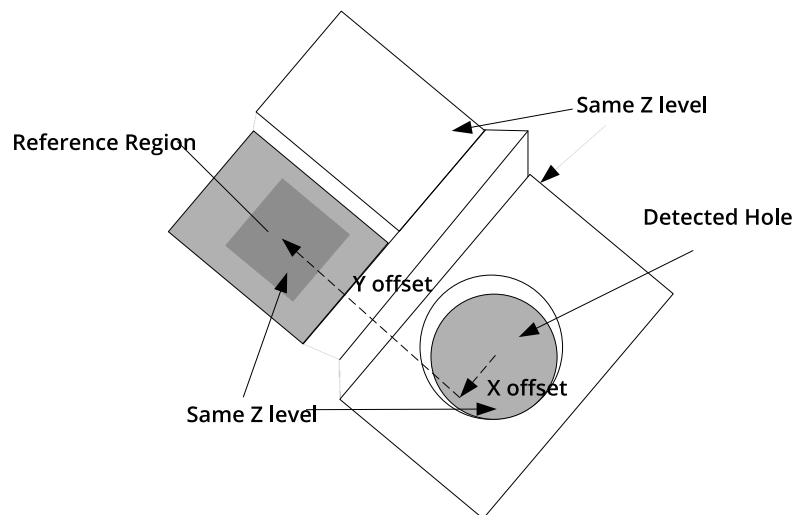
 For more information on geometric features, see *Geometric Features* on page 171.

## Parameters

| Parameter         | Description                                                                                                                                                   |
|-------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Nominal Radius    | Expected radius of the hole.                                                                                                                                  |
| Radius Tolerance  | The maximum variation from the nominal radius (+/- from the nominal radius).                                                                                  |
| Partial Detection | Enable if only part of the hole is within the measurement region. If disabled, the hole must be completely in the region of interest for results to be valid. |



|                   |                                                                                                                                                                       |
|-------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Depth Limit       | Data below this limit (relative to the surface) is excluded from the hole calculations.                                                                               |
| Reference Regions | The algorithm uses the Reference Regions option to calculate the Z position of the hole. It is typically used in cases where the surface around the hole is not flat. |



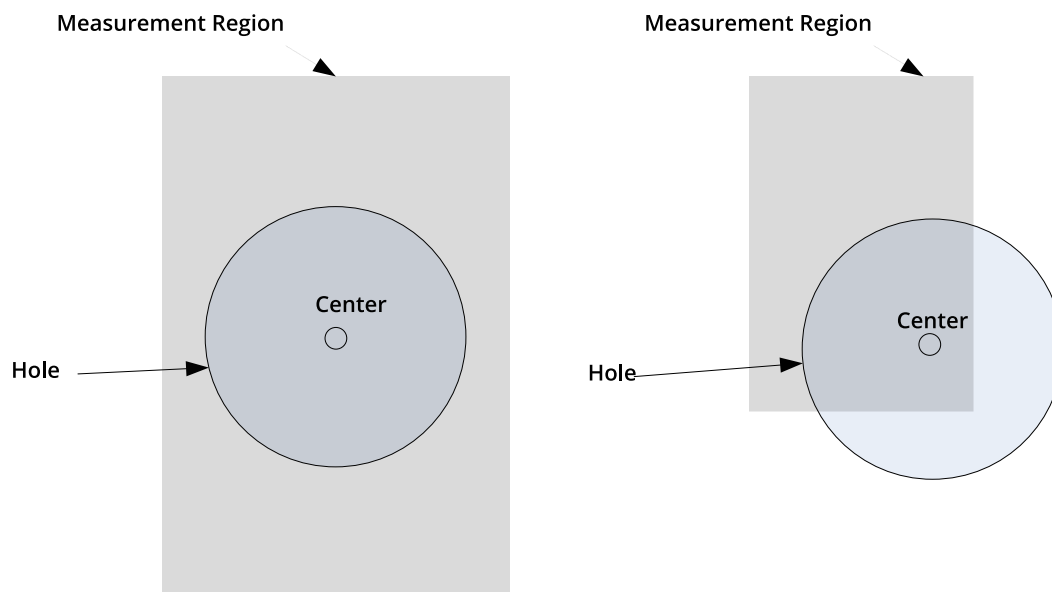
When this option is set to Autoset, the algorithm automatically determines the reference region. When the option is not set to Autoset, the user manually specifies the reference region. The location of the reference region is relative to the detected center of the hole and positioned on the nominal surface plane.

When the Reference Regions option is disabled, the tool measures the hole's Z position using all the data in the measurement region, except for a bounding rectangular region around the hole.

| Parameter       | Description                                                                                                                                                                                                                                                                                                                                                                                          |
|-----------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Tilt Correction | <p>Tilt of the target with respect to the alignment plane.</p> <p>When this option is set to Autoset, the tool automatically detects the tilt. Otherwise, the user must enter the angles manually. Autoset requires the measurement region to cover more areas on the surface plane than other planes.</p> <p>The results from the Plane X and Y tool can be used for angles X and Y parameters.</p> |
| Decision        | See <i>Decisions</i> on page 172.                                                                                                                                                                                                                                                                                                                                                                    |
| Region          | See <i>Regions</i> on page 165.                                                                                                                                                                                                                                                                                                                                                                      |
| Output          | See <i>Filters</i> on page 173.                                                                                                                                                                                                                                                                                                                                                                      |

## Measurement Region

The center of the hole must be inside the measurement region, even if the Partial Detection option is enabled.



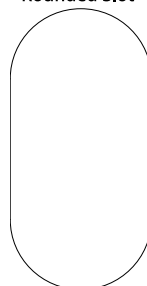
## Opening

The Opening tool locates rounded, rectangular, and rounded corner openings. The opening can be on a surface at an angle to the sensor.

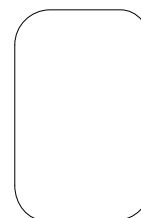


The Opening tool does not search for or detect an opening. The tool expects that an opening conforming reasonably well to the defined parameters is present and that it is on a sufficiently uniform background.

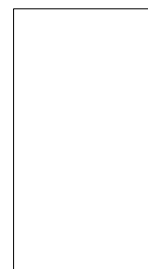
Rounded Slot



Rounded Corner Slot



Rectangular Slot

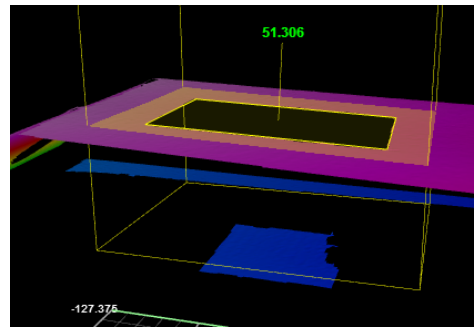


See *Adding and Configuring a Tool* on page 163 for instructions on how to add measurement tools.

The tool uses a complex feature-locating algorithm to find a hold and then return measurements. See "Opening Algorithm" in the *Gocator Measurement Tool Technical Manual* for a detailed explanation of the algorithm. The behavior of the algorithm can be adjusted by changing the parameters in the measurement panel.

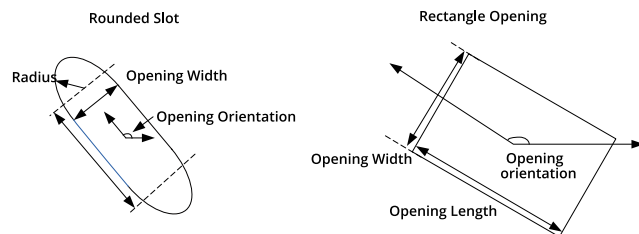
Gocator compares the measurement value with the values in **Min** and **Max** to yield a decision. For more information on decisions, see *Decisions* on page 172. You can select the measurement region in which the opening is expected to appear.

The algorithm can separate out background information that appears inside the opening. It can also detect a slot that only partially appears in the data.

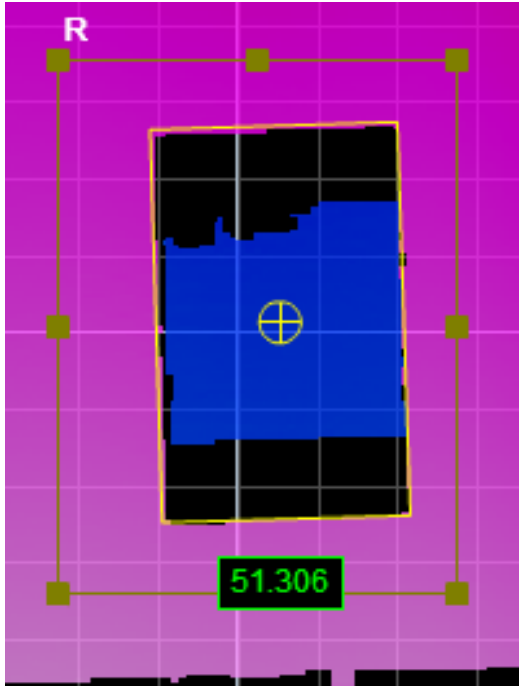


The shape of the opening is defined by its type and its nominal width, length, and radius.

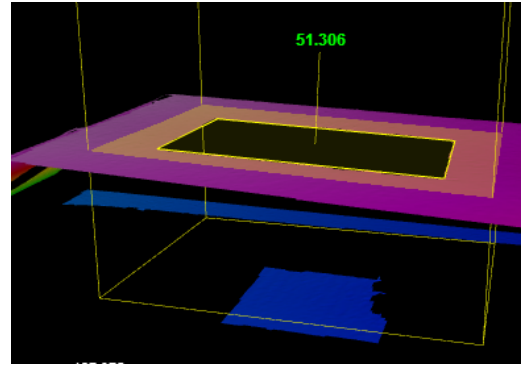
The orientation defines the rotation around the normal of the alignment plane.







2D View



3D View

Parameters
Advanced
Anchoring

Source:
Top
Type:
Rectangle
Nominal Width:
30 mm
Nominal Length:
45 mm
Nominal Angle:
90 °
Nominal Radius:
5 mm
Width Tolerance:
10 mm
Length Tolerance:
10 mm
Angle Tolerance:
5 °
Partial Detection:
☐
☒ Depth Limit:
5 mm
☒ Region

Measurements
Features

X
☐
Y
☐
Z
☐
Width
☐
Length
51.306 ☒
Angle
☐

ID:
5

Output

Filters

Decision

Min:
50 mm
Max:
60 mm

ParameterAdvancedAnchoring

Reference Region

Auto Set

Tilt Correction

Auto Set

X

Y

Z

Width

Length

Angle

51.306

Id:

11

Output

Filters

Decision

Min:

50 mm

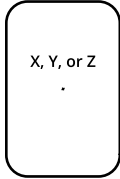
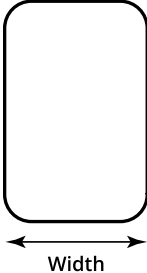
Max:

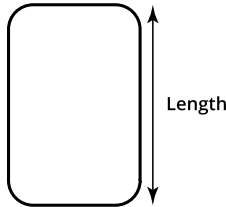
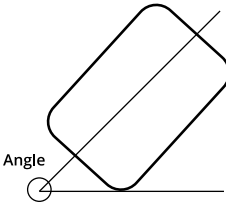
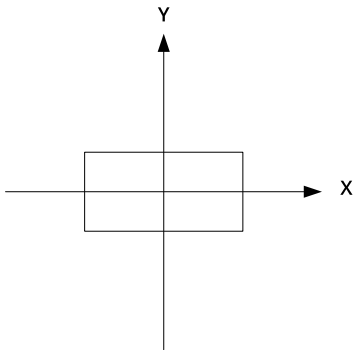
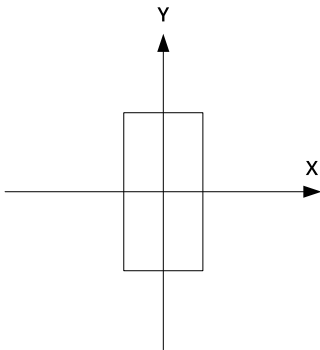
60 mm

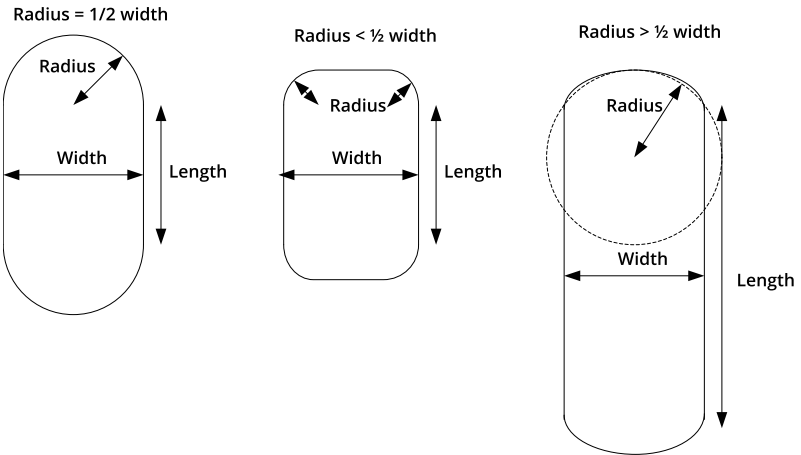
Measurement Panel

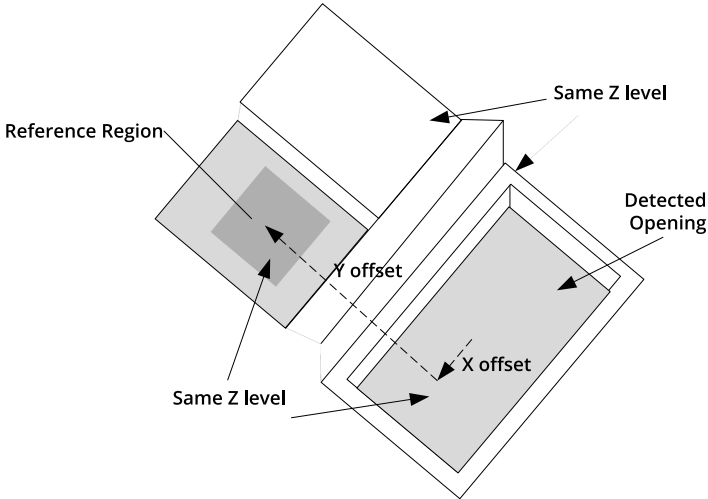
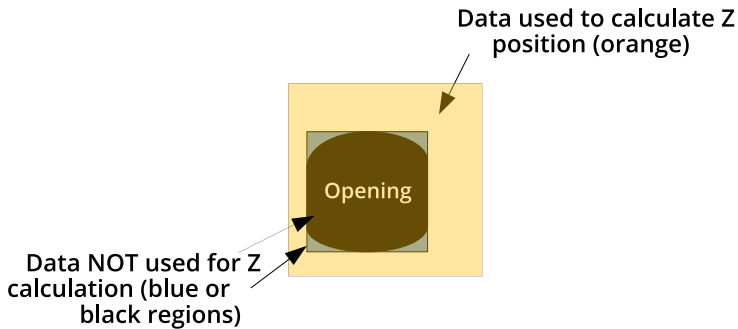
## Measurements, Features, and Settings

### Measurements

| Measurement                                                    | Illustration                                                                          |
|----------------------------------------------------------------|---------------------------------------------------------------------------------------|
| <b>X</b><br>Determines the X position of the opening's center. |  |
| <b>Y</b><br>Determines the Y position of the opening's center. |                                                                                       |
| <b>Z</b><br>Determines the Z position of the opening's center. |                                                                                       |
| <b>Width</b><br>Determines the width of the opening.           |  |

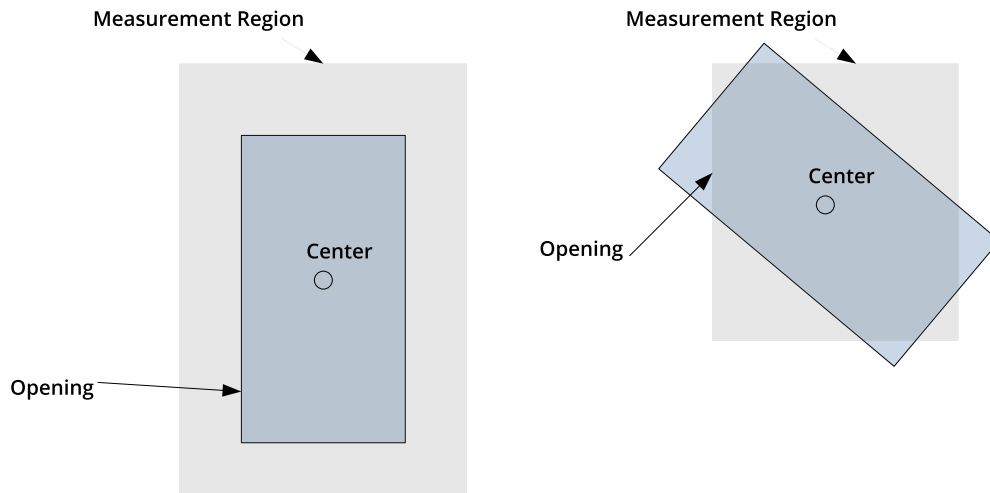
| Measurement                                                                                                                                                                                                                                                    | Illustration                                                                                                         |
|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------------------------------------------------------------------------------------------------------------------|
| <b>Length</b><br>Determines the length of the opening.                                                                                                                                                                                                         |                                    |
| <b>Angle</b><br>Determines the angle (rotation) around the normal of the alignment plane.                                                                                                                                                                      |                                    |
| Features                                                                                                                                                                                                                                                       |                                                                                                                      |
| Type                                                                                                                                                                                                                                                           | Description                                                                                                          |
| Center Point                                                                                                                                                                                                                                                   | The center point of the opening. The Z position of the center point is at the Z position of the surrounding surface. |
| <div>  For more information on geometric features, see <i>Geometric Features</i> on page 171. </div>                                                                          |                                                                                                                      |
| Parameters                                                                                                                                                                                                                                                     |                                                                                                                      |
| Parameter                                                                                                                                                                                                                                                      | Description                                                                                                          |
| Type                                                                                                                                                                                                                                                           | Rounded Slot, Rectangle.                                                                                             |
| Nominal Width                                                                                                                                                                                                                                                  | Nominal width of the opening.                                                                                        |
| Nominal length                                                                                                                                                                                                                                                 | Nominal length of the opening.                                                                                       |
| Nominal Angle                                                                                                                                                                                                                                                  | Nominal angle of the opening. The default orientation is the length of the opening along the X axis.                 |
| <div> <div> Orientation: 0 degrees  </div> <div> Orientation: 90 degrees  </div> </div> |                                                                                                                      |
| The diagram above illustrates the case where the surface is not tilted. When the surface is tilted, the orientation is defined with respect to the normal of the surface, not with respect to the X-Y plane                                                    |                                                                                                                      |

| Parameter         | Description                                                                                                                                                                                                                                                                                                                                                                                                    |
|-------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Nominal Radius    | <p>Nominal radius of the opening ends. If the opening type is set to rectangular, the radius setting is disabled. The opening has an oval shape if the radius is equal to <math>\frac{1}{2}</math> of the width. The opening is a rounded rectangle when the radius is less than <math>\frac{1}{2}</math> of the width.</p>  |
| Width Tolerance   | The maximum variation from the nominal width (+/- from the nominal value).                                                                                                                                                                                                                                                                                                                                     |
| Length Tolerance  | The maximum variation from the nominal length (+/- from the nominal value).                                                                                                                                                                                                                                                                                                                                    |
| Angle Tolerance   | The maximum variation from the nominal orientation (+/- from the nominal value).                                                                                                                                                                                                                                                                                                                               |
| Partial Detection | Enable if only part of the opening is within the measurement region. If disabled, the opening must be completely in the region of interest for results to be valid.                                                                                                                                                                                                                                            |
| Depth Limit       | Data below this limit (relative to the surface) is excluded from the opening calculations.                                                                                                                                                                                                                                                                                                                     |

| Parameter         | Description                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       |
|-------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Reference Regions | <p>The algorithm uses reference regions to calculate the Z position of the opening. Reference regions are relative to the center location of the feature. This option is typically used in cases where the surface around the opening is not flat.</p>  <p>When the Reference Regions setting is disabled, the tool measures the opening's Z position using the all data in the measurement region, except for a bounding rectangular region around the opening.</p>  <p>With one or more reference region, the algorithm calculates the Z positions as the average values of the data within the regions.</p> <p>When the user places the reference region manually, all of the data is used, whether the data is inside or outside the opening. The user should place the reference region carefully.</p> |
| Tilt Correction   | <p>Tilt of the target with respect to the alignment plane. Set to Auto-Set to have the tool automatically detect the target's tilt, or enter the angles manually. Auto-Set requires the measurement region to cover more areas on the surface plane than other planes.</p> <p>The results from the Plane X and Y tool can be used for angles X and Y parameters.</p>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              |
| Decision          | See <i>Decisions</i> on page 172.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 |
| Region            | See <i>Regions</i> on page 165.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   |
| Output            | See <i>Filters</i> on page 173.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   |

## Measurement Region

The center and the two sides and ends of the opening must be within the measurement region, even if Partial Detection is enabled.



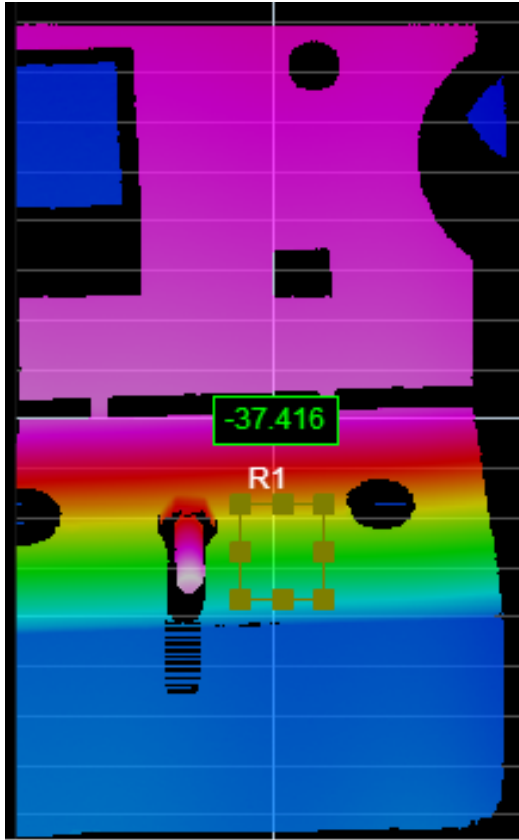
## Plane

The Plane tool provides measurements that report angle X, angle Y, and offset Z of the surface with respect to the alignment target. Gocator compares the measurement value with the values in **Min** and **Max** to yield a decision. For more information on decisions, see *Decisions* on page 172.

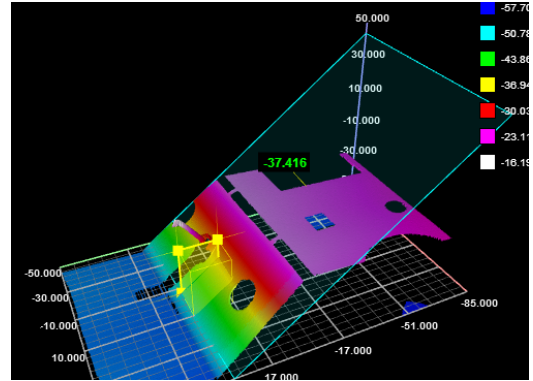
See *Adding and Configuring a Tool* on page 163 for instructions on how to add measurement tools.

The Z offset reported is the Z position at zero position on the X axis and the Y axis.

The results of the Plane Angle X and Plane Angle Y measurements can be used to customize the tilt angle in the Hole, Opening, and Stud tools.



2D View



3D View

ParameterAnchoring

Source:

Top

Regions

1 Region

X Angle

-37.416

Y Angle

Z Offset

Standard Deviation

Min Error

Max Error

Id:

5

Output

Filters

Decision

Min:

-38 mm

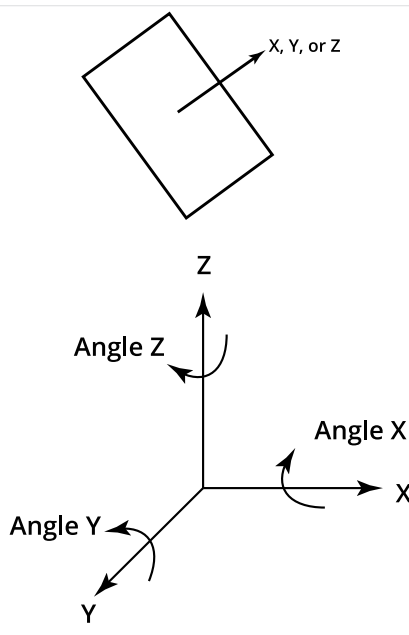
Max:

0 mm

Measurement Panel



## Measurements

| Measurement                                                                                                                                | Illustration                                                                       |
|--------------------------------------------------------------------------------------------------------------------------------------------|------------------------------------------------------------------------------------|
| <b>Angle X</b><br>Determines the X angle of the surface with respect to the alignment target.                                              |  |
| <b>Angle Y</b><br>Determines the Y angle of the surface with respect to the alignment target.                                              |                                                                                    |
| <b>Offset Z</b><br>Determines the Z offset of the surface with respect to the alignment target.                                            |                                                                                    |
| <b>Standard Deviation</b><br>Measures the standard deviation of the points of the surface from the detected plane.                         |                                                                                    |
| <b>Min Error</b><br>Measures the minimum error from the detected plane (the maximum distance below the plane, perpendicular to the plane). |                                                                                    |
| <b>Max Error</b><br>Measures the maximum error from the detected plane (the maximum distance above the plane, perpendicular to the plane). |                                                                                    |
| <b>X Normal</b><br>Returns the X component of the surface normal vector.                                                                   |                                                                                    |
| <b>Y Normal</b><br>Returns the Y component of the surface normal vector.                                                                   |                                                                                    |
| <b>Z Normal</b><br>Returns the Z component of the surface normal vector.                                                                   |                                                                                    |
| <b>Distance</b><br>Distance from the origin to the plane.                                                                                  |                                                                                    |

## Parameters

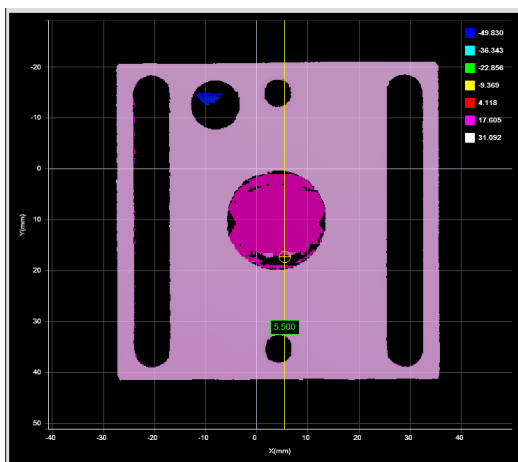
| Parameter | Description                       |
|-----------|-----------------------------------|
| Decision  | See <i>Decisions</i> on page 172. |
| Region    | See <i>Regions</i> on page 165.   |
| Output    | See <i>Filters</i> on page 173.   |

## Position

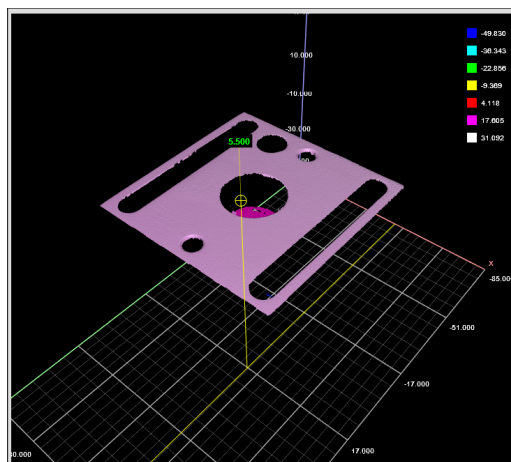
The Position tool reports the X, Y, or Z position of a part. The feature type must be specified and is one of the following: Average (the mean X, Y, and Z of the data points), Median (median X, Y, and Z of the data points), Centroid (the centroid of the data considered as a volume with respect to the  $z = 0$  plane), Min X, Max X, Min Y, Max Y, Min Z, or Max Z.

Gocator compares the measurement value with the values in **Min** and **Max** to yield a decision. For more information on decisions, see *Decisions* on page 172.

See *Adding and Configuring a Tool* on page 163 for instructions on how to add measurement tools.



2D View



3D View

ParametersAnchoring

Source:Top
Feature:Max Z

MeasurementsFeatures

X5.500
Y
Z

ID:6

Output

Filters

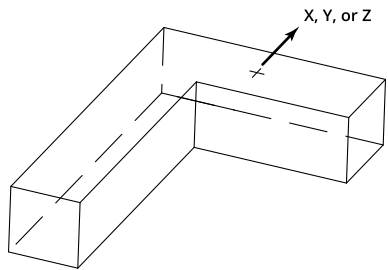
Decision

Min:5 mm
Max:6 mm

Measurement Panel

## Measurements, Features, and Settings

### Measurements

| Measurement                                                         | Illustration                                                                        |
|---------------------------------------------------------------------|-------------------------------------------------------------------------------------|
| <b>X</b><br>Determines the X position of the selected feature type. |  |
| <b>Y</b><br>Determines the Y position of the selected feature type. |                                                                                     |
| <b>Z</b><br>Determines the Z position of the selected feature type. |                                                                                     |

### Features

| Type         | Description            |
|--------------|------------------------|
| Center Point | The returned position. |


For more information on geometric features, see *Geometric Features* on page 171.

### Parameters

| Parameter    | Description                                                                                |
|--------------|--------------------------------------------------------------------------------------------|
| Feature Type | One of the following: Average, Centroid, Min X, Max X, Min Y, Max Y, Min Z, Max Z, Median. |
| Decision     | See <i>Decisions</i> on page 172.                                                          |
| Region       | See <i>Regions</i> on page 165.                                                            |
| Output       | See <i>Filters</i> on page 173.                                                            |

## Stud

The Stud tool measures the location and radius of a stud.



The Stud tool does not search for or detect a stud. The tool expects that a stud conforming reasonably well to the defined parameters is present and that it is on a sufficiently uniform background.

See *Adding and Configuring a Tool* on page 163 for instructions on how to add measurement tools.

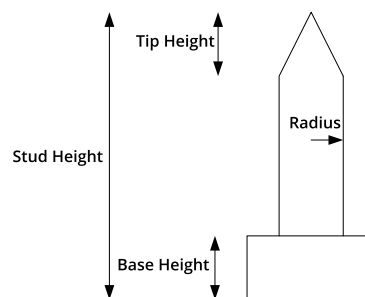
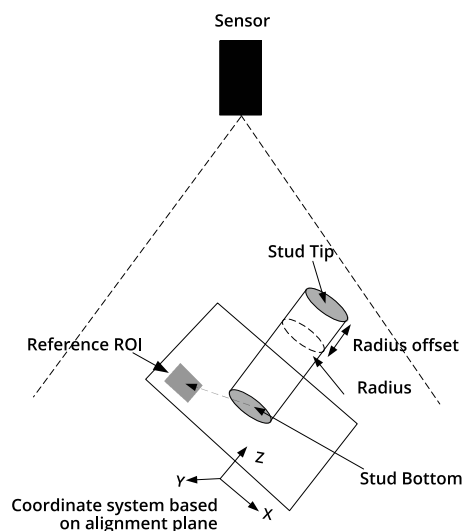
The tool uses a complex feature-locating algorithm to find a stud and then return measurements. See "Stud Algorithm" in the *Gocator Measurement Tool Technical Manual* for a detailed explanation of the algorithm.

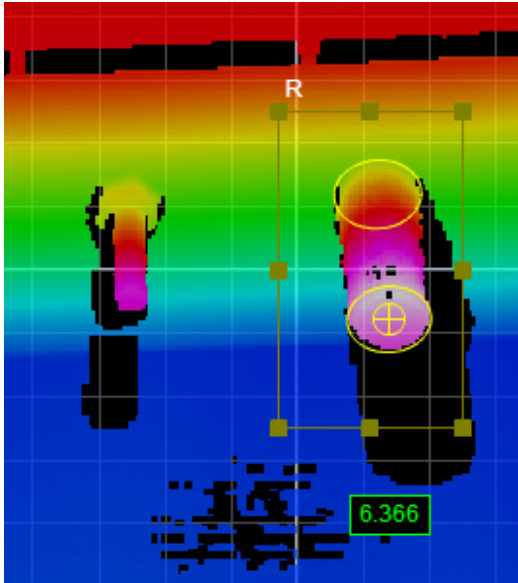
The behavior of the algorithm can be adjusted by changing the parameters in the measurement panel.

Gocator compares the measurement value with the values in **Min** and **Max** to yield a decision. For more information on decisions, see *Decisions* on page 172.

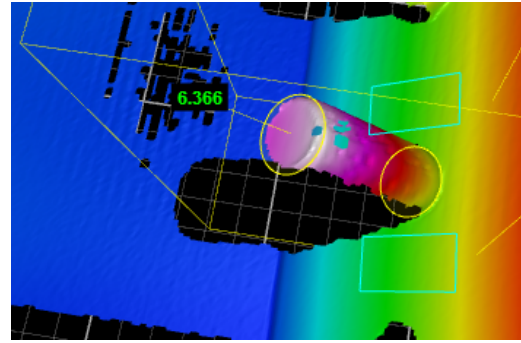
The location of the stud is defined at either the stud tip or the stud base. The tip is the intersection of the stud axis and the top of the stud; the base is the intersection of the stud axis and the surrounding plane.

The stud shape is defined by the tip height and base height. The base and tip heights specify where the shaft with the nominal radius begins and ends.





2D View



3D View

Parameters
Advanced
Anchoring

Source: Top
Stud Radius: 5 mm
Stud Height: 20 mm
Base Height: 0 mm
Tip Height: 0 mm
☒ Region

Measurements
Features

Base X ☐
Base Y ☐
Base Z ☐
Tip X ☐
Tip Y ☐
Tip Z ☐
Radius 6.366 ☒

ID: 8

Parameters
Output

Filters

Decision

Min: 6.25 mm
Max: 6.4 mm

ParameterAdvancedAnchoring

Reference Region

Auto Set

Tilt Correction

Auto Set

Base X

Base Y

Base Z

Tip X

Tip Y

Tip Z

Radius

Id:

13

Parameters

Output

Radius Offset:

0 mm

Measurement Panel

## Measurements, Features, and Settings

### Measurements

| Measurement                                                  | Illustration                                                                          |
|--------------------------------------------------------------|---------------------------------------------------------------------------------------|
| <b>Tip X</b><br>Determines the X position of the stud tip.   |  |
| <b>Tip Y</b><br>Determines the Y position of the stud tip.   |                                                                                       |
| <b>Tip Z</b><br>Determines the Z position of the stud tip.   |                                                                                       |
| <b>Base X</b><br>Determines the X position of the stud base. |  |
| <b>Base Y</b><br>Determines the Y position of the stud base. |                                                                                       |
| <b>Base Z</b><br>Determines the Z position of the stud base. |                                                                                       |
| <b>Radius</b><br>Determines the radius of the stud.          |  |

## Features

| Type       | Description                               |
|------------|-------------------------------------------|
| Tip Point  | The center point of the tip of the stud.  |
| Base Point | The center point of the base of the stud. |



For more information on geometric features, see *Geometric Features* on page 171.

## Parameters

| Parameter                        | Description                                                                                                                                                                                                                                                                                                                                      |
|----------------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Nominal Stud Radius              | Expected radius of the stud.                                                                                                                                                                                                                                                                                                                     |
| Nominal Stud Length              | Expected length of the stud.                                                                                                                                                                                                                                                                                                                     |
| Base Height                      | The height above the base surface that will be ignored when the (truncated) cone is fit to the stud data.                                                                                                                                                                                                                                        |
| Tip Height                       | The height from the top of the surface that will be ignored when the (truncated) cone is fit to the stud data.                                                                                                                                                                                                                                   |
| Radius Offset                    | The distance from the tip of the stud from which the radius is measured.                                                                                                                                                                                                                                                                         |
| <i>(Radius measurement only)</i> |                                                                                                                                                                                                                                                                                                                                                  |
| Reference Regions                | The algorithm uses reference regions to calculate the base plane of the stud. Reference regions are relative to the base of the stud.                                                                                                                                                                                                            |
| Tilt Correction                  | Tilt of the target with respect to the alignment plane. Set to Auto-Set to have the tool automatically detect the tilt, or enter the angles manually. Auto-Set requires the measurement region to cover more areas on the surface plane than other planes.<br>The results from the Plane X and Y tool can be used for angles X and Y parameters. |
| Decision                         | See <i>Decisions</i> on page 172.                                                                                                                                                                                                                                                                                                                |
| Region                           | See <i>Regions</i> on page 165.                                                                                                                                                                                                                                                                                                                  |
| Output                           | See <i>Filters</i> on page 173.                                                                                                                                                                                                                                                                                                                  |

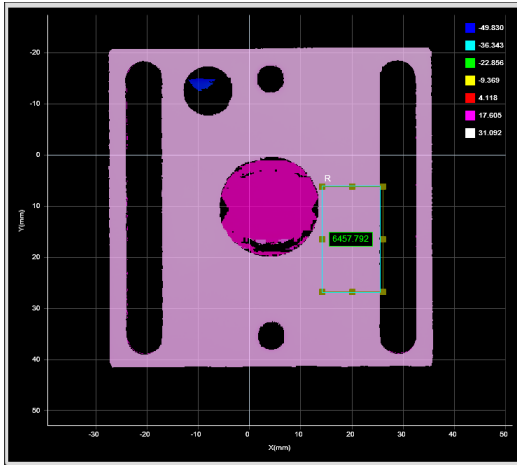
## Measurement Region

The tip and the side of the stud must be within the measurement region.

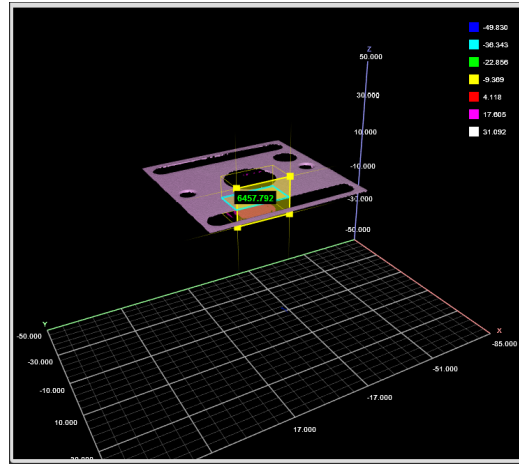
## Volume

The Volume tool determines the volume, area, and thickness of a part. Gocator compares the measurement value with the values in **Min** and **Max** to yield a decision. For more information on decisions, see *Decisions* on page 172.

See *Adding and Configuring a Tool* on page 163 for instructions on how to add measurement tools.



2D View



3D View

Parameters
Anchoring

Source:
Top

☒ Region

Volume
6457.792
☒

Area
☐

Thickness
☐

Id:
8

Output

Filters

Decision

Min:
6540
mm<sup>3</sup>

Max:
6560
mm<sup>3</sup>

Measurement Panel

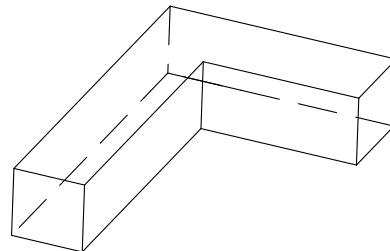
## Measurements

### Measurement

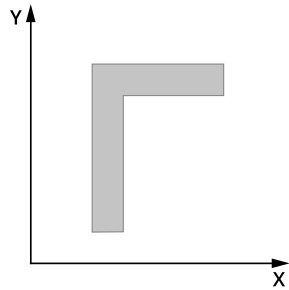
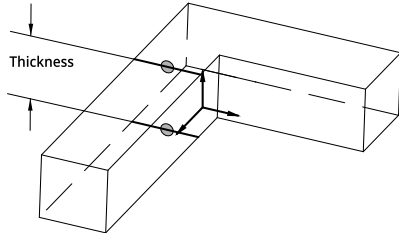
### Illustration

#### Volume

Measures volume in XYZ space.





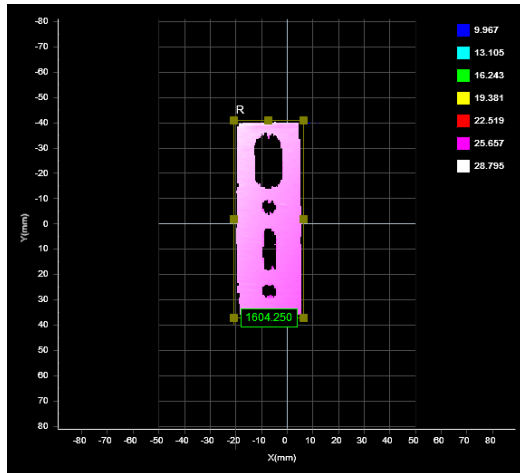
| Measurement                                                | Illustration                                                                                                                                                                       |
|------------------------------------------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <b>Area</b><br>Measures area in the XY plane.              |                                                                                                  |
| <b>Thickness</b><br>Measures thickness (height) of a part. |                                                                                                  |
| <b>Parameters</b>                                          |                                                                                                                                                                                    |
| Parameter                                                  | Description                                                                                                                                                                        |
| Location<br><i>(Thickness measurement only)</i>            | One of the following: maximum height, minimum height, average height, median height, the height at the 2D centroid in the XY plane, or the height at the 3D centroid in XYZ space. |
| Decision                                                   | See <i>Decisions</i> on page 172.                                                                                                                                                  |
| Region                                                     | See <i>Regions</i> on page 165.                                                                                                                                                    |
| Output                                                     | See <i>Filters</i> on page 173.                                                                                                                                                    |

## Script

A Script measurement can be used to program a custom measurement using a simplified C-based syntax. A script measurement can produce multiple measurement values and decisions for the output.

See *Adding and Configuring a Tool* on page 163 for instructions on how to add measurement tools.

See *Scripts* on page 278 for more information on scripts.



```

Code
1 double VolumeArea = Measurement_Value(4);
2
3 if (Measurement_Valid(4))
4 {
5   Output_Set(VolumeArea + 10000, 1);
6 }
7 else
8 {
9   Output_SetAt(0, 0);
10 }

```

\*Press save button or 'Ctrl+S' to apply change.  
Press 'Esc' to exit full screen.

Output:

Output 0 1604.250

Id:

See *Scripts* on page 278 for more information on the script syntax.

*To create or edit a Script measurement:*

1. Add a new Script tool or select an existing Script measurement.
2. Edit the script code.
3. Add script outputs using the **Add** button.  
For each script output that is added, an index will be added to the **Output** drop-down and a unique ID will be generated.  
To remove a script output, click on the  button next to it.
4. Click the **Save** button  to save the script code.  
If there is a mistake in the script syntax, the result will be shown as a "Invalid" with a red border in the data viewer when you run the sensor.  
Outputs from multiple measurement tools can be used as inputs to the script. A typical script would take results from other measurement tools using the value and decision function, and output the result using the output function. Stamp information, such as time and encoder stamps, are available in the script, whereas the actual 3D point cloud data is not. (The script engine is not powerful enough to process the data itself.) Only one script can be created.

## Feature Measurement

The following sections describe Gocator's Feature tools.

Feature tools produce measurements based on more complex geometry, letting you implement applications more quickly by reducing dependence on writing scripts to accomplish these kinds of measurements. Feature tools take [geometric features](#) generated by other tools as input and perform measurements on those features.

Feature tools are available in either Profile or Surface mode.

## Dimension

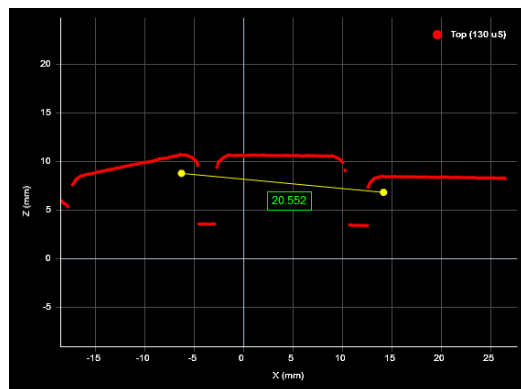
The Feature Dimension tool provides dimensional measurements that you can apply to geometric features generated by Profile or Surface tools.

Some examples:

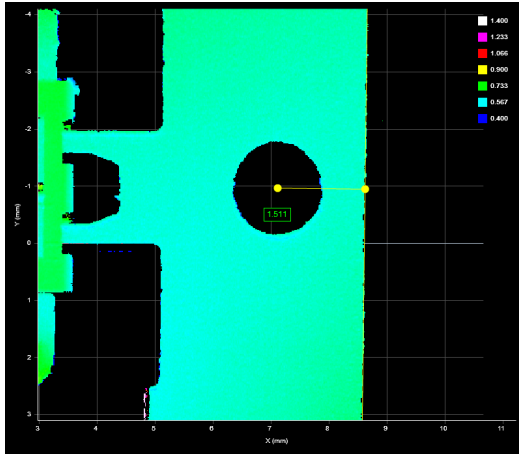
- Measuring the distance between the center of a hole and an edge.
- Measuring the distance between the centers of two holes.
- Obtaining the length of a stud by measuring the distance between its tip and base.

Gocator compares the measurement value with the values in **Min** and **Max** to yield a decision. For more information on decisions, see *Decisions* on page 172.

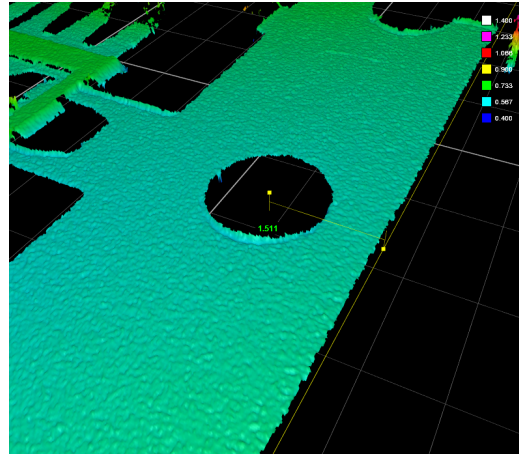
See *Adding and Configuring a Tool* on page 163 for instructions on how to add measurement tools.



| Parameters                    |                                            |
|-------------------------------|--------------------------------------------|
| Reference Point               | Profile Circle - Left/Center P... ▾        |
| Feature                       | Profile Circle - Right/Center... ▾         |
| Width                         | 20.458 <input checked="" type="checkbox"/> |
| Length                        | <input type="checkbox"/>                   |
| Height                        | -1.960 <input checked="" type="checkbox"/> |
| Distance                      | 20.552 <input checked="" type="checkbox"/> |
| Plane Distance                | <input type="checkbox"/>                   |
| ID:                           | 4                                          |
| <div>Parameters Output</div>  |                                            |
| <b>Filters</b> <span>⋮</span> |                                            |
| <b>Decision</b>               |                                            |
| Min:                          | 20.25 mm                                   |
| Max:                          | 20.75 mm                                   |



2D View



3D View

Parameters

Reference Point  
Surface Hole/Center Point

Feature  
Surface Edge/Edge Line

Width  
Length  
Height  
Distance  
Plane Distance 1.511

ID: 4

Parameters Output

Filters

Decision

Min: 1.5 mm  
Max: 1.55 mm

Measurement Panel

## Measurements

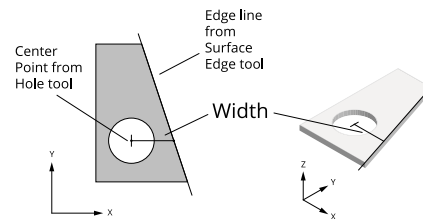
### Measurement

#### Width

**Point-point:** Separation, along and parallel to the X axis, between two point geometric features

**Point-line:** Separation, along and parallel to the X axis, between a point geometric feature (**Reference Point** setting) and the intersection of a line extending from that point along the X axis and the line geometric feature selected in the **Feature** setting.

### Illustration



## Measurement

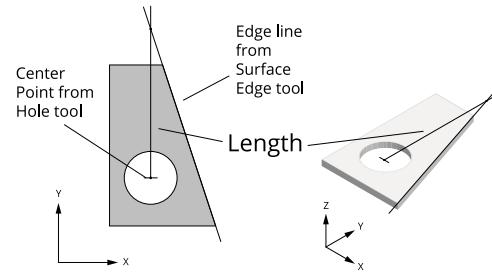
## Illustration

### Length

*Point-point:* Separation, along and parallel to the Y axis, between two point geometric features

*Point-line:* Separation, along and parallel to the Y axis, between a point geometric feature (**Reference Point** setting) and the intersection of a line extending from that point along the Y axis and the line geometric feature selected in the **Feature** setting.

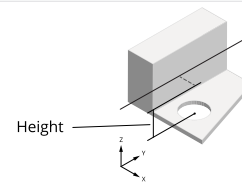
For profiles, always 0.



### Height

*Point-point:* Separation, along and parallel to the Z axis, between two point geometric features.

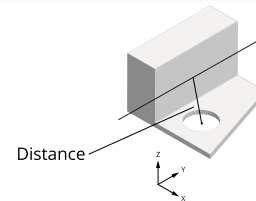
*Point-line:* Separation, along and parallel to the Z axis, between a point geometric feature (**Reference Point** setting) and the Z position of the center of the line geometric feature selected in the **Feature** setting.



### Distance

*Point-point:* The direct, Euclidean separation between two point geometric features.

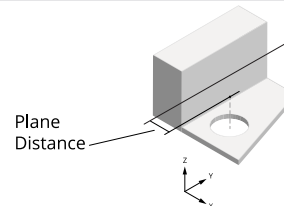
*Point-line:* The direct, Euclidean separation between a point geometric feature (**Reference Point** setting) and the intersection of a line extending from that point and the line geometric feature selected in **Feature**.



### Plane Distance

*Point-point:* The distance between two point geometric features, projected onto the XY plane (for surfaces) or the distance projected onto the XZ plane (for profiles).

*Point-line:* The distance between a point geometric feature (**Reference Point** setting) and the intersection of a line extending from that point and the line geometric feature selected in **Feature**, projected onto the XY plane (for surfaces) or the distance projected onto the XZ plane (for profiles).



## Parameters

| Parameter       | Description                                                          |
|-----------------|----------------------------------------------------------------------|
| Reference Point | A point <a href="#">geometric feature</a> generated by another tool. |
| Feature         | A point or line geometric feature generated by another tool.         |
| Decision        | See <i>Decisions</i> on page 172.                                    |
| Region          | See <i>Regions</i> on page 165.                                      |
| Output          | See <i>Filters</i> on page 173.                                      |

## Intersect

The Feature Intersect tool returns the intersection of the specified line [geometric features](#) projected onto the Z = reference Z line plane for features extracted from a surface, and the intersection of the lines projected onto the Y = 0 plane for features extracted from a profile. The angle measurement between the two lines is also returned. The lines the tool takes as input are generated by other tools, such as [Surface Edge](#) or [Surface Ellipse](#).

The Feature Intersect tool saves you from having to write complicated calculations in [script tools](#) to find intersect point between lines. Previously, calculating the intercept point of two lines was difficult and prone to bugs, involving finding lines in indirect ways.

The Feature Intersect tool's positional measurements are particularly useful as anchor sources. For example, you can easily find a corner point on a part from two edges (produced by two Surface Edge tools) and using the X and Y positions as anchor sources.

When you use these positional anchors in combination with a Z Angle anchor from tools such as Surface Edge, you can achieve extremely robust, repeatable measurements.



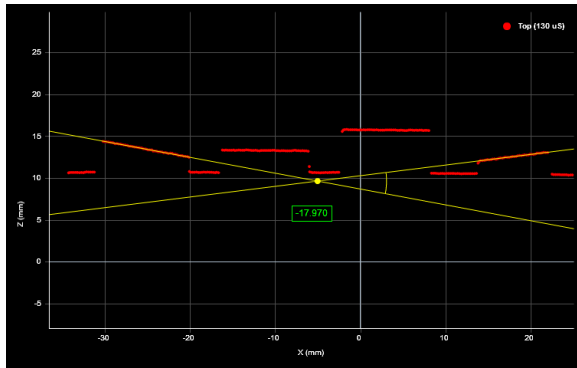
This tool's Angle measurement cannot be used as an angle anchor source. Only Z Angle measurements can be used as angle anchor sources.

For more information on anchoring, see *Measurement Anchoring* on page 175.

The Feature Intersect tool can also generate a point [geometric feature](#) representing the point of intersection of the lines that the [Feature Dimension](#) tool can use in measurements.

Gocator compares the measurement value with the values in **Min** and **Max** to yield a decision. For more information on decisions, see *Decisions* on page 172.

See *Adding and Configuring a Tool* on page 163 for instructions on how to add measurement tools.



Parameters

Line: Profile Line - Left/Line

Reference Line: Profile Line - Right/Line

Measurements Features

X ☐

Y ☐

Z ☐

Angle -17.970 ☒

ID: 3

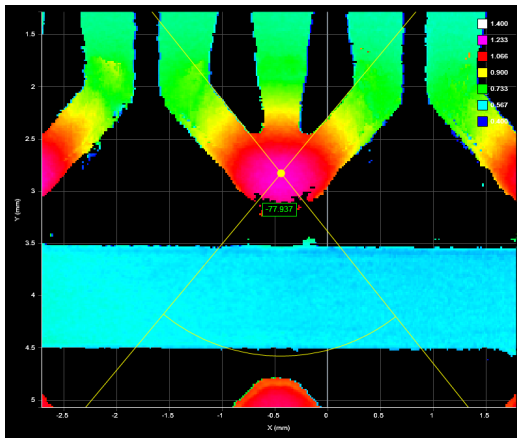
Parameters Output

Filters

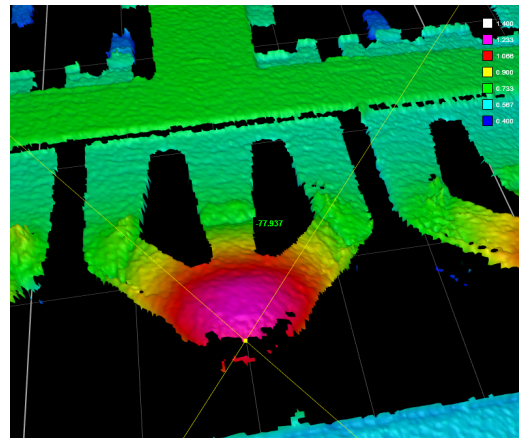
Decision

Min: -18 mm

Max: -17.9 mm



2D View



3D View

Parameters

Line Surface Edge Left/Edge Line

Reference Line Surface Edge Right/Edge Line

Measurements Features

X

Y

Z 0.473

Angle -77.937

ID: 3

Parameters Output

Filters

Decision

Min: -78 mm

Max: -77.9 mm

Measurement Panel

## Measurements

### Measurement

### Illustration

#### X

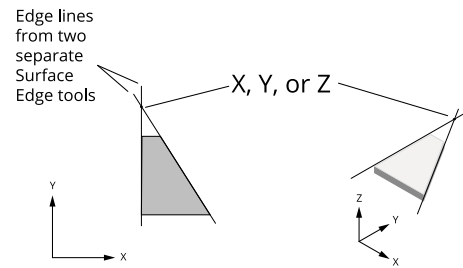
The X position of the intersect point the lines in **Line** and **Reference Line**.

#### Y

The Y position of the intersect point the lines in **Line** and **Reference Line**.

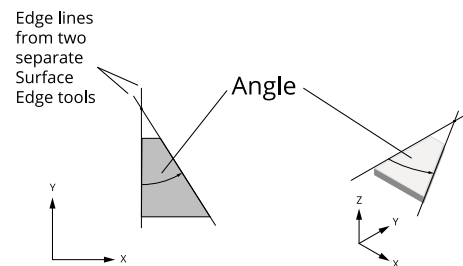
#### Z

The Z position of the intersect point the lines in **Line** and **Reference Line**.



#### Angle

The angle between the lines, as measured from the line geometric feature selected in **Reference Line** to the one selected in **Line**.



## Features

### Type

### Description

Intersect Point

The intersect point of the two edge lines.



## Parameters

| Parameter                               | Description                                                                                                                                          |
|-----------------------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------|
| Line                                    | A line <a href="#">geometric feature</a> generated by another tool.                                                                                  |
| Reference Line                          | A line <a href="#">geometric feature</a> generated by another tool. For the Angle measurement, the angle is measured <i>from</i> the reference line. |
| Angle Range<br>(Angle measurement only) | Determines the angle range. The options are:<br>-180 – 180<br>0 – 360                                                                                |
| Decision                                | See <i>Decisions</i> on page 172.                                                                                                                    |
| Region                                  | See <i>Regions</i> on page 165.                                                                                                                      |
| Output                                  | See <i>Filters</i> on page 173.                                                                                                                      |

## Scripts

Scripts use outputs from other measurement tools to produce custom measurements.

Similar to other measurement tools, a script measurement can output multiple measurement values and decisions. Scripts are added, configured, and removed much like other measurement tools; for more information on this, see *Script* under *Profile Measurement* on page 183 or *Surface Measurement* on page 217.



Scripts must be less than 27,000 characters long.

Scripts use a simplified C-based syntax. The following elements of the C language are supported:

### Supported Elements

| Elements                        | Supported                                                                                                                                                             |
|---------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Control Operators               | if, while, do, for, switch and return.                                                                                                                                |
| Data Types                      | char, int, unsigned int, float, double, long long (64-bit integer).                                                                                                   |
| Arithmetic and Logical Operator | Standard C arithmetic operators, except ternary operator (i.e., "condition? trueValue: falseValue"). Explicit casting (e.g., int a = (int) a_float) is not supported. |
| Function Declarations           | Standard C function declarations with argument passed by values. Pointers are not supported.                                                                          |

## Built-in Functions

### Measurement Functions

| Function                       | Description                                                                                         |
|--------------------------------|-----------------------------------------------------------------------------------------------------|
| int Measurement_Exists(int id) | Determines if a measurement exists by ID.<br><br>Parameters:<br>id – Measurement ID<br><br>Returns: |

| Function                                                          | Description                                                                                                                                                                                                   |
|-------------------------------------------------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
|                                                                   | 0 – measurement does not exist<br>1 – measurement exists                                                                                                                                                      |
| int Measurement_Valid(int id)                                     | Determines if a measurement value is valid by its ID.<br>Parameters:<br>id - Measurement ID<br>Returns<br>0 - Measurement is invalid<br>1 - Measurement is valid                                              |
| double Measurement_Value (int id)                                 | Gets the value of a measurement by its ID.<br>Parameters:<br>id - Measurement ID<br>Returns:<br>Value of the measurement<br>0 – if measurement does not exist<br>1 – if measurement exists                    |
| int Measurement_Decision (int id)                                 | Gets the decision of a measurement by its ID.<br>Parameters:<br>ID - Measurement ID<br>Returns:<br>Decision of the measurement<br>0 – if measurement decision is false<br>1 – If measurement decision is true |
| int Measurement_NameExists(char* toolName, char* measurementName) | Determines if a measurement exist by name.<br>Parameter:<br>toolName – Tool name<br>measurementName – Measurement name<br>Returns:<br>0 – measurement does not exist<br>1 – measurement exists                |
| int Measurement_Id (char* toolName, char* measurementName)        | Gets the measurement ID by the measurement name.<br>Parameters:<br>toolName – Tool name<br>measurementName – Measurement name<br>Returns:<br>-1 – measurement does not exist<br>Other value – Measurement ID  |

### *Output Functions*

| Function                                                          | Description                                                                                                                                                                                                                                                                                                                                                                                       |
|-------------------------------------------------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| void Output_Set (double value, int decision)                      | Sets the output value and decision on Output index 0. Only the last output value / decision in a script run is kept and passed to the Gocator output. To output an invalid value, the constant INVALID_VALUE can be used (e.g., Output_SetAt(0, INVALID_VALUE, 0))<br><br>Parameters:<br>value - value output by the script<br>decision - decision value output by the script. Can only be 0 or 1 |
| void Output_SetAt(unsigned int index, double value, int decision) | Sets the output value and decision at the specified output index. To output an invalid value, the constant INVALID_VALUE can be used (e.g., Output_SetAt(0, INVALID_VALUE, 0))<br><br>Parameters:<br>index – Script output index<br>value – value output by the script<br>decision – decision value output by the script. Can only be 0 or 1                                                      |
| void Output_SetId(int id, double value, int decision)             | Sets the output value and decision at the specified script output ID. To output an invalid value, the constant INVALID_VALUE can be used (e.g., Output_SetId(0, INVALID_VALUE, 0))<br><br>Parameters:<br>id – Script output ID                                                                                                                                                                    |

### *Memory Functions*

| Function                                              | Description                                                                                                                                                   |
|-------------------------------------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------|
| void Memory_Set64s (int id, long long value)          | Stores a 64-bit signed integer in persistent memory.<br><br>Parameters:<br>id - ID of the value<br>value - Value to store                                     |
| long long Memory_Get64s (int id)                      | Loads a 64-bit signed integer from persistent memory.<br><br>Parameters:<br>id - ID of the value<br><br>Returns:<br>value - Value stored in persistent memory |
| void Memory_Set64u (int id, unsigned long long value) | Stores a 64-bit unsigned integer in the persistent memory<br><br>Parameters:<br>id - ID of the value<br>value - Value to store                                |
| unsigned long long Memory_Get64u (int id)             | Loads a 64-bit unsigned integer from persistent memory.<br><br>Parameters:<br>id - ID of the value                                                            |

| Function                                  | Description                                                                                                                                                                                                     |
|-------------------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
|                                           | Returns:<br>value - Value stored in persistent memory                                                                                                                                                           |
| void Memory_Set64f (int id, double value) | Stores a 64-bit double into persistent memory.<br>Parameters:<br>id - ID of the value<br>value - Value to store                                                                                                 |
| double Memory_Get64f (int id)             | Loads a 64-bit double from persistent memory. All persistent memory values are set to 0 when the sensor starts.<br>Parameters:<br>id - ID of the value<br>Returns:<br>value - Value stored in persistent memory |
| int Memory_Exists (int id)                | Tests for the existence of a value by ID.<br>Parameters:<br>id - Value ID<br>Returns:<br>0 - value does not exist<br>1 - value exists                                                                           |
| void Memory_Clear (int id)                | Erases a value associated with an ID.<br>Parameters:<br>id - Value ID                                                                                                                                           |
| void Memory_ClearAll()                    | Erases all values from persistent memory                                                                                                                                                                        |

#### *Runtime Variable Functions*

| Function                           | Description                                                                                                                                           |
|------------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------|
| int RuntimeVariable_Count()        | Returns the number of runtime variables that can be accessed.<br>Returns:<br>The count of runtime variables.                                          |
| int RuntimeVariable_Get32s(int id) | Returns the value of the runtime variable at the given index.<br>Parameters:<br>Id - ID of the runtime variable<br>Returns:<br>Runtime variable value |

### *Stamp Functions*

| Function                    | Description                                           |
|-----------------------------|-------------------------------------------------------|
| long long Stamp_Frame()     | Gets the frame index of the current frame.            |
| long long Stamp_Time()      | Gets the time stamp of the current frame.             |
| long long Stamp_Encoder()   | Gets the encoder position of the current frame.       |
| long long Stamp_EncoderZ()  | Gets the encoder index position of the current frame. |
| unsigned int Stamp_Inputs() | Gets the digital input state of the current frame.    |

### *Math Functions*

| Function                     | Description                                                        |
|------------------------------|--------------------------------------------------------------------|
| float sqrt(float x)          | Calculates square root of x                                        |
| float sin(float x)           | Calculates sin(x) (x in radians)                                   |
| float cos(float x)           | Calculates cos(x) (x in radians)                                   |
| float tan(float x)           | Calculates tan(x) (x in radians)                                   |
| float asin(float x)          | Calculates asin(x) (x in radians)                                  |
| float acos(float x)          | Calculates acos(x) (x in radians)                                  |
| float atan(float x)          | Calculates atan(x) (x in radians)                                  |
| float pow (float x, float y) | Calculates the exponential value. x is the base, y is the exponent |
| float fabs(float x)          | Calculates the absolute value of x                                 |

### **Example: Accumulated Volume**

The following example shows how to create a custom measurement that is based on the values from other measurements and persistent values. The example calculates the volume of the target using a series of box area measurement values.

```
/* Calculate the volume of an object by accumulating the boxArea measurements*/
/* Encoder Resolution is 0.5mm. */
/* BoxArea Measurement ID is set to 1*/

long long encoder_res = 500;
long long Volume = Memory_Get64s(0);

Memory_Set64s(0, Volume);
if (Volume > 1000000)
{
    Output_Set(Volume, 1);
}
else
{
    Output_Set(Volume, 0);
}
```

# Output

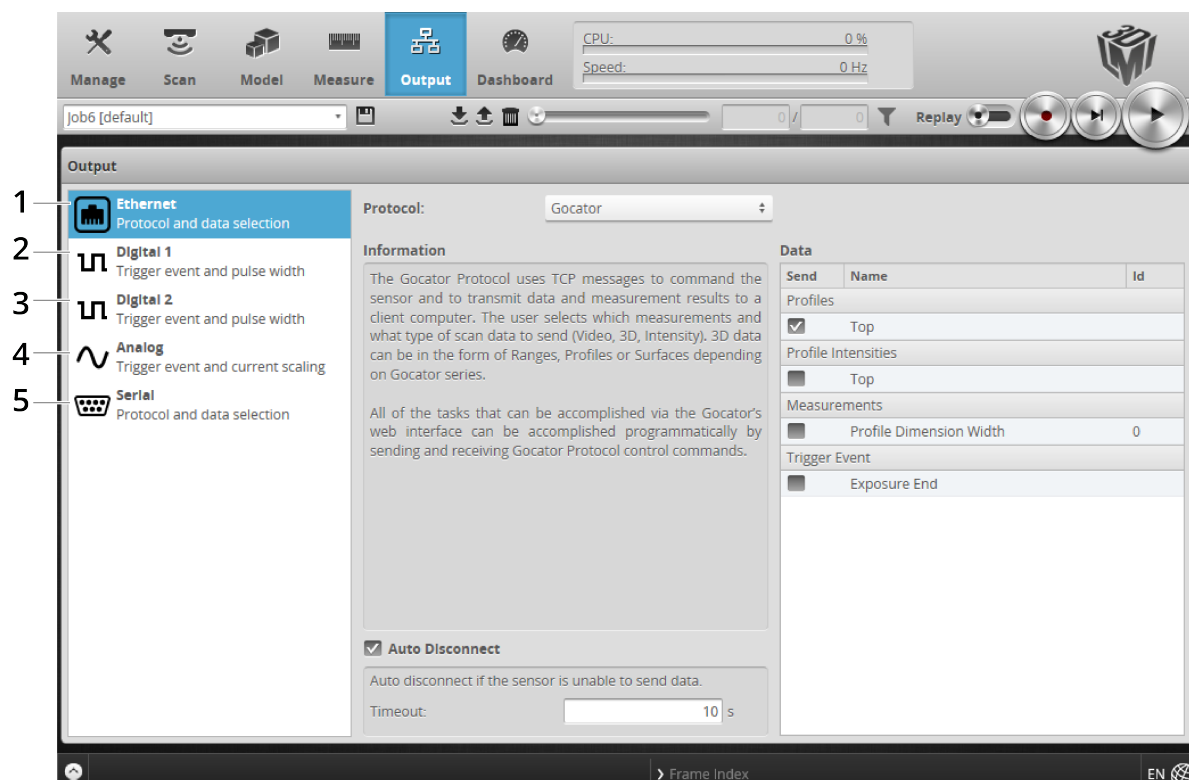
The following sections describe the **Output** page.

## Output Page Overview

Output configuration tasks are performed using the **Output** page. Gocator sensors can transmit laser profiles and measurement results to various external devices using several output interface options.



Up to two outputs can have scheduling enabled with ASCII as the Serial output protocol. When Selcom is the current Serial output protocol, only one other output can have scheduling enabled.



|   | Category         | Description                                                                                                                                 |
|---|------------------|---------------------------------------------------------------------------------------------------------------------------------------------|
| 1 | Ethernet         | Used to select the data sources that will transmit data via Ethernet. See <i>Ethernet Output</i> on the next page.                          |
| 2 | Digital Output 1 | Used to select the data sources that will be combined to produce a digital output pulse on Output 1. See <i>Digital Output</i> on page 288. |
| 3 | Digital Output 2 | Used to select the data sources that will be combined to produce a digital output pulse on Output 2. See <i>Digital Output</i> on page 288. |
| 4 | Analog Panel     | Used to convert a measurement value or decision into an analog output signal. See <i>Analog Output</i> on page 291.                         |
| 5 | Serial Panel     | Used to select the measurements that will be transmitted via RS-485 serial output. See <i>Serial Output</i> on page 292.                    |

## Ethernet Output

A sensor uses TCP messages (Gocator protocol) to receive commands from client computers, and to send video, laser profile, intensity, and measurement results to client computers. The sensor can also receive commands from and send measurement results to a PLC using ASCII, Modbus TCP, or EtherNet/IP protocol. See *Protocols* on page 404 for the specification of these protocols.

The specific protocols used with Ethernet output are selected and configured within the panel.

The screenshot shows the 'Output' panel of the Gocator web interface. On the left, a sidebar lists output categories: Ethernet (selected), Digital 1, Digital 2, Analog, and Serial. The main area is divided into three sections: Protocol, Information, and Data.

**Protocol:** A dropdown menu showing 'Gocator'.

**Information:** Contains two paragraphs. The first describes the Gocator Protocol using TCP messages. The second states that tasks can be accomplished programmatically by sending and receiving Gocator Protocol control commands.

**Data:** A table with columns 'Send', 'Name', and 'Id'. It lists various data items with checkboxes in the 'Send' column.

| Send                                | Name                       | Id |
|-------------------------------------|----------------------------|----|
| <b>Profiles</b>                     |                            |    |
| <input checked="" type="checkbox"/> | Top                        |    |
| <b>Profile Intensities</b>          |                            |    |
| <input type="checkbox"/>            | Top                        |    |
| <b>Measurements</b>                 |                            |    |
| <input checked="" type="checkbox"/> | Profile Dimension Distance | 2  |
| <input type="checkbox"/>            | Profile Groove X           | 1  |
| <b>Trigger Event</b>                |                            |    |
| <input type="checkbox"/>            | Exposure End               |    |

**Auto Disconnect:** A checkbox that is checked. Below it, a text box says 'Auto disconnect if the sensor is unable to send data.' and a 'Timeout:' field is set to '10 s'.

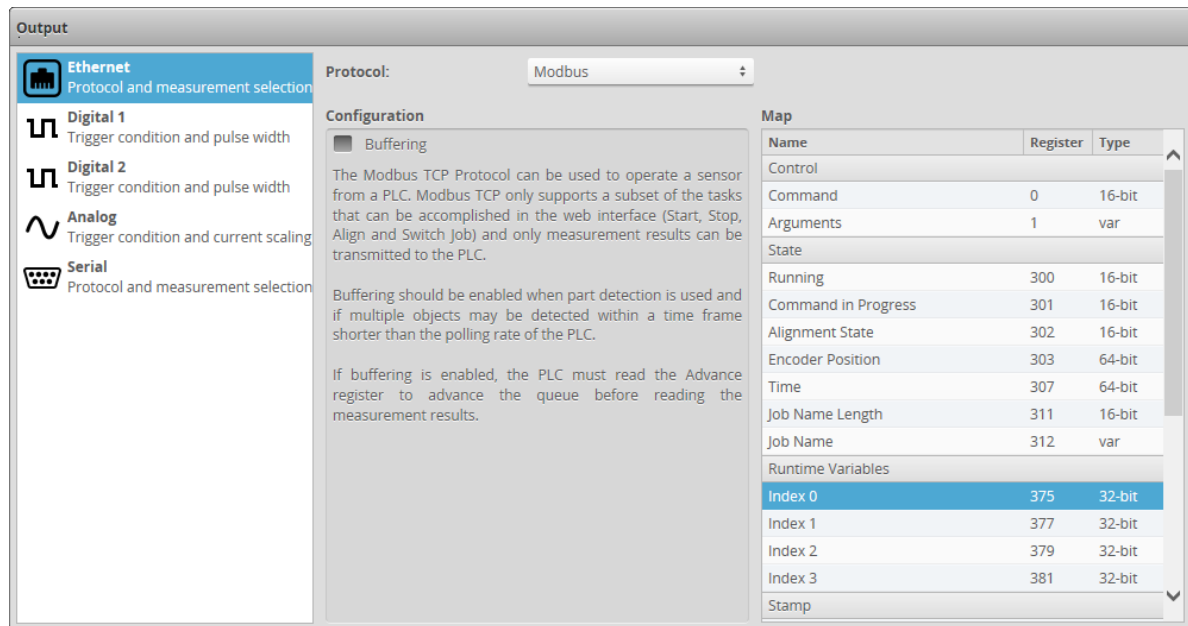
To receive commands and send results using Gocator Protocol messages:

1. Go to the **Output** page.
2. Click on the **Ethernet** category in the **Output** panel.
3. Select **Gocator** as the protocol in the **Protocol** drop-down.
4. Check the video, profile, intensity, or measurement items to send.
5. (Optional) Uncheck the Auto Disconnect setting.  
By default, this setting is checked, and the timeout is set to 10 seconds.



Measurements shown here correspond to measurements that have been added using the **Measure** page (see *Measure Page Overview* on page 161).

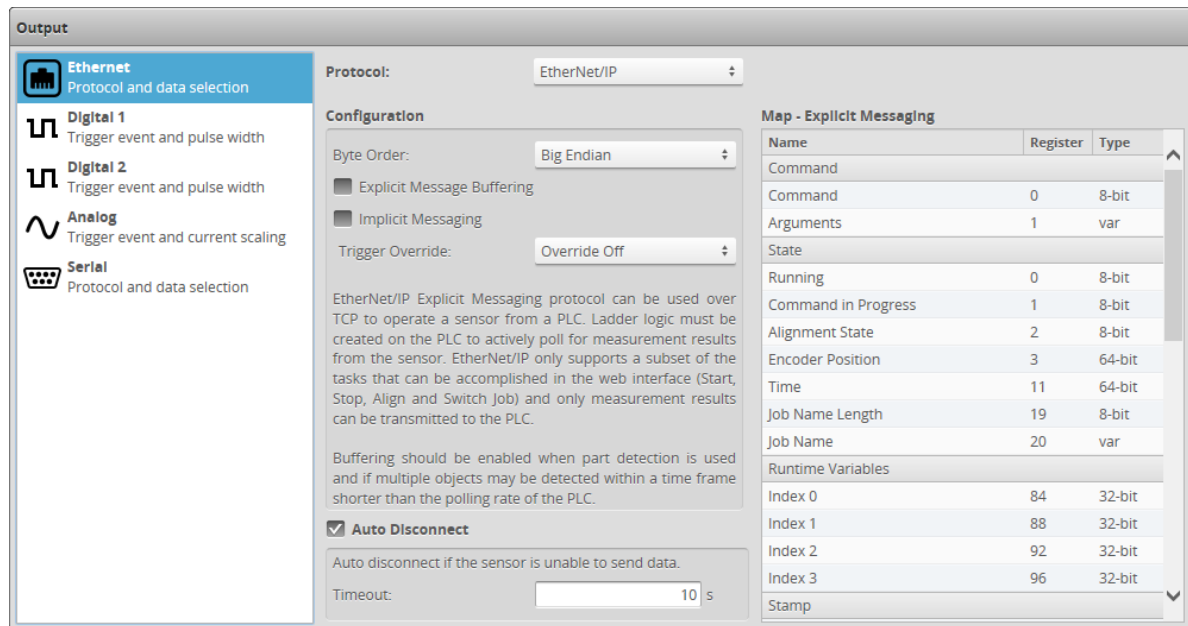
All of the tasks that can be accomplished with the Gocator's web interface (creating jobs, performing alignment, sending data and health information, and software triggering, etc.) can be accomplished programmatically by sending Gocator protocol control commands.



*To receive commands and send results using Modbus TCP messages:*

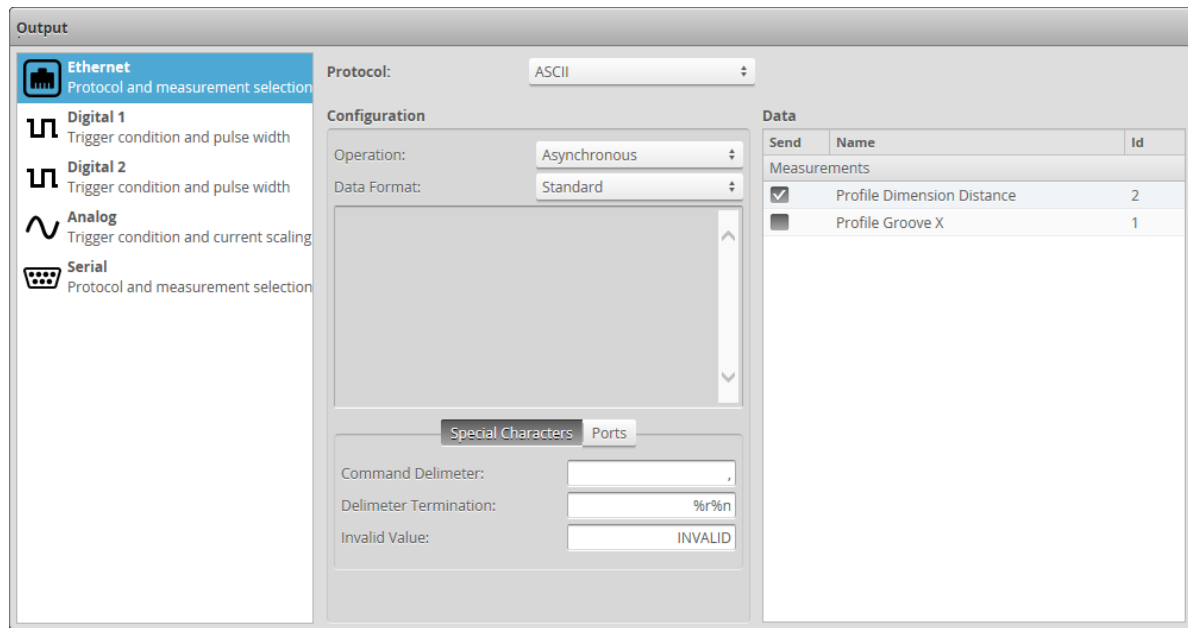
1. Go to the **Output** page.
2. Click on **Ethernet** in the **Output** panel.
3. Select **Modbus** as the protocol in the **Protocol** drop-down.  
Unlike the Gocator Protocol, you do not select which measurement items to output. The Ethernet panel will list the register addresses that are used for Modbus TCP communication.  
The Modbus TCP protocol can be used to operate a sensor. Modbus TCP only supports a subset of the tasks that can be performed in the web interface. A sensor can only process Modbus TCP commands when Modbus is selected in the **Protocol** drop-down.
4. Check the **Buffering** checkbox, if needed.  
Buffering is needed, for example, in Surface mode if multiple objects are detected within a time frame shorter than the polling rate of the PLC.  
If buffering is enabled with the Modbus protocol, the PLC must read the Advance register to advance the queue before reading the measurement results.





To receive commands and send results using EtherNet/IP messages:

1. Go to the **Output** page.
2. Click on **Ethernet** in the **Output** panel.
3. Select **EtherNet/IP** in the **Protocol** option.  
Unlike using the Gocator Protocol, you don't select which measurement items to output. The **Ethernet** panel will list the register addresses that are used for EtherNet/IP messages communication.  
The EtherNet/IP protocol can be used to operate a sensor. EtherNet/IP only supports a subset of the tasks that can be accomplished in the web interface. A sensor can only process EtherNet/IP commands when the EtherNet/IP is selected in the **Protocol** option.
4. Check the **Explicit Message Buffering** option, if needed.  
Buffering is needed, for example, in Surface mode if multiple objects are detected within a time frame shorter than the polling rate of the PLC. If buffering is enabled with the EtherNet/IP protocol, the buffer is automatically advanced when the Sample State Assembly Object is read (*Sample State Assembly* on page 471).
5. Check the **Implicit Messaging** option, if needed.  
Implicit messaging uses UDP and is faster than explicit messaging, so it is intended for time-critical applications. However, implicit messaging is layered on top of UDP. UDP is connectionless and data delivery is not guaranteed. For this reason, implicit messaging is only suitable for applications where occasional data loss is acceptable.  
For more information on setting up implicit messaging, see [http://lmi3d.com/sites/default/files/APPNOTE\\_Implicit\\_Messaging\\_with\\_Allen-Bradley\\_PLCs.pdf](http://lmi3d.com/sites/default/files/APPNOTE_Implicit_Messaging_with_Allen-Bradley_PLCs.pdf).
6. Choose the byte order in the **Byte Order** dropdown.



To receive commands and send results using ASCII messages:

1. Go to the **Output** page.
2. Click on **Ethernet** in the **Output** panel.
3. Select **ASCII** as the protocol in the **Protocol** drop-down.
4. Set the operation mode in the **Operation** drop-down.  
In asynchronous mode, the data results are transmitted when they are available. In polling mode, users send commands on the data channel to request the latest result. See *Polling Operation Commands (Ethernet Only)* on page 476 for an explanation of the operation modes.
5. Select the data format from the **Data Format** drop-down.  
**Standard:** The default result format of the ASCII protocol. Select the measurement to send by placing a check in the corresponding checkbox. See *Standard Result Format* on page 483 for an explanation of the standard result mode.  
**Standard with Stamp:** Select the measurement to send by placing a check in the corresponding checkbox. See *Standard Result Format* on page 483 for an explanation of the standard result mode.  
**Custom:** Enables the custom format editor. Use the replacement patterns listed in **Replacement Patterns** to create a custom format in the editor.
6. Set the special characters in the **Special Characters** tab.  
Set the command delimiter, delimiter termination, and invalid value characters. Special characters are used in commands and standard-format data results.
7. Set the TCP ports in the **Ports** tab.  
Select the TCP ports for the control, data, and health channels. If the port numbers of two channels are the same, the messages for both channels are transmitted on the same port.

## Digital Output

Gocator sensors can convert measurement decisions or software commands to digital output pulses, which can then be used to output to a PLC or to control external devices, such as indicator lights or air ejectors.

A digital output can act as a measurement valid signal to allow external devices to synchronize to the timing at which measurement results are output. In this mode, the sensor outputs a digital pulse when a measurement result is ready.

A digital output can also act as a strobe signal to allow external devices to synchronize to the timing at which the sensor exposes. In this mode, the sensor outputs a digital pulse when the sensor exposes.

Each sensor supports two digital output channels. See *Gocator Power/LAN Connector* on page 558 for information on wiring digital outputs to external devices.

Trigger conditions and pulse width are then configured within the panel.

The screenshot shows the 'Output' configuration panel in the Gocator Web Interface. On the left is a sidebar with icons and labels for 'Ethernet', 'Digital 1', 'Digital 2', 'Analog', and 'Serial'. 'Digital 1' is selected and highlighted in blue. The main area is divided into three sections: 'Trigger Event' with a dropdown set to 'Measurement' and an 'Invert Output Signal' checkbox; 'Configuration' with 'Assert On' set to 'Pass', 'Signal' set to 'Pulsed', a pulse width slider at 100 µs, and a 'Scheduled' checkbox; and 'Data' which contains a table of selected measurement decisions.

| Send                                | Name                       | Id |
|-------------------------------------|----------------------------|----|
| <input checked="" type="checkbox"/> | Profile Dimension Distance | 2  |
| <input checked="" type="checkbox"/> | Profile Groove X           | 1  |

*To output measurement decisions:*

1. Go to the **Output** page.
2. Click **Digital 1** or **Digital 2** in the **Output** panel.
3. Set **Trigger Event** to **Measurement**.
4. In **Configuration**, set **Assert On** and select the measurements that should be combined to determine the output.  
If multiple measurement decisions are selected and **Assert On** is set to **Pass**, the output is activated when all selected measurements pass.  
If **Assert On** is set to **Fail**, the output is activated when any one of the selected measurements fails.

5. Set the **Signal** option.  
The signal type specifies whether the digital output is a continuous signal or a pulsed signal. If **Signal** is set to **Continuous**, the signal state is maintained until the next transition occurs. If **Signal** is set to **Pulsed**, you must specify the pulse width and how it is scheduled.
6. Specify a pulse width using the slider.  
The pulse width is the duration of the digital output pulse, in microseconds.
7. Check the **Scheduled** option if the output needs to be scheduled; otherwise, leave it unchecked for immediate output.  
A scheduled output becomes active after the delay from the start of Gocator exposure. A scheduled output can be used to track the decisions for multiple objects as these objects travel from the sensor to the eject gates.  
The **Delay** setting specifies the distance from the sensor to the eject gates.  
An immediate output becomes active as soon as measurement results are available. The output activates after the sensor finishes processing the data. As a result, the time between the start of sensor exposure and output activates can vary and is dependent on the processing latency. The latency is reported in the dashboard and in the health messages.
8. If you checked **Scheduled**, specify a delay and a delay domain.  
The **Delay** specifies the time or encoder distance between the start of sensor exposure and when the output becomes active. The delay should be larger than the time needed to process the data inside the sensor. It should be set to a value that is larger than the processing latency reported in the dashboard or in the health messages.  
The unit of the delay is configured with the **Delay Domain** setting.
9. If you want to invert the output signal, check **Invert Output Signal**.

*To output a measurement valid signal:*

1. Go to the **Output** page.
2. Click on **Digital 1** or **Digital 2** in the **Output** panel.
3. Set **Trigger Event** to **Measurement**.
4. In **Configuration**, set **Assert On** to **Always**.
5. Select the measurements.  
The output activates when the selected decisions produce results. The output activates only once for each frame even if multiple decision sources are selected.
6. Specify a pulse width using the slider.  
The pulse width determines the duration of the digital output pulse, in microseconds.

*To respond to software scheduled commands:*

1. Go to the **Output** page.
2. Click **Digital 1** or **Digital 2** in the **Output** panel.

3. Set **Trigger Event** to **Software**.
4. Specify a **Signal** type.  
The signal type specifies whether the digital output is a continuous signal or a pulsed signal. If the signal is continuous, its state is maintained until the next transition occurs. If the signal is pulsed, user specifies the pulse width and the delay.
5. Specify a **Pulse Width**.  
The pulse width determines the duration of the digital output pulse, in microseconds.
6. Specify if the output is immediate or scheduled.  
A pulsed signal can become active immediately or be scheduled. A continuous signal always becomes active immediately.  
Immediate output becomes active as soon as a scheduled digital output (*Schedule Digital Output* on page 428) is received.  
Scheduled output becomes active at a specific target time or position, given by the Scheduled Digital Output command. Commands that schedule an event in the past will be ignored. An encoder value is in the future if the value will be reached by moving in the forward direction (the direction that encoder calibration was performed in).

*To output an exposure signal:*

1. Go to the **Output** page.
2. Click **Digital 1** or **Digital 2** in the **Output** panel.
3. Set **Trigger Event** to **Exposure Begin** or **Exposure End**.
4. Set the **Pulse Width** option.  
The pulse width determines the duration of the digital output pulse, in microseconds.

*To output an alignment signal:*

1. Go to the **Output** page.
2. Click **Digital 1** or **Digital 2** in the **Output** panel.
3. Set **Trigger Event** to **Alignment**.  
The digital output state is High if the sensor is aligned, and Low if not aligned. Whether the sensor is running does not affect the output.

*To respond to exposure begin/end:*

1. Go to the **Output** page.
2. Click **Digital 1** or **Digital 2** in the **Output** panel.
3. Set **Trigger Event** to **Exposure Begin** or **Exposure End**.

## Analog Output

Gocator sensors can convert a measurement result or software request to an analog output. Each sensor supports one analog output channel.

See *Analog Output* on page 563 for information on wiring analog output to an external device.

**Output**

**Ethernet**  
Protocol and data selection

**Digital 1**  
Trigger event and pulse width

**Digital 2**  
Trigger event and pulse width

**Analog**  
Trigger event and current scaling

**Serial**  
Protocol and data selection

**Trigger Event:** Measurement

**Configuration**

**Analog Current**

Data Scale: 0 - 10000

Specifies the range of output values to use in scaling to the current range below.

Default output units are in mm, mm<sup>2</sup>, mm<sup>3</sup> and degrees depending on the output type. Values outside this range are clamped to the minimum or maximum values.

Current Range: 0 - 20 mA

☒ Invalid 0 mA

☐ Scheduled

**Data**

| Send                             | Name                       | Id |
|----------------------------------|----------------------------|----|
| <input type="radio"/>            | None                       |    |
| <input checked="" type="radio"/> | Profile Dimension Distance | 2  |
| <input type="radio"/>            | Profile Groove X           | 1  |

To output measurement value or decision:

1. Go to the **Output** page.
2. Click on **Analog** in the **Output** panel.
3. Set **Trigger Event** to **Measurement**.
4. Select the measurement that should be used for output.  
Only one measurement can be used for analog output. Measurements shown here correspond to measurements that have been programmed using the **Measurements** page.
5. Specify **Data Scale** values.  
The values specified here determine how measurement values are scaled to the minimum and maximum current output. The **Data Scale** values are specified in millimeters for dimensional measurements such as distance, square millimeters for areas, cubic millimeters for volumes, and degrees for angle results.
6. Specify **Current Range** and **Invalid** current values.  
The values specified here determine the minimum and maximum current values in milliamperes. If **Invalid** is checked, the current value specified with the slider is used when a measurement value is not valid. If **Invalid** is not checked, the output holds the last value when a measurement value is not valid.
7. Specify if the output is immediate or scheduled.  
An analog output can become active immediately or scheduled. Check the **Scheduled** option if the

output needs to be scheduled.

A scheduled output becomes active after a specified delay from the start of Gocator exposure. A scheduled output can be used to track the decisions for multiple objects as these objects travel from the sensor to the eject gates. The delay specifies the distance from the sensor to the eject gates.

An Immediate output becomes active as soon as the measurement results are available. The output activates after the Gocator finishes processing the data. As a result, the time between the start of Gocator exposure and output activates depends on the processing latency. The latency is reported in the dashboard and in the health messages.

8. Specify a delay.

The delay specifies the time or spatial location between the start of Gocator exposure and the output becomes active. The delay should be larger than the time needed to process the data inside the Gocator. It should be set to a value that is larger than the processing latency reported in the dashboard and in the health messages.

The unit of the delay is configured in the trigger panel. See *Triggers* on page 93 for details.



The analog output takes about 75 us to reach 90% of the target value for a maximum change, then another ~40 us to settle completely.

*To respond to software scheduled commands:*

1. Go to the **Output** page.

2. Click on **Analog** in the **Output** panel.

3. Set **Trigger Event** to **Software**.

4. Specify if the output is immediate or scheduled.

An analog output value becomes active immediately or scheduled. Immediate output becomes active as soon as a Scheduled Analog Output command (see *Schedule Analog Output* on page 429) is received. Software scheduled command can schedule an analog value to output at a specified future time or encoder value, or changes its state immediately. The Delay setting in the panel is ignored. Commands that schedule event in the past will be ignored. An encoder value is in future if the value will be reached by moving in the forward direction (the direction that encoder calibration was performed in).

## Serial Output

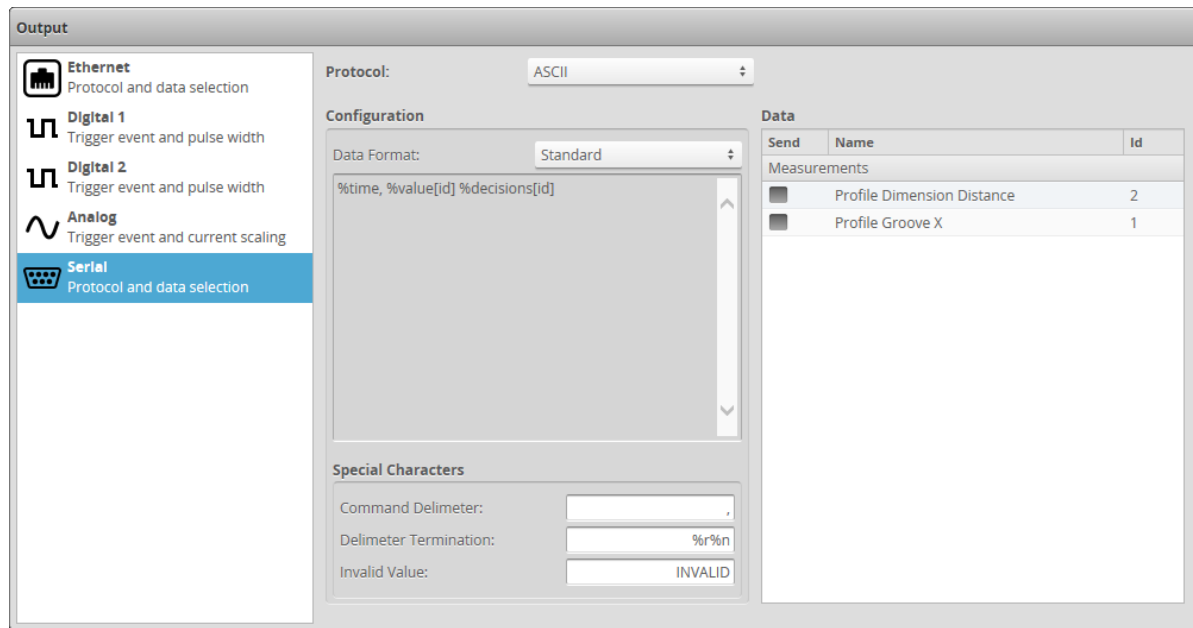
The Gocator's web interface can be used to select measurements to be transmitted via RS-485 serial output. Each sensor has one serial output channel.

Two protocols are supported: ASCII Protocol and Selcom Serial Protocol.

The ASCII protocol outputs data asynchronously using a single serial port. For information on the ASCII Protocol parameters and data formats, see *ASCII Protocol* on page 475.

The Selcom Serial Protocol outputs synchronized serial data using two serial ports. For information on the Selcom serial protocol and data formats, see *Selcom Protocol* on page 486.

For information on wiring serial output to an external device, see *Serial Output* on page 563.



To configure ASCII output:

1. Go to the **Output** page.
2. Click on **Serial** in the **Output** panel.
3. Select **ASCII** in the **Protocol** option.
4. Select the **Data Format**.  
 Select **Standard** to use the default result format of the ASCII protocol. Select value and decision to send by placing a check in the corresponding check box. See *Standard Result Format* on page 483 for an explanation of the standard result mode.  
 Select **Custom** to customize the output result. A data format box will appear in which you can type the format string. See *Custom Result Format* on page 484 for the supported format string syntax.
5. Select the measurements to send.  
 Select measurements by placing a check in the corresponding check box.
6. Set the **Special Characters**.  
 Select the delimiter, termination and invalid value characters. Special characters are used in commands and standard-format data results.



**Output**

**Ethernet**  
Protocol and data selection

**Digital 1**  
Trigger event and pulse width

**Digital 2**  
Trigger event and pulse width

**Analog**  
Trigger event and current scaling

**Serial**  
Protocol and data selection

**Protocol:** Selcom

**Configuration**

Rate: 96000

Format: SLS

Data Scale: 0 - 10000

Specifies the range of output values to use in scaling to the range selected in the Format above.  
Default output units are in mm, mm<sup>2</sup>, mm<sup>3</sup> and degrees depending on the output type. Values outside this range are clamped to the minimum or maximum values.

**Scheduled**

Delay: 3000 μs

**Data**

| Send                                | Name             | Id |
|-------------------------------------|------------------|----|
| Measurements                        |                  |    |
| <input checked="" type="checkbox"/> | Range Position Z | 0  |

To configure Selcom output:

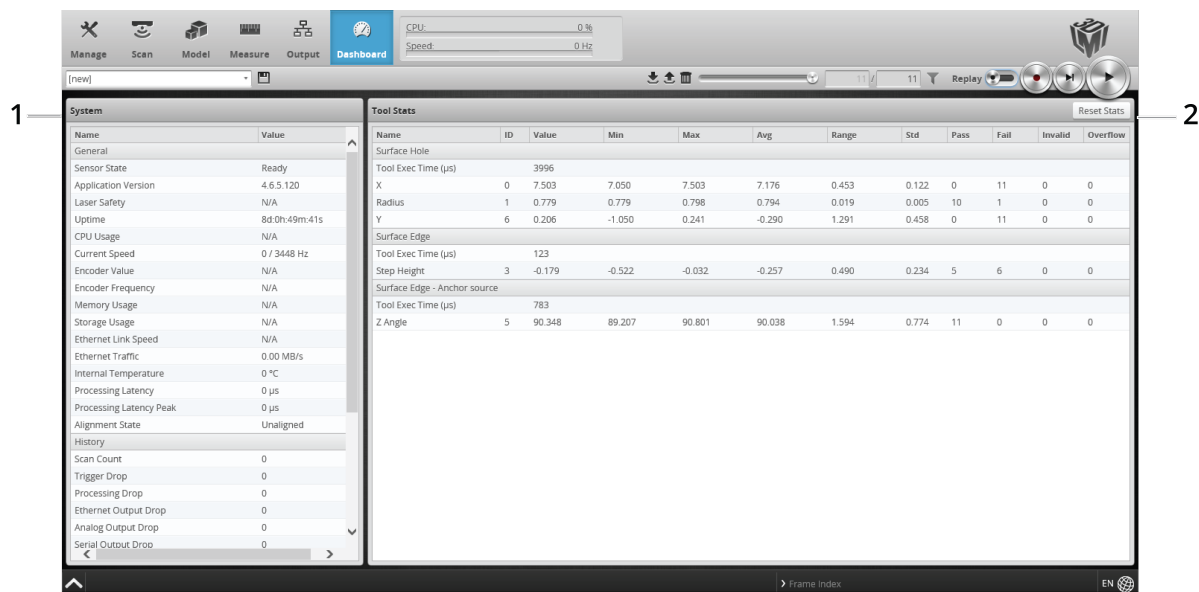
1. Go to the **Output** page.
2. Click on **Serial** in the **Output** panel.
3. Select **Selcom** in the **Protocol** option.
4. Select the measurements to send.  
To select an item for transmission, place a check in the corresponding check box. Measurements shown here correspond to measurements that have been programmed using the **Measurements** page.
5. Select the baud rate in **Rate**.
6. Select the **Data Format**.  
See *Selcom Protocol* on page 486 for definitions of the formats.
7. Specify **Data Scale** values.  
The **Data Scale** values are specified in millimeters for dimensional measurements such as distance, square millimeters for areas, cubic millimeters for volumes, and degrees for angle results.  
The results are scaled according to the number of serial bits used to cover the data scale range. For example, the 12-bit output would break a 200 mm data scale range into 4096 increments (0.0488 mm/bit), and the 14-bit output would break a 200 mm data scale range into 16384 increments (0.0122 mm/bit).
8. Set the output delay in **Delay**.  
The scheduled delay must be longer than the processing latency to prevent drops.

# Dashboard

The following sections describe the **Dashboard** page.

## Dashboard Page Overview

The **Dashboard** page summarizes sensor health information and provides measurement statistics.



|   | Element    | Description                                                                                  |
|---|------------|----------------------------------------------------------------------------------------------|
| 1 | System     | Displays sensor state and health information. See <i>State and Health Information</i> below. |
| 2 | Tool Stats | Displays measurement tool statistics. See <i>Tool Statistics</i> on the next page.           |

## State and Health Information

The following state and health information is available in the **System** panel on the **Dashboard** page:

### Dashboard General System Values

| Name                | Description                                                |
|---------------------|------------------------------------------------------------|
| Sensor State*       | Current sensor state (Conflict, Ready, or Running).        |
| Application Version | Gocator firmware version.                                  |
| Laser Safety        | Whether Laser Safety is enabled.                           |
| Uptime              | Length of time since the sensor was power-cycled or reset. |
| CPU Usage           | Sensor CPU utilization (%).                                |
| Current Speed*      | Current speed of the sensor.                               |
| Encoder Value       | Current encoder value (ticks).                             |
| Encoder Frequency   | Current encoder frequency (Hz).                            |

| Name                    | Description                                                                                           |
|-------------------------|-------------------------------------------------------------------------------------------------------|
| Memory Usage            | Sensor memory utilization (MB used / MB total available).                                             |
| Storage Usage           | Sensor flash storage utilization (MB used / MB total available).                                      |
| Ethernet Link Speed     | Speed of the Ethernet link (Mbps).                                                                    |
| Ethernet Traffic        | Network output utilization (MB/sec).                                                                  |
| Internal Temperature    | Internal sensor temperature.                                                                          |
| Processing Latency      | Last delay from camera exposure to when results can be scheduled to.                                  |
| Processing Latency Peak | Peak latency delay from camera exposure to when results can be scheduled to Rich I/O. Reset on start. |
| Alignment State         | Whether the sensor or sensor system has been aligned.                                                 |

#### *Dashboard History Values*

| Name                        | Description                                                                                          |
|-----------------------------|------------------------------------------------------------------------------------------------------|
| Scan Count*                 | Number of scans performed since sensor state last changed to Running.                                |
| Trigger Drop**              | Count of camera frames dropped due to excessive trigger speed.                                       |
| Processing Drop**           | Count of frame drops due to excessive CPU utilization.                                               |
| Ethernet Output Drop**      | Count of frame drops due to slow Ethernet link.                                                      |
| Analog Output Drop**        | Count of analog output drops because last output has not been completed.                             |
| Serial Output Drop**        | Count of serial output drops because last output has not been completed.                             |
| Digital Output 1 Drop**     | Count of digital output drops because last output has not been completed.                            |
| Digital Output 2 Drop**     | Count of digital output drops because last output has not been completed.                            |
| Digital Output 1 High Count | Count of high states on digital output.                                                              |
| Digital Output 2 High Count | Count of high states on digital output.                                                              |
| Digital Output 1 Low Count  | Count of low states on digital output.                                                               |
| Digital Output 2 Low Count  | Count of low states on digital output.                                                               |
| Anchor Invalid Count**      | Count of invalid anchors.                                                                            |
| Valid Spot Count            | Count of valid spots detected in the last frame.                                                     |
| Max Spot Count*             | Maximum number of spots detected since sensor was started.                                           |
| Camera Search Count         | Count of camera frame where laser has lost tracked. Only applicable when tracking window is enabled. |

\* When the sensor is accelerated, the indicator's value is reported from the accelerating PC.

\*\* When the sensor is accelerated, the indicator's value is the sum of the values reported from the sensor and the accelerating PC.

## Tool Statistics

Measurement statistics are displayed for each measurement tool that has been configured on the **Measure** page. Use the **Reset Stats** button to reset the statistics.

| Tool Stats          |    |         |         |         |        |         |        |      |      |         | Reset Stats |
|---------------------|----|---------|---------|---------|--------|---------|--------|------|------|---------|-------------|
| Name                | ID | Value   | Min     | Max     | Avg    | Range   | Std    | Pass | Fail | Invalid | Overflow    |
| Profile Area        |    |         |         |         |        |         |        |      |      |         |             |
| Tool Exec Time (µs) |    | 32      |         |         |        |         |        |      |      |         |             |
| Area                | 0  | 0.083   | 0.000   | 262.862 | 38.564 | 262.862 | 40.806 | 688  | 657  | 47      | 0           |
| Centroid X          | 5  | -13.803 | -16.665 | 17.276  | 2.828  | 33.941  | 7.232  | 69   | 1274 | 49      | 0           |
| Profile Line        |    |         |         |         |        |         |        |      |      |         |             |
| Tool Exec Time (µs) |    | 20      |         |         |        |         |        |      |      |         |             |
| Offset              | 3  | 0.074   | -0.005  | 13.333  | 7.628  | 13.338  | 4.346  | 868  | 477  | 47      | 0           |
| Angle               | 4  | -0.062  | -8.216  | 15.583  | 1.026  | 23.799  | 2.691  | 731  | 614  | 47      | 0           |
| Profile Position    |    |         |         |         |        |         |        |      |      |         |             |
| Tool Exec Time (µs) |    | 9       |         |         |        |         |        |      |      |         |             |
| X                   | 2  | -8.448  | -20.064 | 20.284  | 7.466  | 40.348  | 12.659 | 290  | 1055 | 47      | 0           |
| Z                   | 6  | 0.118   | 0.045   | 17.000  | 9.646  | 16.955  | 5.494  | 607  | 738  | 47      | 0           |

For each tool, Gocator displays the time the tool took to execute on the current frame, in microseconds (Tool Exec Time).

For each measurement, Gocator displays the following information:

#### Measurement Statistics

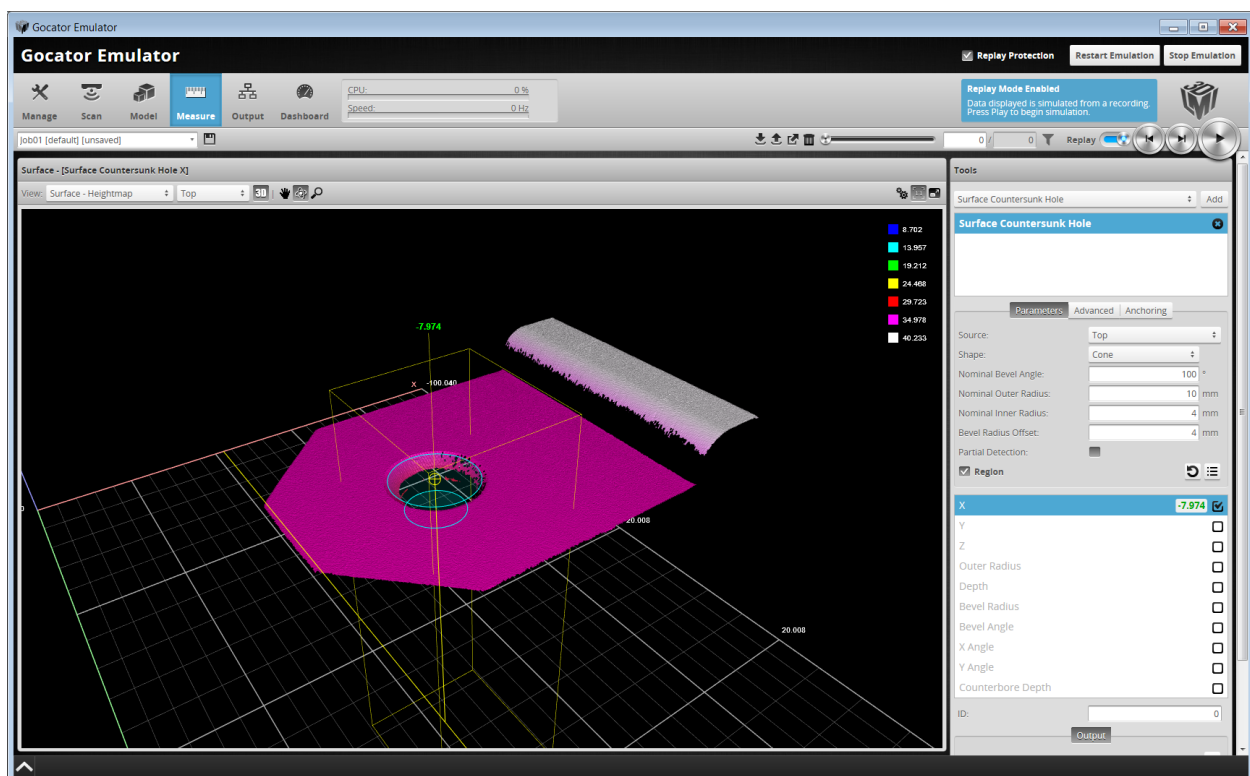
| Name     | Description                                                                                   |
|----------|-----------------------------------------------------------------------------------------------|
| ID       | The measurement ID as set in the measurement's ID field on the <a href="#">Measure page</a> . |
| Value    | The most recent measurement value.                                                            |
| Min      | The minimum measurement value that has been observed.                                         |
| Max      | The maximum measurement value that has been observed.                                         |
| Avg      | The average of all measurement results collected since the sensor was started.                |
| Std      | The standard deviation of all measurement results collected since the sensor was started.     |
| Range    | The difference between Max and Min.                                                           |
| Pass     | The number of pass decisions that have been generated by the measurement.                     |
| Fail     | The number of fail decisions that have been generated by the measurement.                     |
| Invalid  | The number of frames from which no valid measurement value was returned.                      |
| Overflow | The number of frames returned an overflow.                                                    |

# Gocator Emulator

The Gocator emulator is a stand-alone application that lets you run a "virtual" sensor. In a virtual sensor, you can test jobs, evaluate data, and even learn more about new features, rather than take a physical device off the production line to do this. You can also use a virtual sensor to familiarize yourself with the overall interface if you are new to Gocator.



The Gocator emulator is only supported on 64-bit versions of Windows 7, 8, and 10.



*Emulator showing a part in recorded data.  
A measurement is applied to the recorded data.*

## Limitations

In most ways, the emulator behaves like a real sensor, especially when visualizing data, setting up models and part matching, and adding and configuring measurement tools. The following are some of the limitations of the emulator:

- Changes to job files in the emulator are *not* persistent (they are lost when you close or restart the emulator). However, you can keep a modified job by first [saving](#) it and then [downloading](#) it from the

**Jobs** list on the **Manage** page to a client computer. The job file can then be loaded into the emulator at a later time or even onto a physical sensor for final testing.

- Performing alignment in the emulator has no effect and will never complete.
- Only one instance can be run at a time.

For information on saving and loading jobs in the emulator, see *Creating, Saving, and Loading Jobs* on page 304 .

For information on uploading and downloading jobs between the emulator and a computer, and performing other job file management tasks, see *Downloading and Uploading Jobs* on page 309.

## Downloading a Support File

The emulator is provided with several virtual sensors preinstalled.

You can also create virtual sensors yourself by downloading a support file from a physical Gocator and then adding it to the emulator.

Support files can contain jobs, letting you configure systems and add measurements in an emulated sensor. Support files can also contain replay data, letting you test measurements and some configurations on real data. Dual-sensor systems are supported.

**Support File**

Download a support file which contains all jobs, data and current state of the sensor.

Filename:

Description:

Download

*To download a support file:*

1. Go to the **Manage** page and click on the **Support** category.
2. In **Filename**, type the name you want to use for the support file.  
When you create a scenario from a support file in the emulator, the filename you provide here is displayed in the emulator's scenario list.  
Support files end with the .gs extension, but you do not need to type the extension in **Filename**.
3. (Optional) In **Description**, type a description of the support file.  
When you create a scenario from a support file in the emulator, the description is displayed below the emulator's scenario list.

- Click **Download**, and then when prompted, click **Save**.

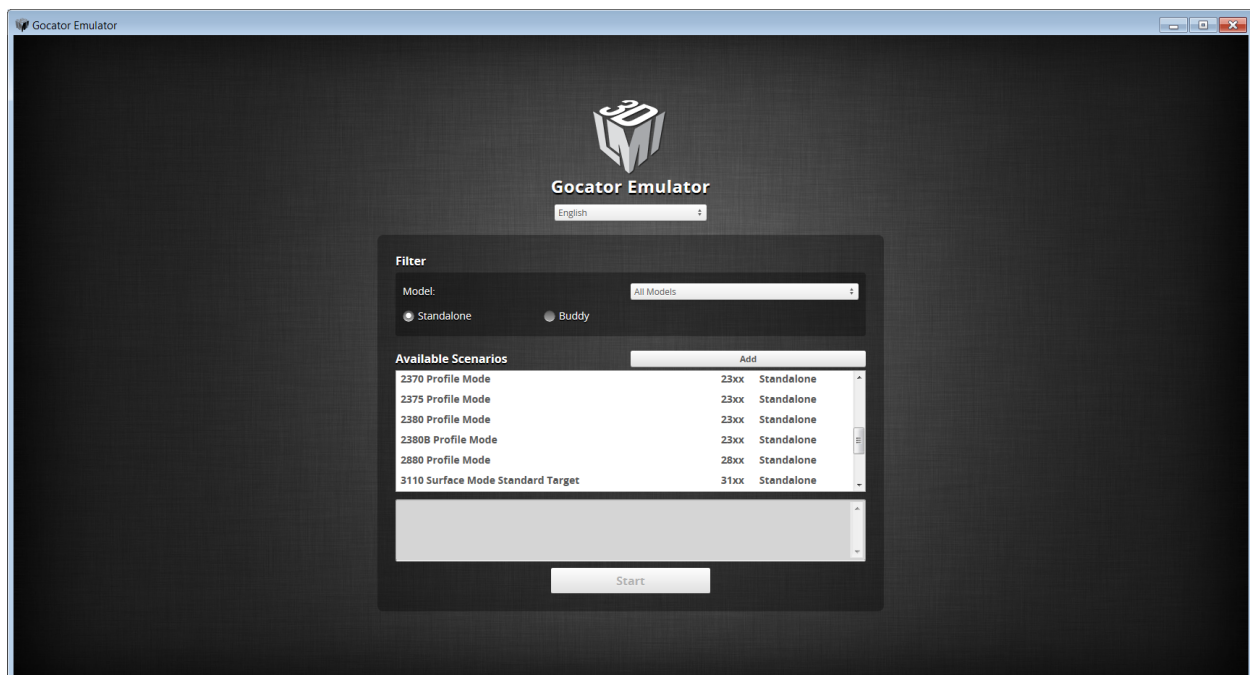


Downloading a support file stops the sensor.

## Running the Emulator

The emulator is contained in the Gocator tools package (14405-x.x.x.x\_SOFTWARE\_GO\_Tools.zip). To get the package, go to <http://lmi3d.com/support>, choose your product from the Product Downloads section, and download the package from the Download Center.

To run the emulator, unzip the package and double-click the *GoEmulator* link in the unzipped emulator folder.



*Emulator launch screen*

You can change the language of the emulator's interface from the launch screen. To change the language, choose a language option from the top drop-down:



*Selecting the emulator interface language*

## Adding a Scenario to the Emulator

To simulate a physical sensor using a support file downloaded from a sensor, you must add it as a scenario in the emulator.



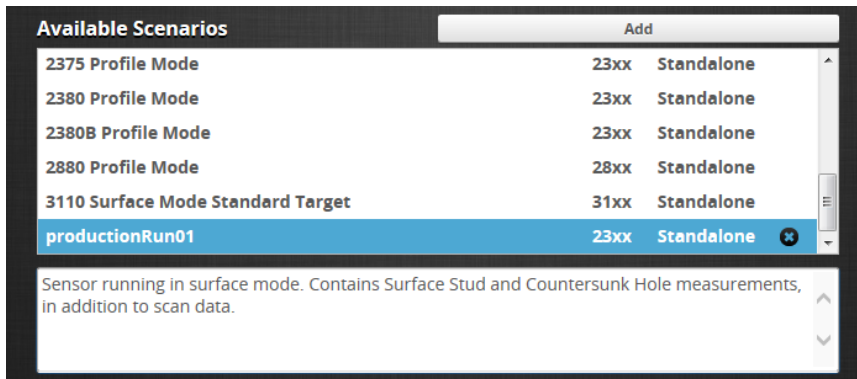
You can add support files downloaded from any series of Gocator sensors to the emulator.

*To add a scenario:*

1. Launch the emulator if it isn't running already.
2. Click the **Add** button and choose a previously saved support file (.gs extension) in the **Choose File to Upload** dialog.



3. (Optional) In **Description**, type a description.

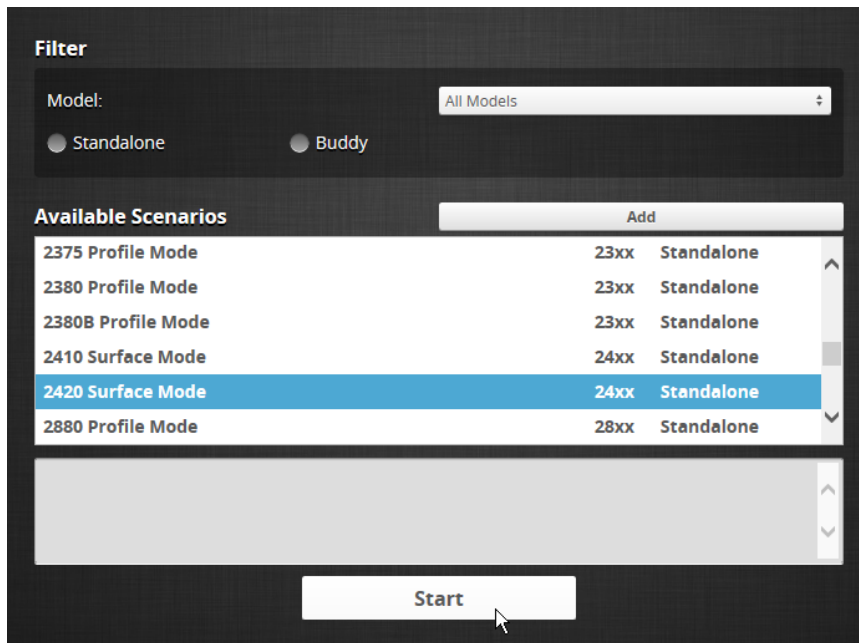


You can only add descriptions for user-added scenarios.

## Running a Scenario

After you have added a virtual sensor by uploading a support file to the emulator, you can run it from the **Available Scenarios** list on the emulator launch screen. You can also run any of the scenarios included in the installation.





To run a scenario:

1. If you want to filter the scenarios listed in **Available Scenarios**, do one or both of the following:
  - Choose a model family in the **Model** drop-down.
  - Choose **Standalone** or **Buddy** to limit the scenarios to single-sensor or dual-/multi-sensor scenarios, respectively.
2. Select a scenario in the **Available Scenarios** list and click **Start**.

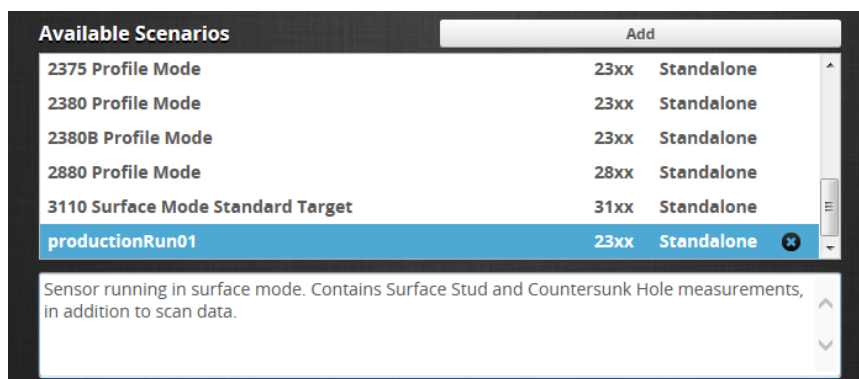
## Removing a Scenario from the Emulator

You can easily remove a scenario from the emulator.

 You can only remove user-added scenarios.

To remove a scenario:

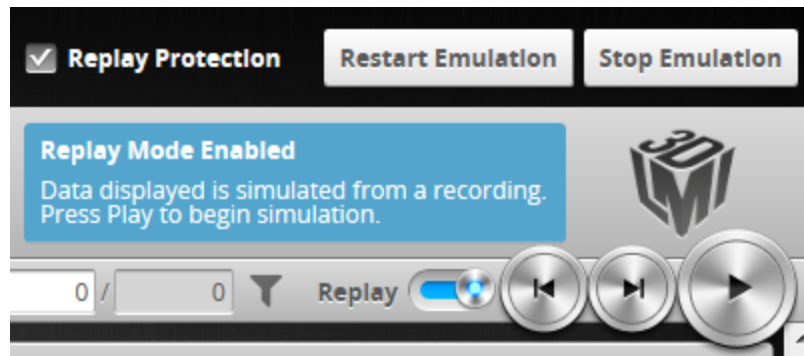
1. If the emulator is running a scenario, click **Stop Emulation** to stop it.
2. In the **Available Scenarios** list, scroll to the scenario you want to remove.



3. Click the  button next to the scenario you want to remove.  
The scenario is removed from the emulator.

## Using Replay Protection

Making changes to certain settings on the **Scan** page causes the emulator to flush replay data. The **Replay Protection** option protects replay data by preventing changes to settings that affect replay data. Settings that do not affect replay data can be changed.



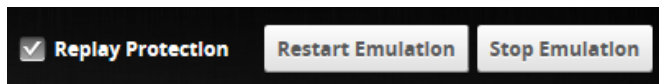
If you try to uncheck **Replay Protection**, you must confirm that you want to disable it.

**Replay Protection** is on by default.

## Stopping and Restarting the Emulator

*To stop the emulator:*

- Click **Stop Emulation**.



Stopping the emulator returns you to the launch screen.

*To restart the emulator when it is running:*

- Click **Restart Emulation**.

Restarting the emulator restarts the currently running simulation.

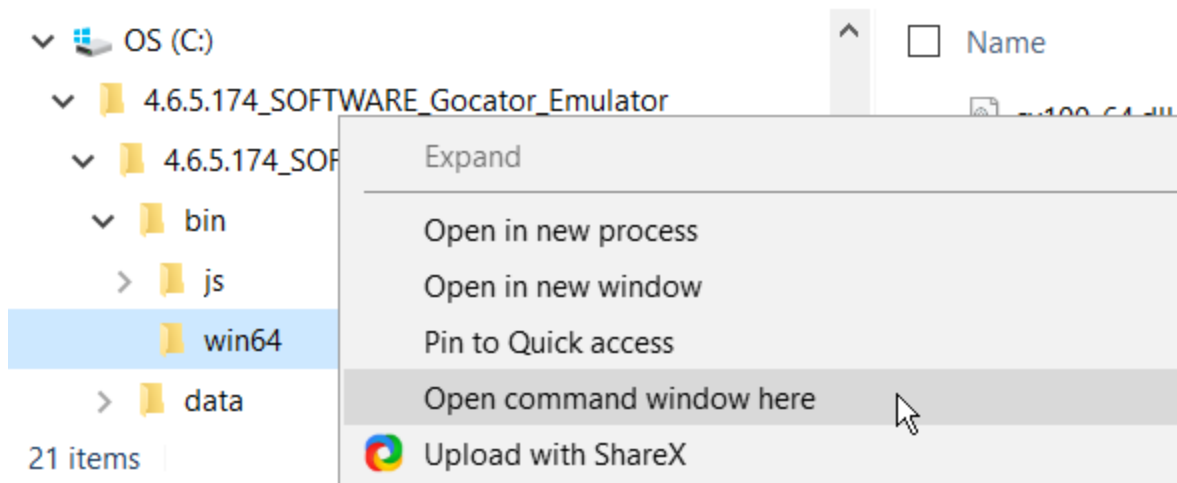
## Running the Emulator in Default Browser

When you use the `/browser` command line parameter, the emulator application launches normally but also launches in your default browser. This provides additional flexibility when using the emulator. For example, you can resize the emulator running in a browser window.

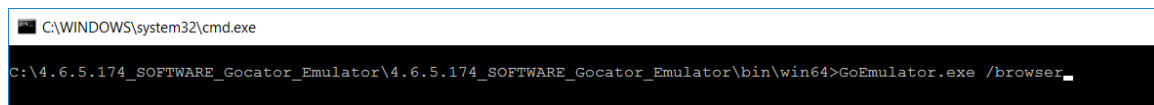
*To run the emulator in your default browser:*

1. In Windows Explorer (Windows 7) or File Explorer (Windows 8 or 10), browse to the location of the emulator.  
The emulator is under `bin\win64`, in the location in which you installed the emulator.

2. Press and hold **Shift**, right-click the **win64** folder containing the emulator, and choose **Open command window here**.



3. In the command prompt, type `GoEmulator.exe /browser`, followed by an IPV4 address.



After the emulator application starts, the emulator also launches in your default browser.

## Working with Jobs and Data

The following topics describe how to work with jobs and replay data (data recorded from a physical sensor) in the emulator.

### Creating, Saving, and Loading Jobs

Changes saved to job files in the emulator are *not* persistent (they are lost when you close or restart the emulator). To keep jobs permanently, you must first save the job in the emulator and then download the job file to a client computer. See below for more information on creating, saving, and switching jobs. For information on downloading and uploading jobs between the emulator and a computer, see *Downloading and Uploading Jobs* on page 309.

The job drop-down list in the toolbar shows the jobs available in the emulator. The job that is currently active is listed at the top. The job name will be marked with "[unsaved]" to indicate any unsaved changes.



*To create a job:*

1. Choose **[New]** in the job drop-down list and type a name for the job.
2. Click the **Save** button  or press **Enter** to save the job.  
The job is saved to the emulator using the name you provided.

To save a job:

- Click the **Save** button .

The job is saved to the emulator.

To load (switch) jobs:

- Select an existing file name in the job drop-down list.

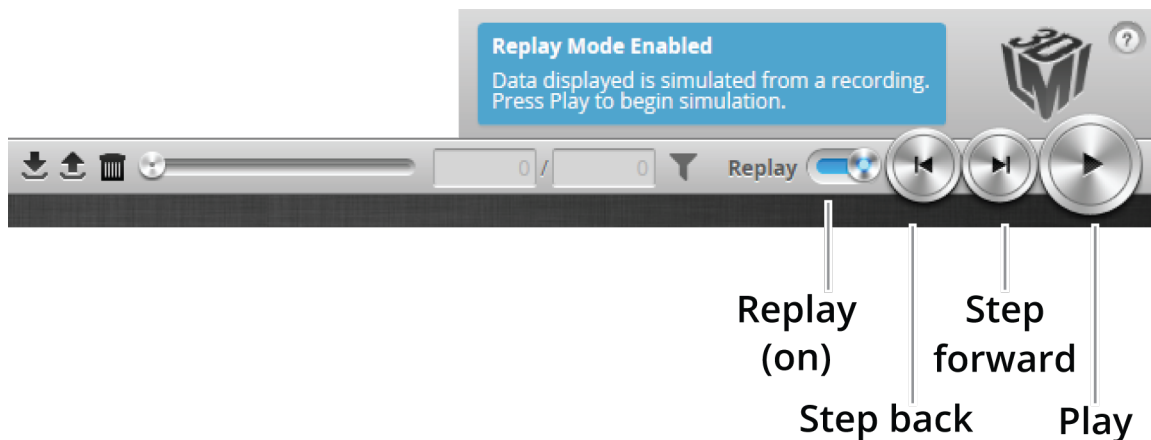
The job is activated. If there are any unsaved changes in the current job, you will be asked whether you want to discard those changes.

## Playback and Measurement Simulation

The emulator can replay scan data previously recorded by a physical sensor, and also simulate measurement tools on recorded data. This feature is most often used for troubleshooting and fine-tuning measurements, but can also be helpful during setup.

Playback is controlled using the toolbar controls.

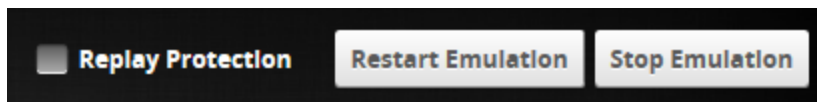
 Recording is not functional in the emulator.



*Playback controls when replay is on*

To replay data:

- Toggle **Replay** mode on by setting the slider to the right in the **Toolbar**. The slider's background turns blue. To change the mode, you must uncheck **Replay Protection**.



- Use the **Replay** slider or the **Step Forward**, **Step Back**, or **Play** buttons to review data. The **Step Forward** and **Step Back** buttons move and the current replay location backward and forward by a single frame, respectively.

The **Play** button advances the replay location continuously, animating the playback until the end of the replay data.

The **Stop** button (replaces the **Play** button while playing) can be used to pause the replay at a particular location.

The **Replay** slider (or **Replay Position** box) can be used to go to a specific replay frame.

*To simulate measurements on replay data:*

1. Toggle **Replay** mode on by setting the slider to the right in the **Toolbar**.  
The slider's background turns blue.  
To change the mode, **Replay Protection** must be unchecked.
2. Go to the **Measure** page.  
Modify settings for existing measurements, add new measurement tools, or delete measurement tools as desired. For information on adding and configuring measurements, see *Measurement* on page 161.
3. Use the **Replay Slider**, **Step Forward**, **Step Back**, or **Play** button to simulate measurements.  
Step or play through recorded data to execute the measurement tools on the recording.  
Individual measurement values can be viewed directly in the data viewer. Statistics on the measurements that have been simulated can be viewed in the **Dashboard** page; for more information on the dashboard, see *Dashboard* on page 295.

*To clear replay data:*

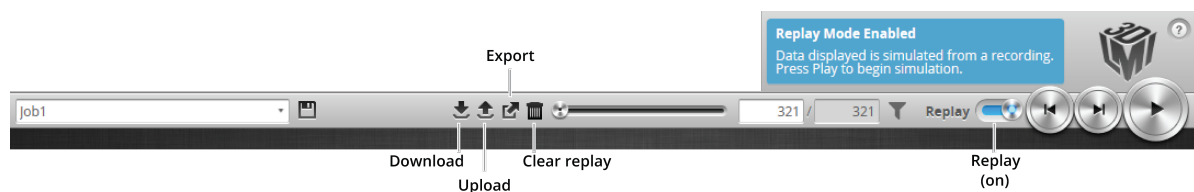
- Click the **Clear Replay Data** button .

## Downloading, Uploading, and Exporting Replay Data

Replay data (recorded scan data) can be downloaded from the emulator to a client computer, or uploaded from a client computer to the emulator.

Data can also be exported from the emulator to a client computer in order to process the data using third-party tools.

 You can only upload replay data to the same sensor model that was used to create the data.



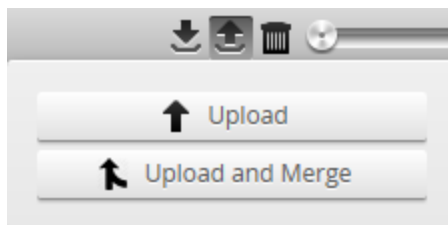
 Replay data is not loaded or saved when you load or save jobs.

*To download replay data:*

1. Click the Download button .
2. In the **File Download** dialog, click **Save**.
3. In the **Save As...** dialog, choose a location, optionally change the name (keeping the .rec extension), and click **Save**.

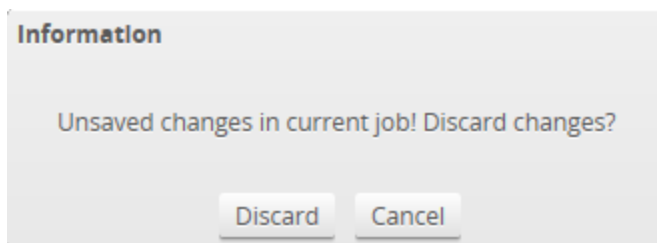
To upload replay data:

1. Click the Upload button .  
The Upload menu appears.



2. In the Upload menu, choose one of the following:
  - **Upload:** Unloads the current job and creates a new unsaved and untitled job from the content of the replay data file.
  - **Upload and merge:** Uploads the replay data and merges the data's associated job with the current job. Specifically, the settings on the **Scan** page are overwritten, but all other settings of the current job are preserved, including any measurements or models.

If you have unsaved changes in the current job, the firmware asks whether you want to discard the changes.

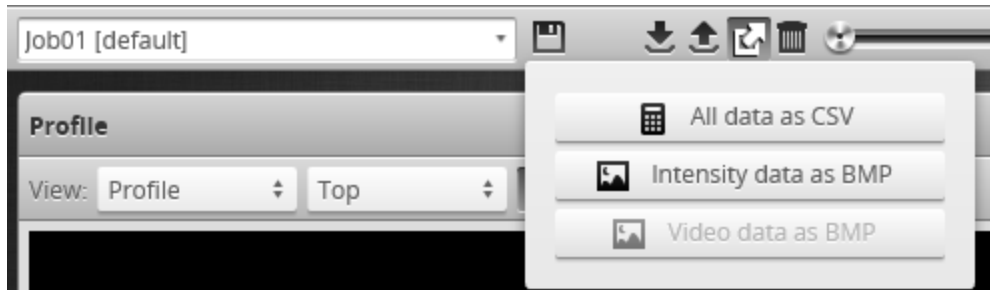


3. Do one of the following:
  - Click **Discard** to discard any unsaved changes.
  - Click **Cancel** to return to the main window to save your changes.
4. If you clicked **Discard**, navigate to the replay data to upload from the client computer and click **OK**.  
The replay data is loaded, and a new unsaved, untitled job is created.

Replay data can be exported using the CSV format. If you have enabled **Acquire Intensity** in the **Scan Mode** panel on the **Scan** page, the exported CSV file includes intensity data.



*Surface* intensity data cannot be exported to the CSV format. It can only be [exported separately as a bitmap](#).



*To export replay data in the CSV format:*

1. In the **Scan Mode** panel, switch to Profile or Surface.  
In Profile mode, all data in the record buffer is exported. In Surface mode, only data at the current replay location is exported.  
Use the playback control buttons to move to a different replay location; for information on playback, see *To replay data in Playback and Measurement Simulation* on page 305.
2. Click the Export button  and select **All Data as CSV**.  
In Profile mode, all data in the record buffer is exported. In Surface mode, only data at the current replay location is exported.  
Use the playback control buttons to move to a different replay location; for information on playback, see *To replay data in Playback and Measurement Simulation* on page 305.
3. Optionally, convert exported data to another format using the CSV Converter Tool. For information on this tool, see *CSV Converter Tool* on page 519.



The decision values in the exported data depend on the *current* state of the job, not the state during recording. For example, if you record data when a measurement returns a *pass* decision, change the measurement's settings so that a *fail* decision is returned, and then export to CSV, you will see a *fail* decision in the exported data.

Recorded intensity data can be exported to a bitmap (.BMP format). **Acquire Intensity** must be checked in the **Scan Mode** panel while data was being recorded in order to export intensity data.

*To export recorded intensity data to the BMP format:*

- Click the **Export** button  and select **Intensity data as BMP**.

Only the intensity data in the current replay location is exported.

Use the playback control buttons to move to a different replay location; for information on playback, see *To replay data in Playback and Measurement Simulation* on page 305.

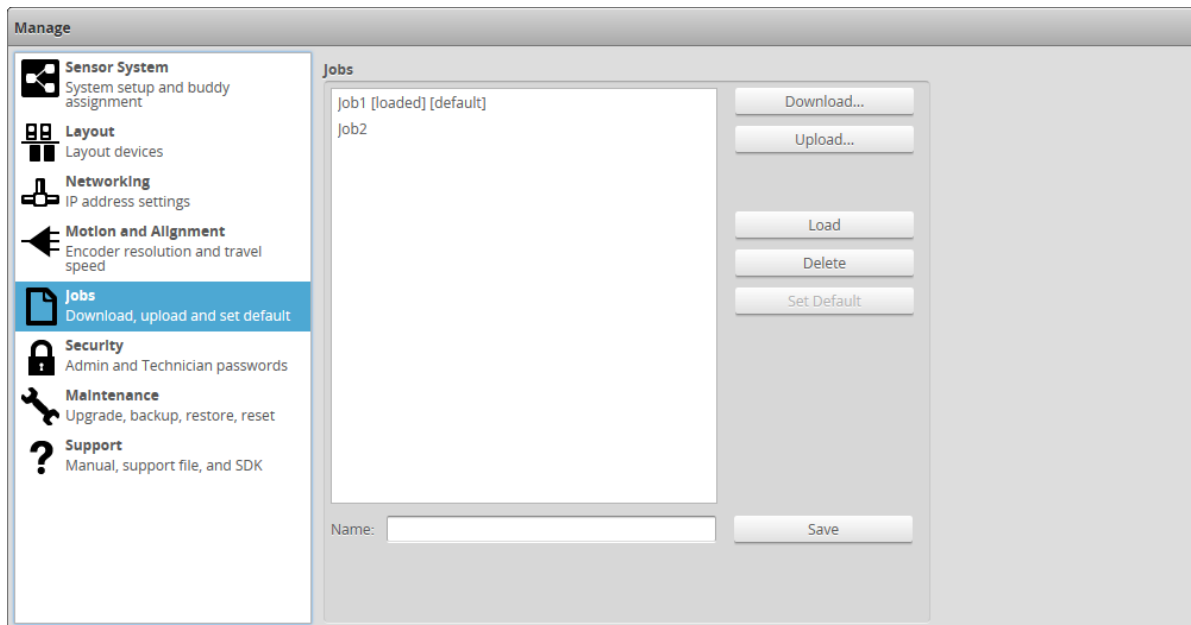


To export video data to a BMP file:

1. In the **Scan Mode** panel, switch to Video mode.  
Use the playback control buttons to move to a different replay location; for information on playback, see *To replay data in Playback and Measurement Simulation* on page 305.
2. Click the Export button  and select **Video data as BMP**.

## Downloading and Uploading Jobs

The **Jobs** category on the **Manage** page lets you manage the jobs in the emulator.

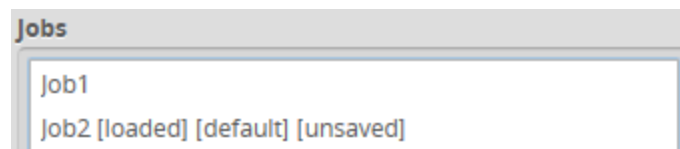


| Element     | Description                                                                                                                                                                                                                                                                              |
|-------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Name field  | Used to provide a job name when saving files.                                                                                                                                                                                                                                            |
| Jobs list   | Displays the jobs that are currently saved in the emulator.                                                                                                                                                                                                                              |
| Save button | Saves current settings to the job using the name in the <b>Name</b> field. Changes to job files are not persistent in the emulator. To keep changes, first save changes in the job file, and then download the job file to a client computer. See the procedures below for instructions. |
| Load button | Loads the job that is selected in the job list. Reloading the current job discards any unsaved changes.                                                                                                                                                                                  |



| Element               | Description                                                                                                                                                                                                                      |
|-----------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Delete button         | Deletes the job that is selected in the job list.                                                                                                                                                                                |
| Set as Default button | Setting a different job as the default is not persistent in the emulator. The job set as default when the support file (used to create a virtual sensor) was downloaded is used as the default whenever the emulator is started. |
| Download... button    | Downloads the selected job to the client computer.                                                                                                                                                                               |
| Upload... button      | Uploads a job from the client computer.                                                                                                                                                                                          |

Unsaved jobs are indicated by "[unsaved]".



Changes to job files in the emulator are *not* persistent (they are lost when you close or restart the emulator). However, you can keep modified jobs by first saving them and then downloading them to a client computer.

*To save a job:*

1. Go to the **Manage** page and click on the **Jobs** category.
2. Provide a name in the **Name** field.  
To save an existing job under a different name, click on it in the **Jobs** list and then modify it in the **Name** field.
3. Click on the **Save** button or press **Enter**.

*To download, load, or delete a job, or to set one as a default, or clear a default:*

1. Go to the **Manage** page and click on the **Jobs** category.
2. Select a job in the **Jobs** list.
3. Click on the appropriate button for the operation.

## Scan, Model, and Measurement Settings

The settings on the **Scan** page related to actual scanning will clear the buffer of any scan data that is uploaded from a client computer, or is part of a support file used to create a virtual sensor. If **Replay Protection** is checked, the emulator will indicate in the log that the setting can't be changed because the change would clear the buffer. For more information on Replay Protection, see *Using Replay Protection* on page 303.

Other settings on the **Scan** page related to the post-processing of data can be modified to test their influence on scan data, without modifying or clearing the data, for example edge filtering (page 126), and filters on the X axis (page 116). Note that modifying the Y filters causes the buffer to be cleared.

For information on creating models and setting up part matching, see *Models* on page 140. For information on adding and configuring measurement tools, see *Measurement* on page 161.

## Calculating Potential Maximum Frame Rate

You can use the emulator to calculate the potential maximum frame rate you can achieve with different settings.

For example, when you reduce the active area, in the **Active Area** tab on the **Sensor** panel, the maximum frame rate displayed on the **Trigger** panel is updated to reflect the increased speed that would be available in a physical Gocator sensor. (See *Active Area* on page 99 for more information on active area.)

Similarly, you can adjust exposure on the **Exposure** tab on the **Sensor** panel to see how this affects the maximum frame rate. (See *Exposure* on page 103 for more information on exposure.)



To adjust active area in the emulator, **Replay Protection** must be turned off. See *Using Replay Protection* on page 303 for more information.



Saving changes to active area causes replay data to be flushed.

## Protocol Output

The emulator simulates output for all of Gocator's Ethernet-based protocols.

- [Gocator](#)
- [ASCII](#)
- [Modbus](#)
- [EtherNet/IP](#)

Clients (such as PLCs) can connect to the emulator to access the simulated output and use the protocols as they would with a physical sensor.

The emulator allows connections to emulated sensors on localhost (127.0.0.1). You can also allow connections to emulated sensors on your computer's network card; for more information, see *Remote Operation* below.

## Remote Operation

You can specify the IP address of one of your computer's network cards to allow clients to connect remotely to an emulated sensor using the `/ip` command line parameter. When the `/ip` parameter is not used, emulated sensors are only available on the local machine (that is, 127.0.0.1 or localhost).



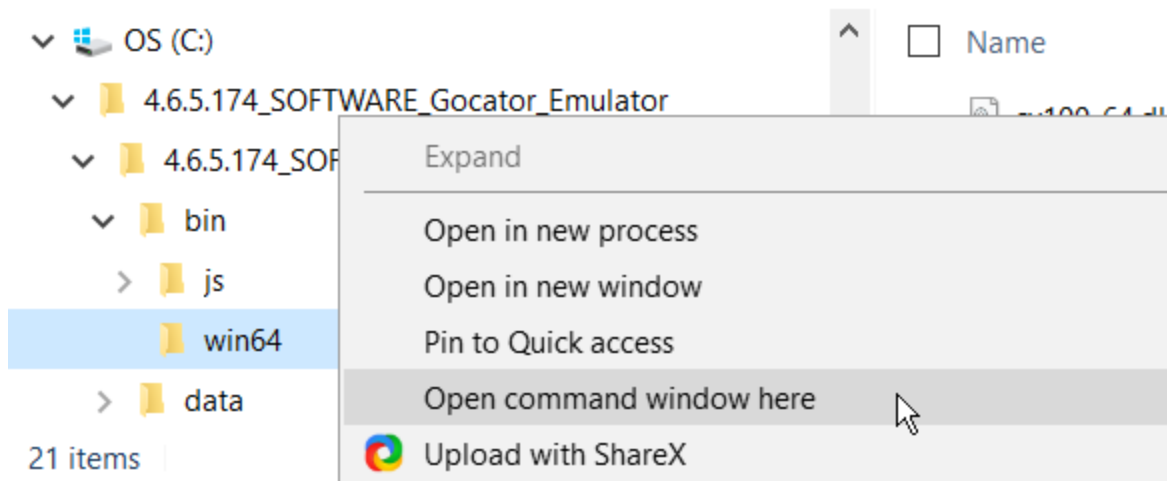
Clients can only connect to emulated sensors, not to the emulator's launch page.



You may need to contact your network administrator to allow connections to the computer running the emulated sensor.

*To allow remote connections to an emulated sensor:*

1. In Windows Explorer (Windows 7) or File Explorer (Windows 8 or 10), browse to the location of the emulator. The emulator is under `bin\win64`, in the location in which you installed the emulator.
2. Press and hold **Shift**, right-click the `win64` folder containing the emulator, and choose **Open command window here**.



3. In the command prompt, type `GoEmulator.exe /ip`, followed by an IPV4 address, for example:

```
C:\WINDOWS\system32\cmd.exe
C:\4.6.5.174_SOFTWARE_Gocator_Emulator\4.6.5.174_SOFTWARE_Gocator_Emulator\bin\win64>GoEmulator.exe /ip 192.168.1.42_
```

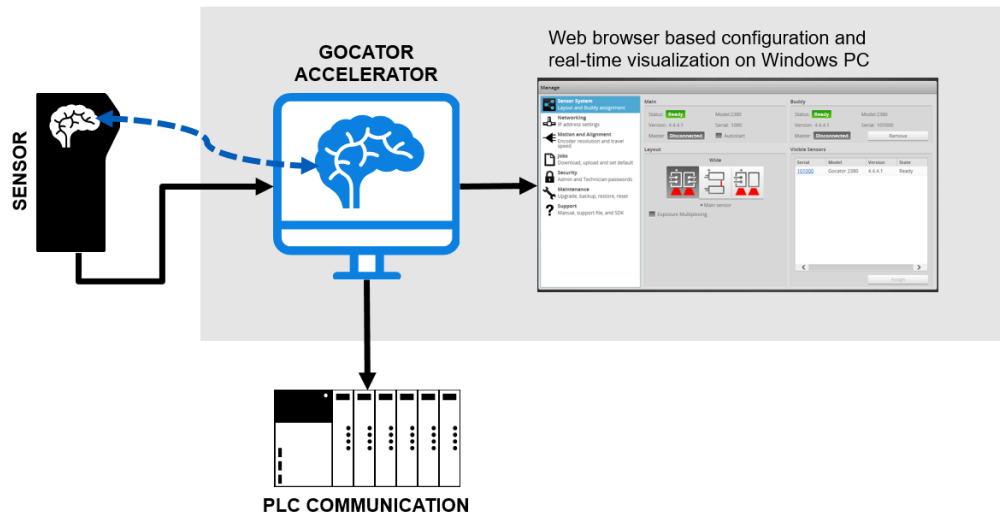
The emulator application starts.

 The emulator does not check that the IP address is valid.

4. From the emulator launch page, start a scenario.  
For more information, see *Running a Scenario* on page 301.
5. Provide the IP address you used with the `/ip` parameter, followed by port number 3191, to users who want to connect to the emulated sensor, for example:  
`192.168.1.42:3191`

# Gocator Accelerator

The Gocator Accelerator improves a Gocator system's processing capability by transferring the processing to PCs that are in the system.



The web interface and the supported output protocols (Gocator, EtherNet/IP, and ASCII protocols over Ethernet) are identical to an unaccelerated sensor.



The Gocator Accelerator does not currently support the Modbus protocol. It also does not currently support digital, analog, and Selcom serial output.

An application that can accelerate a standalone sensor or a dual-/multi-sensor system is provided in the Accelerator package (see below). You can also fully integrate Gocator acceleration into a client SDK-based application.

When a sensor is accelerated, it sends data directly to the Accelerator application or an accelerator-enabled SDK application. Users access the Gocator web interface using the IP address of the computer running the application.



Some health indicators behave differently when a sensor is accelerated. For information on which indicators in the Dashboard that acceleration affects, see *State and Health Information* on page 295. For information on which indicators available through the Gocator protocol acceleration affects, see *Health Results* on page 455.

For installation and usage instructions, as well as information on implementing acceleration in an [SDK](#) application, see the technical user manual (15201-x.x.x.xxx\_MANUAL\_Technical\_Gocator\_Measurement\_Tool.pdf). To get the manual, go to <http://lmi3d.com/support>, choose your product from the Product Downloads section, and download it from the Download Center. You can download the

GoAccelerator application in the 14405-4.5.x.xxx\_SOFTWARE\_GO\_Tools.zip package from the same location.

## Benefits

Accelerated sensors provide several benefits.

Acceleration is completely transparent: because the output protocols of an accelerated sensor are identical to those of an unaccelerated sensor, SDK and PLC applications require no changes whatsoever for controlling accelerated sensors and receiving health information and data.

Measurement latency is reduced on accelerated sensors, which results in shorter cycle times. This means a sensor can scan more targets in a given time period.

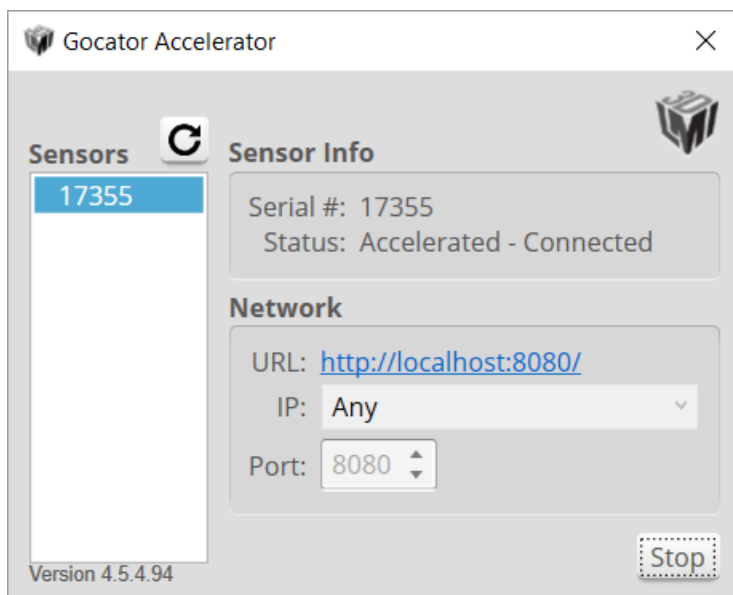
The memory of accelerated sensors is limited only by the memory of the PC on which the Accelerator is running. Accelerated sensors can therefore handle large 3D point clouds more effectively.

## Installation

To get the Accelerator, go to <http://lmi3d.com/support>, choose your product from the Product Downloads section, and download it from the Download Center. You can find the GoAccelerator application in the 14405-X.X.X.X\_SOFTWARE\_GO\_Tools.zip package. The libraries and DLL for integrating GoAccelerator into a SDK application are included in the 14400-X.X.X.X\_SOFTWARE\_GO\_SDK.zip, available at the same location.

## Gocator Accelerator Application

The Gocator Accelerator application accelerates the standalone sensor or dual-sensor system you choose.



An SDK application can interface to the Accelerator application the same way as a physical sensor. For more information on SDK application integration, see *SDK Application Integration* on page 316.

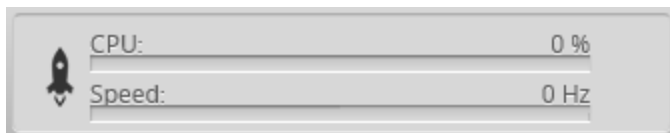
*To accelerate a sensor using the Gocator Accelerator application:*

1. Power up the sensor system you want to accelerate.
2. Launch the Gocator Accelerator application.
3. If a Windows Security alert asks whether you want to allow GoAccelerator.exe to communicate on networks, make sure **Public** and **Private** are checked, and then click **Allow Access**.
4. Click the sensor you want to accelerate in the **Sensors** list.  
If you do not see the sensor, you may need to wait a few seconds and then click the Refresh button ().
5. (Optional) Choose an IP in the **IP** list, or choose **Any** to let the application choose.
6. (Optional) Change the port in **Port**.

 If port 8080 is already in use, set **Port** to another port.

7. Click **Start**.  
The sensor is now accelerated.
8. In the Gocator Accelerator application, click the link next to **URL** to open the accelerated sensor's web interface.

When a sensor is accelerated, a "rocket" icon appears in the [metrics area](#).



 If you restart an accelerated sensor, the sensor will continue to be accelerated when it restarts.

*To stop an accelerated sensor in the Gocator Accelerator application:*

1. Select the sensor in the **Sensors** list.
2. Click **Stop**.

*To exit the Gocator Accelerator application:*

1. Right-click the icon Gocator Accelerator icon () in the notification tray.  
Clicking the X icon in the application only minimizes the application.
2. Choose **Exit**.

## Dashboard and Health Indicators

After a sensor is accelerated, the values of some health indicators come from the accelerating PC instead of the sensor. Others come from a combination of the accelerated sensor and the accelerating PC.

- For information on which indicators are affected in the Dashboard in the web interface, see *State and Health Information* on page 295.
- For information on which indicators accessed through the Gocator protocol are affected, see *Health Results* on page 455.

# SDK Application Integration



When you integrate the Gocator accelerator into an SDK application, the firmware version of the accelerator must match the firmware version of the sensor to guarantee proper operations.

Gocator Accelerator can be fully integrated into a SDK application. Users simply need to instantiate the GoAccelerator object and connect it to a sensor object.

```
GoAccelerator accelerator = kNULL;

// obtain GoSensor object by sensor IP address
if ((status = GoSystem_FindSensorByIpAddress(system, &ipAddress, &sensor)) != kOK)
{
    printf("Error: GoSystem_FindSensorByIpAddress:%d\n", status);
    return;
}

// construct accelerator
if ((status = GoAccelerator_Construct(&accelerator, kNULL)) != kOK)
{
    printf("Error: GoAccelerator_Construct:%d\n", status);
    return;
}

// start accelerator
if ((status = GoAccelerator_Start(accelerator)) != kOK)
{
    printf("Error: GoAccelerator_Start:%d\n", status);
    return;
}

printf("GoAccelerator_Start completed\n");
if ((status = GoAccelerator_Attach(accelerator, sensor)) != kOK)
{
    printf("Error: GoAccelerator_Attach:%d\n", status);
    return;
}

// create connection to GoSensor object
if ((status = GoSensor_Connect(sensor)) != kOK)
{
    printf("Error: GoSensor_Connect:%d\n", status);
    return;
}
```

After, the SDK application is the same as controlling and acquiring data from a standalone sensor.

## Limitations

The Gocator Accelerator currently has the following limitations:

1. Digital, Serial and Analog I/Os are not supported.
2. Only one instance of the Gocator Accelerator can run at a time. Note that one instance can accelerate one standalone sensor or a dual-/multi-sensor system.

These limitations will be removed in future releases.



# Gocator Device Files

This section describes the user-accessible device files stored on a Gocator.

## Live Files

Various "live" files stored on a Gocator sensor represent the sensor's active settings and transformations (represented together as "job" files), the active replay data (if any), and the sensor log.

By changing the live job file, you can change how the sensor behaves. For example, to make settings and transformations active, [write to](#) or [copy to](#) the `_live.job` file. You can also save active settings or transformations to a client computer, or to a file on the sensor, by [reading from](#) or [copying](#) these files, respectively.



The live files are stored in volatile storage. Only user-created job files are stored in non-volatile storage.

The following table lists the live files:

### Live Files

| Name                        | Read/Write | Description                                                                                                                                                                                                                                                                                                                                                                                            |
|-----------------------------|------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <code>_live.job</code>      | Read/Write | The active job. This file contains a Configuration component containing the current settings. If <a href="#">Alignment Reference</a> in the active job is set to Dynamic, it also contains a Transform component containing transformations.<br><br>For more information on job files (live and user-created), accessing their components, and their structure, see <i>Job Files</i> on the next page. |
| <code>_live.cfg</code>      | Read/Write | A standalone representation of the Configuration component contained in <code>_live.job</code> . Used primarily for backwards compatibility.                                                                                                                                                                                                                                                           |
| <code>_live.tfm</code>      | Read/Write | <b>If Alignment Reference of the active job is set to Dynamic:</b><br>A copy of the Transform component in <code>_live.job</code> . Used primarily for backwards compatibility.<br><br><b>If Alignment Reference of the active job is set to Fixed:</b><br>The transformations that are used for <i>all</i> jobs whose Alignment Reference setting is set to Fixed.                                    |
| <code>_live.log</code>      | Read       | A sensor log containing various messages. For more information on the log file, see <i>Log File</i> below.                                                                                                                                                                                                                                                                                             |
| <code>_live.rec</code>      | Read/Write | The active replay simulation data.                                                                                                                                                                                                                                                                                                                                                                     |
| <code>ExtendedId.xml</code> | Read       | Sensor identification.                                                                                                                                                                                                                                                                                                                                                                                 |

## Log File

The log file contains log messages generated by the sensor. The root element is *Log*.

To access the log file, use the [Read File](#) command, passing "\_live.log" to the command. The log file is read-only.

#### *Log Child Elements*

| Element                          | Type | Description                                                            |
|----------------------------------|------|------------------------------------------------------------------------|
| @idStart                         | 64s  | Identifier of the first log.                                           |
| @idEnd                           | 64s  | Identifier of the final log.                                           |
| List of (Info   Warning   Error) | List | An ordered list of log entries. This list is empty if idEnd < idStart. |

#### *Log/Info | Log/Warning | Log/Error Elements*

| Element                           | Type   | Description                                                                                                                |
|-----------------------------------|--------|----------------------------------------------------------------------------------------------------------------------------|
| @time                             | 64u    | Log time, in uptime ( $\mu$ s).                                                                                            |
| @source                           | 32u    | The serial number of the sensor the log was produced by.                                                                   |
| @id                               | 32u    | The Identifier, or index, of the log                                                                                       |
| @value                            | String | Log content; may contain printf-style format specifiers (e.g. %u).                                                         |
| List of (IntArg   FloatArg   Arg) | List   | An ordered list of arguments:<br>IntArg – Integer argument<br>FloatArg – Floating-point argument<br>Arg – Generic argument |

The arguments are all sent as strings and should be applied in order to the format specifiers found in the content.

## Job Files

The following sections describe the structure of job files.

Job files, which are stored in a Gocator's internal storage, control system behavior when a sensor is running. Job files contain the settings and potentially the transformations and models associated with the job (if [Alignment Reference](#) is set to Dynamic).

There are two kinds of job files:

- A special job file called "\_live.job." This job file contains the *active* settings and potentially the transformations and models associated with the job. It is stored in volatile storage.
- Other job files that are stored in non-volatile storage.

## Job File Components

A job file contains components that can be loaded and saved as independent files. The following table lists the components of a job file:

### Job File Components

| Component     | Path          | Description                                                                                            |
|---------------|---------------|--------------------------------------------------------------------------------------------------------|
| Configuration | config.xml    | The job's configurations. This component is always present.                                            |
| Transform     | transform.xml | Transformation values. Present only if <a href="#">Alignment Reference</a> is set to Dynamic.          |
| Part model    | <name>.mdl    | One or more part model files. Part models are created using <a href="#">models and part matching</a> . |

Elements in the components contain three types of values: settings, constraints, and properties. Settings are input values that can be edited. Constraints are read-only limits that define the valid values for settings. Properties are read-only values that provide supplemental information related to sensor setup.

When a job file is received from a sensor, it will contain settings, constraints, and properties. When a job file is sent to a sensor, any constraints or properties in the file will be ignored.

Changing the value of a setting can affect multiple constraints and properties. After you upload a job file, you can download the job file again to access the updated values of the constraints and properties.

All Gocator sensors share a common job file structure.

## Accessing Files and Components

Job file components can be accessed individually as XML files using path notation. For example, the configurations in a user-created job file called *productionRun01.job* can be read by passing "productionRun01.job/config.xml" to the [Read File](#) command. In the same way, the configurations in the active job could be read using "\_live.job/config.xml".



If [Alignment Reference](#) is set to Fixed, the active job file (\_live.job) will not contain transformations. To access transformations in this case, you must access them via \_live.tfm.



The following sections correspond to the XML structure used in job file components.

## Configuration

The Configuration component of a job file contains settings that control how a Gocator sensor behaves.

You can access the Configuration component of the active job as an XML file, either using path notation, via "\_live.job/config.xml", or directly via "\_live.cfg".

You can access the Configuration component in user-created job files in non-volatile storage, for example, "productionRun01.job/config.xml". You can only access configurations in user-created job files using path notation.

See the following sections for the elements contained in this component.

### Configuration Child Elements

| Element  | Type | Description                  |
|----------|------|------------------------------|
| @version | 32u  | Configuration version (101). |

| Element       | Type         | Description                                                                                                                                                                                           |
|---------------|--------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| @versionMinor | 32u          | Configuration minor version (5).                                                                                                                                                                      |
| Setup         | Section      | For a description of the Setup elements, see <i>Setup</i> below.                                                                                                                                      |
| Replay        | Section      | Contains settings related to recording filtering (see <i>Replay</i> on page 339).                                                                                                                     |
| Streams       | Section      | Read-only collection of available data streams (see <i>Streams/Stream (Read-only)</i> on page 340).                                                                                                   |
| ToolOptions   | Section      | List of available tool types and their information. See <i>ToolOptions</i> on page 341 for details.                                                                                                   |
| Tools         | Collection   | Collection of sections. Each section is an instance of a tool and is named by the type of the tool it describes. For more information, see the sections for each tool under <i>Tools</i> on page 343. |
| Tools.options | String (CSV) | Deprecated. Replaced by <a href="#">ToolOptions</a> .                                                                                                                                                 |
| Outputs       | Section      | For a description of the Output elements, see <i>Output</i> on page 393.                                                                                                                              |

## Setup

The Setup element contains settings related to system and sensor setup.

### Setup Child Elements

| Element                         | Type         | Description                                                                       |
|---------------------------------|--------------|-----------------------------------------------------------------------------------|
| TemperatureSafetyEnabled        | Bool         | Enables laser temperature safety control.                                         |
| TemperatureSafetyEnabled.used   | Bool         | Whether or not this property is used.                                             |
| ScanMode                        | 32s          | The default scan mode.                                                            |
| ScanMode options                | String (CSV) | List of available scan modes.                                                     |
| OcclusionReductionEnabled       | Bool         | Enables occlusion reduction.                                                      |
| OcclusionReductionEnabled.used  | Bool         | Whether or not property is used.                                                  |
| OcclusionReductionEnabled.value | Bool         | Actual value used if not configurable.                                            |
| OcclusionReductionAlg           | 32s          | The Algorithm to use for occlusion reduction:<br>0 – Standard<br>1 – High Quality |
| OcclusionReductionAlg.used      | Bool         | Whether or not property is used                                                   |
| OcclusionReductionAlg.value     | Bool         | Actual value used if not configurable                                             |
| UniformSpacingEnabled           | Bool         | Enables uniform spacing.                                                          |
| UniformSpacingEnabled.used      | Bool         | Whether or not property is used.                                                  |
| UniformSpacingEnabled.value     | Bool         | Actual value used if not configurable.                                            |
| IntensityEnabled                | Bool         | Enables intensity data collection.                                                |

| Element                     | Type       | Description                                                                                               |
|-----------------------------|------------|-----------------------------------------------------------------------------------------------------------|
| IntensityEnabled.used       | Bool       | Whether or not property is used.                                                                          |
| IntensityEnabled.value      | Bool       | Actual value used if not configurable.                                                                    |
| FlickerFreeModeEnabled      | Bool       | Enables flicker-free operation.                                                                           |
| FlickerFreeModeEnabled.used | Bool       | Whether flicker-free operation can be used on this sensor.                                                |
| ExternalInputZPulseEnabled  | Bool       | Enables the External Input based encoder Z Pulse feature.                                                 |
| Filters                     | Section    | See <i>Filters</i> below.                                                                                 |
| Trigger                     | Section    | See <i>Trigger</i> on page 325.                                                                           |
| Layout                      | Section    | See <i>Layout</i> on page 326.                                                                            |
| Alignment                   | Section    | See <i>Alignment</i> on page 327.                                                                         |
| Devices                     | Collection | A collection of two Device sections (with roles main and buddy). See <i>Devices / Device</i> on page 328. |
| SurfaceGeneration           | Section    | See <i>SurfaceGeneration</i> on page 334.                                                                 |
| SurfaceSections             | Section    | See <i>SurfaceSections</i> on page 335.                                                                   |
| ProfileGeneration           | Section    | See <i>ProfileGeneration</i> on page 335. Used by Gocator displacement sensors.                           |
| PartDetection               | Section    | See <i>PartDetection</i> on page 336.                                                                     |
| PartMatching                | Section    | See <i>PartMatching</i> on page 338.                                                                      |
| Custom                      | Custom     | Used by specialized sensors.                                                                              |

## Filters

The Filters element contains settings related to post-processing profiles before they are output or used by measurement tools.

## XSmoothing

### *XSmoothing Child Elements*

| Element    | Type | Description                       |
|------------|------|-----------------------------------|
| @used      | Bool | Whether or not this field is used |
| Enabled    | Bool | Enables filtering.                |
| Window     | 64f  | Window size (mm).                 |
| Window.min | 64f  | Minimum window size (mm).         |
| Window.max | 64f  | Maximum window size (mm).         |

## YSmoothing

### *YSmoothing Child Elements*

| Element | Type | Description                       |
|---------|------|-----------------------------------|
| @used   | Bool | Whether or not this field is used |
| Enabled | Bool | Enables filtering.                |

| Element    | Type | Description               |
|------------|------|---------------------------|
| Window     | 64f  | Window size (mm).         |
| Window.min | 64f  | Minimum window size (mm). |
| Window.max | 64f  | Maximum window size (mm). |

## XGapFilling

### *XGapFilling Child Elements*

| Element    | Type | Description                       |
|------------|------|-----------------------------------|
| @used      | Bool | Whether or not this field is used |
| Enabled    | Bool | Enables filtering.                |
| Window     | 64f  | Window size (mm).                 |
| Window.min | 64f  | Minimum window size (mm).         |
| Window.max | 64f  | Maximum window size (mm).         |

## YGapFilling

### *YGapFilling Child Elements*

| Element    | Type | Description                       |
|------------|------|-----------------------------------|
| @used      | Bool | Whether or not this field is used |
| Enabled    | Bool | Enables filtering.                |
| Window     | 64f  | Window size (mm).                 |
| Window.min | 64f  | Minimum window size (mm).         |
| Window.max | 64f  | Maximum window size (mm).         |

## XMedian

### *XMedian Child Elements*

| Element    | Type | Description                       |
|------------|------|-----------------------------------|
| @used      | Bool | Whether or not this field is used |
| Enabled    | Bool | Enables filtering.                |
| Window     | 64f  | Window size (mm).                 |
| Window.min | 64f  | Minimum window size (mm).         |
| Window.max | 64f  | Maximum window size (mm).         |

## YMedian

### *YMedian Child Elements*

| Element    | Type | Description                       |
|------------|------|-----------------------------------|
| @used      | Bool | Whether or not this field is used |
| Enabled    | Bool | Enables filtering.                |
| Window     | 64f  | Window size (mm).                 |
| Window.min | 64f  | Minimum window size (mm).         |
| Window.max | 64f  | Maximum window size (mm).         |

## XDecimation

### *XDecimation Child Elements*

| Element    | Type | Description                       |
|------------|------|-----------------------------------|
| @used      | Bool | Whether or not this field is used |
| Enabled    | Bool | Enables filtering.                |
| Window     | 64f  | Window size (mm).                 |
| Window.min | 64f  | Minimum window size (mm).         |
| Window.max | 64f  | Maximum window size (mm).         |

## YDecimation

### *YDecimation Child Elements*

| Element    | Type | Description                       |
|------------|------|-----------------------------------|
| @used      | Bool | Whether or not this field is used |
| Enabled    | Bool | Enables filtering.                |
| Window     | 64f  | Window size (mm).                 |
| Window.min | 64f  | Minimum window size (mm).         |
| Window.max | 64f  | Maximum window size (mm).         |

## XSlope

|                                                                                     |                                                        |
|-------------------------------------------------------------------------------------|--------------------------------------------------------|
|  | This filter is only available on displacement sensors. |
|-------------------------------------------------------------------------------------|--------------------------------------------------------|

### *XSlope Child Elements*

| Element    | Type | Description                       |
|------------|------|-----------------------------------|
| @used      | Bool | Whether or not this field is used |
| Enabled    | Bool | Enables filtering.                |
| Window     | 64f  | Window size (mm).                 |
| Window.min | 64f  | Minimum window size (mm).         |
| Window.max | 64f  | Maximum window size (mm).         |

## YSlope

|                                                                                     |                                                        |
|-------------------------------------------------------------------------------------|--------------------------------------------------------|
|  | This filter is only available on displacement sensors. |
|-------------------------------------------------------------------------------------|--------------------------------------------------------|

### *YSlope Child Elements*

| Element    | Type | Description                       |
|------------|------|-----------------------------------|
| @used      | Bool | Whether or not this field is used |
| Enabled    | Bool | Enables filtering.                |
| Window     | 64f  | Window size (mm).                 |
| Window.min | 64f  | Minimum window size (mm).         |
| Window.max | 64f  | Maximum window size (mm).         |

## Trigger

The Trigger element contains settings related to trigger source, speed, and encoder resolution.

### Trigger Child Elements

| Element                  | Type      | Description                                                                                   |
|--------------------------|-----------|-----------------------------------------------------------------------------------------------|
| Source                   | 32s       | Trigger source:<br>0 – Time<br>1 – Encoder<br>2 – Digital Input<br>3 – Software               |
| Source.options           | 32s (CSV) | List of available source options.                                                             |
| Units                    | 32s       | Sensor triggering units when source is not clock or encoder:<br>0 – Time<br>1 – Encoder       |
| FrameRate                | 64f       | Frame rate for time trigger (Hz).                                                             |
| FrameRate.min            | 64f       | Minimum frame rate (Hz).                                                                      |
| FrameRate.max            | 64f       | Maximum frame rate (Hz).                                                                      |
| FrameRate.maxSource      | 32s       | Source of maximum frame rate limit:<br>0 – Imager<br>1 – Surface generation                   |
| MaxFrameRateEnabled      | Bool      | Enables maximum frame rate (ignores FrameRate).                                               |
| EncoderSpacing           | 64f       | Encoder spacing for encoder trigger (mm).                                                     |
| EncoderSpacing.min       | 64f       | Minimum encoder spacing (mm).                                                                 |
| EncoderSpacing.max       | 64f       | Maximum encoder spacing (mm).                                                                 |
| EncoderSpacing.minSource | 32s       | Source of minimum encoder spacing:<br>0 – Resolution<br>1 – Surface generation                |
| EncoderSpacing.used      | Bool      | Whether or not this parameter is configurable.                                                |
| EncoderTriggerMode       | 32s       | Encoder triggering mode:<br>0 – Tracking backward<br>1 – Bidirectional<br>2 – Ignore backward |
| Delay                    | 64f       | Trigger delay ( $\mu$ s or mm).                                                               |
| Delay.min                | 64f       | Minimum trigger delay ( $\mu$ s or mm).                                                       |
| Delay.max                | 64f       | Maximum trigger delay ( $\mu$ s or mm).                                                       |
| GateEnabled              | Bool      | Enables digital input gating.                                                                 |
| GateEnabled.used         | Bool      | True if this parameter can be configured.                                                     |
| GateEnabled.value        | Bool      | Actual value if the parameter cannot be configured.                                           |



| Element           | Type | Description                                      |
|-------------------|------|--------------------------------------------------|
| BurstEnabled      | Bool | Enables burst triggering.                        |
| BurstEnabled.Used | Bool | Whether or not this parameter is configurable.   |
| BurstCount        | 32u  | Number of scans to take during burst triggering. |
| BurstCount.used   | Bool | Whether or not this parameter is configurable.   |
| BurstCount.max    | 32u  | Maximum burst count.                             |

## Layout

### Layout Child Elements

| Element                         | Type                     | Description                                                                                                                                 |
|---------------------------------|--------------------------|---------------------------------------------------------------------------------------------------------------------------------------------|
| DataSource                      | 32s                      | Data source of the layout output (read-only):<br>0 – Top<br>1 – Bottom<br>2 – Top left<br>3 – Top right<br>4 – Top Bottom<br>5 – Left Right |
| XSpacingCount                   | 32u                      | Number of points along X when data is resampled.                                                                                            |
| YSpacingCount                   | 32u                      | Number of points along Y when data is resampled.                                                                                            |
| TransformedDataRegion           | <a href="#">Region3D</a> | Transformed data region of the layout output.                                                                                               |
| Orientation                     | 32s                      | Sensor orientation:<br>0 – Wide<br>1 – Opposite<br>2 – Reverse<br>3 – Grid                                                                  |
| Grid                            | <a href="#">Grid</a>     | Grid representation of the multi-sensor layout.                                                                                             |
| Orientation.options             | 32s (CSV)                | List of available orientation options.                                                                                                      |
| Orientation.value               | 32s                      | Actual value used if not configurable.                                                                                                      |
| MultiplexBuddyEnabled           | Bool                     | Enables multiplexing for buddies.                                                                                                           |
| MultiplexSingleEnabled          | Bool                     | Enables multiplexing for a single sensor configuration.                                                                                     |
| MultiplexSingleExposureDuration | 64f                      | Exposure duration in $\mu$ s (currently rounded to integer when read by the sensor)                                                         |
| MultiplexSingleDelay            | 64f                      | Delay in $\mu$ s. (Currently gets rounded up when read by the sensor.)                                                                      |
| MultiplexSinglePeriod           | 64f                      | Period in $\mu$ s. (Currently gets rounded up when read by the sensor.)                                                                     |
| MultiplexSinglePeriod.min       | 64f                      | Minimum period in $\mu$ s.                                                                                                                  |

### Region3D Child Elements

| Element | Type | Description   |
|---------|------|---------------|
| X       | 64f  | X start (mm). |
| Y       | 64f  | Y start (mm). |

| Element     | Type | Description                           |
|-------------|------|---------------------------------------|
| Z           | 64f  | Z start (mm).                         |
| Width       | 64f  | X extent (mm).                        |
| Length      | 64f  | Y extent (mm).                        |
| Height      | 64f  | Z extent (mm).                        |
| ZAngle      | 64f  | Z Angle start (degrees).              |
| ZAngle.used | Bool | Whether or not this property is used. |

#### *Grid Elements*

| Element           | Type | Description         |
|-------------------|------|---------------------|
| ColumnCount       | 32u  | Column count.       |
| ColumnCount.value | 32u  | Column count value. |

### Alignment

The Alignment element contains settings related to alignment and encoder calibration.

#### *Alignment Child Elements*

| Element                   | Type      | Description                                                                                       |
|---------------------------|-----------|---------------------------------------------------------------------------------------------------|
| @used                     | Bool      | Whether or not this field is used                                                                 |
| InputTriggerEnabled       | Bool      | Enables digital input-triggered alignment operation.                                              |
| InputTriggerEnabled.used  | Bool      | Whether or not this feature can be enabled. This feature is available only on some sensor models. |
| InputTriggerEnabled.value | Bool      | Actual feature status.                                                                            |
| Type                      | 32s       | Type of alignment operation:<br>0 – Stationary<br>1 – Moving                                      |
| Type.options              | 32s (CSV) | List of available alignment types.                                                                |
| StationaryTarget          | 32s       | Stationary alignment target:<br>0 – None<br>1 – Disk<br>2 – Bar<br>3 – Plate                      |
| StationaryTarget.options  | 32s (CSV) | List of available stationary alignment targets.                                                   |
| MovingTarget              | 32s       | Moving alignment target:<br>0 – None<br>1 – Disk<br>2 – Bar<br>3 – Plate                          |
| MovingTarget.options      | 32s (CSV) | List of available moving alignment targets.                                                       |

| Element                 | Type    | Description                             |
|-------------------------|---------|-----------------------------------------|
| EncoderCalibrateEnabled | Bool    | Enables encoder resolution calibration. |
| Disk                    | Section | See <i>Disk</i> below.                  |
| Bar                     | Section | See <i>Bar</i> below.                   |
| Plate                   | Section | See <i>Plate</i> below.                 |

## Disk

### *Disk Child Elements*

| Element  | Type | Description         |
|----------|------|---------------------|
| Diameter | 64f  | Disk diameter (mm). |
| Height   | 64f  | Disk height (mm).   |

## Bar

### *Bar Child Elements*

| Element           | Type | Description                                                            |
|-------------------|------|------------------------------------------------------------------------|
| Width             | 64f  | Bar width (mm).                                                        |
| Height            | 64f  | Bar height (mm).                                                       |
| HoleCount         | 32u  | Number of holes.                                                       |
| HoleCount.value   | 32u  | Actual number of holes expected by system.                             |
| HoleCount.used    | Bool | Whether the hole count will be used in the bar alignment procedure.    |
| HoleDistance      | 64f  | Distance between holes (mm).                                           |
| HoleDistance.used | Bool | Whether the hole distance will be used in the bar alignment procedure. |
| HoleDiameter      | 64f  | Diameter of holes (mm).                                                |
| HoleDiameter.used | Bool | Whether the hole diameter will be used in the bar alignment procedure. |

## Plate

### *Plate Child Elements*

| Element         | Type | Description                         |
|-----------------|------|-------------------------------------|
| Height          | 64f  | Plate height (mm).                  |
| HoleCount       | 32u  | Number of holes.                    |
| RefHoleDiameter | 64f  | Diameter of reference hole (mm).    |
| SecHoleDiameter | 64f  | Diameter of secondary hole(s) (mm). |

## Devices / Device

### *Devices / Device Child Elements*

| Element | Type | Description                           |
|---------|------|---------------------------------------|
| @role   | 32s  | Sensor role:<br>0 – Main<br>1 – Buddy |

| Element                     | Type                     | Description                                                                                                                                                              |
|-----------------------------|--------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Layout                      | <a href="#">Layout</a>   | Multiplexing bank settings.                                                                                                                                              |
| DataSource                  | 32s                      | Data source of device output (read-only):<br>0 – Top<br>1 – Bottom<br>2 – Top Left<br>3 – Top Right                                                                      |
| XSpacingCount               | 32u                      | Number of resampled points along X (read-only).                                                                                                                          |
| YSpacingCount               | 32u                      | Number of resampled points along Y (read-only).                                                                                                                          |
| ActiveArea                  | <a href="#">Region3D</a> | Active area. (Contains min and max attributes for each element.)                                                                                                         |
| TransformedDataRegion       | <a href="#">Region3D</a> | Active area after transformation (read-only).                                                                                                                            |
| FrontCamera                 | <a href="#">Window</a>   | Front camera window (read-only).                                                                                                                                         |
| BackCamera                  | <a href="#">Window</a>   | Back camera window (read-only).                                                                                                                                          |
| BackCamera.used             | Bool                     | Whether or not this field is used.                                                                                                                                       |
| PatternSequenceType         | 32s                      | The projector pattern sequence to display when a projector equipped device is running. The following types are possible:<br>-1 – None<br>0 – Default<br>100 – Nine Lines |
| PatternSequenceType.options | 32s                      | List of available pattern sequence types.                                                                                                                                |
| PatternSequenceType.used    | Bool                     | Whether or not this field is used.                                                                                                                                       |
| PatternSequenceCount        | 32u                      | Number of frames in the active sequence (read-only).                                                                                                                     |
| ExposureMode                | 32s                      | Exposure mode:<br>0 – Single exposure<br>1 – Multiple exposures<br>2 – Dynamic exposure                                                                                  |
| ExposureMode.options        | 32s (CSV)                | List of available exposure modes.                                                                                                                                        |
| Exposure                    | 64f                      | Single exposure (μs).                                                                                                                                                    |
| Exposure.min                | 64f                      | Minimum exposure (μs).                                                                                                                                                   |
| Exposure.max                | 64f                      | Maximum exposure (μs).                                                                                                                                                   |
| Exposure.used               | Bool                     | Whether or not this field is used.                                                                                                                                       |
| DynamicExposureMin          | 64f                      | Dynamic exposure range minimum (μs).                                                                                                                                     |
| DynamicExposureMax          | 64f                      | Dynamic exposure range maximum (μs).                                                                                                                                     |
| ExposureSteps               | 64f (CSV)                | Multiple exposure list (μs).                                                                                                                                             |
| ExposureSteps.countMin      | 32u                      | Minimum number of exposure steps.                                                                                                                                        |
| ExposureSteps.countMax      | 32u                      | Maximum number of exposure steps.                                                                                                                                        |

| Element                  | Type      | Description                                                                                         |
|--------------------------|-----------|-----------------------------------------------------------------------------------------------------|
| IntensitySource          | 32s       | Intensity source:<br>0 – Both cameras<br>1 – Front camera<br>2 – Back camera                        |
| IntensitySource.options  | 32s (CSV) | List of available intensity sources.                                                                |
| ZSubsampling             | 32u       | Subsampling factor in Z.                                                                            |
| ZSubsampling.options     | 32u (CSV) | List of available subsampling factors in Z.                                                         |
| SpacingInterval          | 64f       | Uniform spacing interval (mm).                                                                      |
| SpacingInterval.min      | 64f       | Minimum spacing interval (mm).                                                                      |
| SpacingInterval.max      | 64f       | Maximum spacing interval (mm).                                                                      |
| SpacingInterval.used     | Bool      | Whether or not field is used.                                                                       |
| SpacingInterval value    | 64f       | Actual value used.                                                                                  |
| SpacingIntervalType      | 32s       | Spacing interval type:<br>0 – Maximum resolution<br>1 – Balanced<br>2 – Maximum speed<br>3 – Custom |
| SpacingIntervalType.used | Bool      | Whether or not this field is used.                                                                  |
| Tracking                 | Section   | See <i>Tracking</i> on the next page.                                                               |
| Material                 | Section   | See <i>Material</i> on the next page.                                                               |
| IndependentExposures     | Section   | See <i>IndependentExposures</i> on page 333                                                         |
| Custom                   | Custom    | Used by specialized sensors.                                                                        |

#### *Region3D Child Elements*

| Element     | Type | Description                           |
|-------------|------|---------------------------------------|
| X           | 64f  | X start (mm).                         |
| Y           | 64f  | Y start (mm).                         |
| Z           | 64f  | Z start (mm).                         |
| Width       | 64f  | X extent (mm).                        |
| Length      | 64f  | Y extent (mm).                        |
| Height      | 64f  | Z extent (mm).                        |
| ZAngle      | 64f  | Z Angle start (degrees).              |
| ZAngle.used | Bool | Whether or not this property is used. |

#### *Window Child Elements*

| Element | Type | Description       |
|---------|------|-------------------|
| X       | 32u  | X start (pixels). |

| Element | Type | Description        |
|---------|------|--------------------|
| Y       | 32u  | Y start (pixels).  |
| Width   | 32u  | X extent (pixels). |
| Height  | 32u  | Y extent (pixels). |

#### *Layout Child Elements*

| Element                | Type                 | Description                                |
|------------------------|----------------------|--------------------------------------------|
| Grid                   | <a href="#">Grid</a> | Layout grid information.                   |
| MultiplexingBank       | 32u                  | Multiplexing bank ID                       |
| MultiplexingBank.used  | 32u                  | Whether or not this field can be specified |
| MultiplexingBank.value | 32u                  | Actual value used by system                |

#### *Grid Child Elements*

| Element         | Type | Description                                                                  |
|-----------------|------|------------------------------------------------------------------------------|
| @used           | Bool | Whether or not this section is used.                                         |
| Row             | 32s  | Device row position in grid layout.                                          |
| Row.value       | 32s  | Value in use by the sensor, useful for determining value when used is false. |
| Column          | 32s  | Device column position in grid layout.                                       |
| Column.value    | 32s  | Value in use by the sensor, useful for determining value when used is false. |
| Direction       | 32s  | Sensor orientation direction.                                                |
| Direction.value | 32s  | Value in use by the sensor, useful for determining value when used is false. |

### Tracking

|                                                                                     |                                                                     |
|-------------------------------------------------------------------------------------|---------------------------------------------------------------------|
|  | Tracking is only available on Gocator 2300 and 2400 series sensors. |
|-------------------------------------------------------------------------------------|---------------------------------------------------------------------|

#### *Tracking Child Elements*

| Element         | Type | Description                                                |
|-----------------|------|------------------------------------------------------------|
| Enabled         | Bool | Enables tracking.                                          |
| Enabled.used    | Bool | Whether or not this field is used.                         |
| SearchThreshold | 64f  | Percentage of spots that must be found to remain in track. |
| Height          | 64f  | Tracking window height (mm).                               |
| Height.min      | 64f  | Minimum tracking window height (mm).                       |
| Height.max      | 64f  | Maximum tracking window height (mm).                       |

### Material

#### *Material Child Elements*

| Element | Type | Description                       |
|---------|------|-----------------------------------|
| Type    | 32s  | Type of Material settings to use. |

| Element                   | Type         | Description                                                                                                                                                                                                                                                                                                                                                           |
|---------------------------|--------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
|                           |              | 0 – Custom<br>1 – Diffuse                                                                                                                                                                                                                                                                                                                                             |
| Type.used                 | Bool         | Determines if the setting's value is currently used.                                                                                                                                                                                                                                                                                                                  |
| Type.value                | 32s          | Value in use by the sensor, useful for determining value when used is false.                                                                                                                                                                                                                                                                                          |
| SpotThreshold             | 32s          | Spot detection threshold.                                                                                                                                                                                                                                                                                                                                             |
| SpotThreshold.used        | Bool         | Determines if the setting's value is currently used.                                                                                                                                                                                                                                                                                                                  |
| SpotThreshold.value       | 32s          | Value in use by the sensor, useful for determining value when used is false.                                                                                                                                                                                                                                                                                          |
| SpotWidthMax              | 32s          | Spot detection maximum width.                                                                                                                                                                                                                                                                                                                                         |
| SpotWidthMax.used         | Bool         | Determines if the setting's value is currently used.                                                                                                                                                                                                                                                                                                                  |
| SpotWidthMax.value        | 32s          | Value in use by the sensor, useful for determining value when used is false.                                                                                                                                                                                                                                                                                          |
| SpotWidthMax.min          | 32s          | Minimum allowed spot detection maximum value.                                                                                                                                                                                                                                                                                                                         |
| SpotWidthMax.max          | 32s          | Maximum allowed spot detection maximum value.                                                                                                                                                                                                                                                                                                                         |
| SpotSelectionType         | 32s          | Spot selection type<br>0 – Best. Picks the strongest spot in a given column.<br>1 – Top. Picks the spot which is most Top/Left on the imager<br>2 – Bottom. Picks the spot which is most Bottom/Right on the imager<br>3 – None. All spots are available. This option may not be available in some configurations.<br>4 – Continuity. Picks the most continuous spot. |
| SpotSelectionType.used    | Bool         | Determines if the setting's value is currently used.                                                                                                                                                                                                                                                                                                                  |
| SpotSelectionType.value   | 32s          | Value in use by the sensor, useful for determining value when used is false.                                                                                                                                                                                                                                                                                          |
| SpotSelectionType.options | 32s<br>(CSV) | List of available spot selection types.                                                                                                                                                                                                                                                                                                                               |
| CameraGainAnalog          | 64f          | Analog camera gain factor.                                                                                                                                                                                                                                                                                                                                            |
| CameraGainAnalog.used     | Bool         | Determines if the setting's value is currently used.                                                                                                                                                                                                                                                                                                                  |
| CameraGainAnalog.value    | 64f          | Value in use by the sensor, useful for determining value when used is false.                                                                                                                                                                                                                                                                                          |
| CameraGainAnalog.min      | 64f          | Minimum value.                                                                                                                                                                                                                                                                                                                                                        |
| CameraGainAnalog.max      | 64f          | Maximum value.                                                                                                                                                                                                                                                                                                                                                        |
| CameraGainDigital         | 64f          | Digital camera gain factor.                                                                                                                                                                                                                                                                                                                                           |
| CameraGainDigital.used    | Bool         | Determines if the setting's value is currently used.                                                                                                                                                                                                                                                                                                                  |
| CameraGainDigital.value   | 64f          | Value in use by the sensor, useful for determining value when used is false.                                                                                                                                                                                                                                                                                          |

| Element                              | Type    | Description                                                                                                                    |
|--------------------------------------|---------|--------------------------------------------------------------------------------------------------------------------------------|
| CameraGainDigital.min                | 64f     | Minimum value.                                                                                                                 |
| CameraGainDigital.max                | 64f     | Maximum value.                                                                                                                 |
| DynamicSensitivity                   | 64f     | Dynamic exposure control sensitivity factor. This can be used to scale the control setpoint.                                   |
| DynamicSensitivity.used              | Bool    | Determines if the setting's value is currently used.                                                                           |
| DynamicSensitivity.value             | 64f     | Value in use by the sensor, useful for determining value when used is false.                                                   |
| DynamicSensitivity.min               | 64f     | Minimum value.                                                                                                                 |
| DynamicSensitivity.max               | 64f     | Maximum value.                                                                                                                 |
| DynamicThreshold                     | 32s     | Dynamic exposure control threshold. If the detected number of spots is fewer than this number, the exposure will be increased. |
| DynamicThreshold.used                | Bool    | Determines if the setting's value is currently used.                                                                           |
| DynamicThreshold.value               | 32s     | Value in use by the sensor, useful for determining value when used is false.                                                   |
| DynamicThreshold.min                 | 32s     | Minimum value.                                                                                                                 |
| DynamicThreshold.max                 | 32s     | Maximum value.                                                                                                                 |
| SensitivityCompensationEnabled       | Bool    | Sensitivity compensation toggle. Used in determining analog and digital gain, along with exposure scale.                       |
| SensitivityCompensationEnabled.used  | Bool    | Determines if the setting's value is currently used.                                                                           |
| SensitivityCompensationEnabled.value | Bool    | Value in use by the sensor, useful for determining value when used is false.                                                   |
| GammaType                            | 32s     | Gamma type.                                                                                                                    |
| GammaType used                       | Bool    | Determines if the setting's value is currently used.                                                                           |
| GammaType value                      | 32s     | Value in use by the sensor. Useful for determining value when used is false.                                                   |
| SpotContinuitySorting                | Section | See <i>SpotContinuitySorting Child Elements</i> below.                                                                         |

#### *SpotContinuitySorting Child Elements*

| Element            | Type | Description                                                   |
|--------------------|------|---------------------------------------------------------------|
| MinimumSegmentSize | 32u  | Smallest continuous segment considered in continuity sorting. |
| SearchWindow/X     | 32u  | X component of continuity sorting search window size.         |
| SearchWindow/Y     | 32u  | Y component of continuity sorting search window size.         |

### IndependentExposures

#### *IndependentExposures Child Elements*

| Element | Type | Description                                                     |
|---------|------|-----------------------------------------------------------------|
| @used   | Bool | Whether this field is used                                      |
| Enabled | Bool | Whether to allow using separate exposure values for each camera |



| Element                 | Type | Description                                          |
|-------------------------|------|------------------------------------------------------|
| FrontCameraExposure     | 64f  | The exposure value to use for the front camera       |
| FrontCameraExposure.min | 64f  | The minimum exposure value possible for front camera |
| FrontCameraExposure.max | 64f  | The maximum exposure value possible for back camera  |
| BackCameraExposure      | 64f  | The exposure value to use for the front camera       |
| BackCameraExposure.min  | 64f  | The minimum exposure value possible for front camera |
| BackCameraExposure.max  | 64f  | The maximum exposure value possible for back camera  |

## SurfaceGeneration

The SurfaceGeneration element contains settings related to surface generation.

### SurfaceGeneration Child Elements

| Element        | Type    | Description                                                                                             |
|----------------|---------|---------------------------------------------------------------------------------------------------------|
| Type           | 32s     | Surface generation type:<br>0 – Continuous<br>1 – Fixed length<br>2 – Variable length<br>3 – Rotational |
| FixedLength    | Section | See <i>FixedLength</i> below.                                                                           |
| VariableLength | Section | See <i>VariableLength</i> below.                                                                        |
| Rotational     | Section | See <i>Rotational</i> on the next page.                                                                 |

## FixedLength

### FixedLength Child Elements

| Element      | Type | Description                                                     |
|--------------|------|-----------------------------------------------------------------|
| StartTrigger | 32s  | Start trigger condition:<br>0 – Sequential<br>1 – Digital input |
| Length       | 64f  | Surface length (mm).                                            |
| Length.min   | 64f  | Minimum surface length (mm).                                    |
| Length.max   | 64f  | Maximum surface length (mm).                                    |

## VariableLength

### VariableLength Child Elements

| Element       | Type | Description                                    |
|---------------|------|------------------------------------------------|
| MaxLength     | 64f  | Maximum surface length (mm).                   |
| MaxLength.min | 64f  | Minimum value for maximum surface length (mm). |
| MaxLength.max | 64f  | Maximum value for maximum surface length (mm). |

## Rotational

### *Rotational Child Elements*

| Element           | Type | Description                 |
|-------------------|------|-----------------------------|
| Circumference     | 64f  | Circumference (mm).         |
| Circumference.min | 64f  | Minimum circumference (mm). |
| Circumference.max | 64f  | Maximum circumference (mm). |

## SurfaceSections

### *SurfaceSections Child Elements*

| Element | Type       | Description                                                  |
|---------|------------|--------------------------------------------------------------|
| @xMin   | 64f        | The minimum valid X value to be used for section definition. |
| @xMax   | 64f        | The maximum valid X value to be used for section definition. |
| @yMin   | 64f        | The minimum valid Y value to be used for section definition. |
| @yMax   | 64f        | The maximum valid Y value to be used for section definition. |
| Section | Collection | A series of <a href="#">Section</a> elements.                |

### *Section Child Elements*

| Element                      | Type     | Description                                                                                         |
|------------------------------|----------|-----------------------------------------------------------------------------------------------------|
| @id                          | 32s      | The ID assigned to the surface section.                                                             |
| @name                        | String   | The name associated with the surface section.                                                       |
| StartPoint                   | Point64f | The beginning point of the surface section.                                                         |
| EndPoint                     | Point64f | The end point of the surface section.                                                               |
| CustomSpacingIntervalEnabled | Bool     | Indicates whether a user specified custom spacing interval is to be used for the resulting section. |
| SpacingInterval              | 64f      | The user specified spacing interval.                                                                |
| SpacingInterval.min          | 64f      | The spacing interval limit minimum.                                                                 |
| SpacingInterval.max          | 64f      | The spacing interval limit maximum.                                                                 |
| SpacingInterval.value        | 64f      | The current spacing interval used by the system.                                                    |

## ProfileGeneration

The ProfileGeneration element contains settings related to profile generation.

This element is used by Gocator laser displacement sensors.

### *ProfileGeneration Child Elements*

| Element | Type | Description                                                                                             |
|---------|------|---------------------------------------------------------------------------------------------------------|
| Type    | 32s  | Profile generation type:<br>0 – Continuous<br>1 – Fixed length<br>2 – Variable length<br>3 – Rotational |

| Element        | Type    | Description                      |
|----------------|---------|----------------------------------|
| FixedLength    | Section | See <i>FixedLength</i> below.    |
| VariableLength | Section | See <i>VariableLength</i> below. |
| Rotational     | Section | See <i>Rotational</i> below.     |

## FixedLength

### *FixedLength Child Elements*

| Element      | Type | Description                                                     |
|--------------|------|-----------------------------------------------------------------|
| StartTrigger | 32s  | Start trigger condition:<br>0 – Sequential<br>1 – Digital input |
| Length       | 64f  | Profile length (mm).                                            |
| Length.min   | 64f  | Minimum profile length (mm).                                    |
| Length.max   | 64f  | Maximum profile length (mm).                                    |

## VariableLength

### *VariableLength Child Elements*

| Element       | Type | Description                                    |
|---------------|------|------------------------------------------------|
| MaxLength     | 64f  | Maximum surface length (mm).                   |
| MaxLength.min | 64f  | Minimum value for maximum profile length (mm). |
| MaxLength.max | 64f  | Maximum value for maximum profile length (mm). |

## Rotational

### *Rotational Child Elements*

| Element           | Type | Description                 |
|-------------------|------|-----------------------------|
| Circumference     | 64f  | Circumference (mm).         |
| Circumference.min | 64f  | Minimum circumference (mm). |
| Circumference.max | 64f  | Maximum circumference (mm). |

## PartDetection

### *PartDetection Child Elements*

| Element       | Type | Description                            |
|---------------|------|----------------------------------------|
| Enabled       | Bool | Enables part detection.                |
| Enabled.used  | Bool | Whether or not this field is used.     |
| Enabled value | Bool | Actual value used if not configurable. |
| Threshold     | 64f  | Height threshold (mm).                 |
| Threshold.min | 64f  | Minimum height threshold (mm).         |
| Threshold.max | 64f  | Maximum height threshold (mm).         |

| Element               | Type | Description                                                    |
|-----------------------|------|----------------------------------------------------------------|
| ThresholdDirection    | 32u  | Threshold direction:<br>0 – Above<br>1 – Below                 |
| MinArea               | 64f  | Minimum area (mm <sup>2</sup> ).                               |
| MinArea.min           | 64f  | Minimum value of minimum area.                                 |
| MinArea.max           | 64f  | Maximum value of minimum area.                                 |
| MinArea.used          | Bool | Whether or not this field is used.                             |
| GapWidth              | 64f  | Gap width (mm).                                                |
| GapWidth.min          | 64f  | Minimum gap width (mm).                                        |
| GapWidth.max          | 64f  | Maximum gap width (mm).                                        |
| GapWidth.used         | Bool | Whether or not this field is used.                             |
| GapLength             | 64f  | Gap length (mm).                                               |
| GapLength.min         | 64f  | Minimum gap length (mm).                                       |
| GapLength.max         | 64f  | Maximum gap length (mm).                                       |
| GapLength.used        | Bool | Whether or not this field is used.                             |
| PaddingWidth          | 64f  | Padding width (mm).                                            |
| PaddingWidth.min      | 64f  | Minimum padding width (mm).                                    |
| PaddingWidth.max      | 64f  | Maximum padding width (mm).                                    |
| PaddingWidth.used     | Bool | Whether or not this field is used.                             |
| PaddingLength         | 64f  | Padding length (mm).                                           |
| PaddingLength.min     | 64f  | Minimum padding length (mm).                                   |
| PaddingLength.max     | 64f  | Maximum padding length (mm).                                   |
| PaddingLength.used    | Bool | Whether or not this field is used.                             |
| MinLength             | 64f  | Minimum length (mm).                                           |
| MinLength.min         | 64f  | Minimum value of minimum length (mm).                          |
| MinLength.max         | 64f  | Maximum value of minimum length (mm).                          |
| MinLength.used        | Bool | Whether or not this field is used.                             |
| MaxLength             | 64f  | Maximum length (mm).                                           |
| MaxLength.min         | 64f  | Minimum value of maximum length (mm).                          |
| MaxLength.max         | 64f  | Maximum value of maximum length (mm).                          |
| MaxLength.used        | Bool | Whether or not this field is used.                             |
| FrameOfReference      | 32s  | Part frame of reference:<br>0 – Sensor<br>1 – Scan<br>2 – Part |
| FrameOfReference.used | Bool | Whether or not this field is used.                             |

| Element                | Type    | Description                     |
|------------------------|---------|---------------------------------|
| FrameOfReference.value | 32s     | Actual value.                   |
| EdgeFiltering          | Section | See <i>EdgeFiltering</i> below. |

## EdgeFiltering

### *EdgeFiltering Child Elements*

| Element                 | Type | Description                          |
|-------------------------|------|--------------------------------------|
| @used                   | Bool | Whether or not this section is used. |
| Enabled                 | Bool | Enables edge filtering.              |
| PreserveInteriorEnabled | Bool | Enables preservation of interior.    |
| ElementWidth            | 64f  | Element width (mm).                  |
| ElementWidth.min        | 64f  | Minimum element width (mm).          |
| ElementWidth.max        | 64f  | Maximum element width (mm).          |
| ElementLength           | 64f  | Element length (mm).                 |
| ElementLength.min       | 64f  | Minimum element length (mm).         |
| ElementLength.max       | 64f  | Maximum element length (mm).         |

## PartMatching

The PartMatching element contains settings related to part matching.

### *PartMatching Child Elements*

| Element      | Type    | Description                                                            |
|--------------|---------|------------------------------------------------------------------------|
| Enabled      | Bool    | Enables part matching.                                                 |
| Enabled.used | Bool    | Whether or not this field is used.                                     |
| MatchAlgo    | 32s     | Match algorithm.<br>0 – Edge points<br>1 – Bounding Box<br>2 – Ellipse |
| Edge         | Section | See <i>Edge</i> below.                                                 |
| BoundingBox  | Section | See <i>BoundingBox</i> on the next page.                               |
| Ellipse      | Section | See <i>Ellipse</i> on the next page.                                   |

## Edge

### *Edge Child Elements*

| Element                | Type   | Description                                                         |
|------------------------|--------|---------------------------------------------------------------------|
| ModelName              | String | Name of the part model to use. Does not include the .mdl extension. |
| Acceptance/Quality/Min | 64f    | Minimum quality value for a match.                                  |

## BoundingBox

### *BoundingBox Child Elements*

| Element                | Type | Description                                                                                                                                                                  |
|------------------------|------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| ZAngle                 | 64f  | Z rotation to apply to bounding box (degrees).                                                                                                                               |
| AsymmetryDetectionType | 32s  | Determine whether to use asymmetry detection and, if enabled, which dimension is the basis of detection. The possible values are:<br><br>0 – None<br>1 – Length<br>2 – Width |
| Acceptance/Width/Min   | 64f  | Minimum width (mm).                                                                                                                                                          |
| Acceptance/Width/Max   | 64f  | Maximum width (mm).                                                                                                                                                          |
| Acceptance/Length/Min  | 64f  | Minimum length (mm).                                                                                                                                                         |
| Acceptance/Length/Max  | 64f  | Maximum length (mm).                                                                                                                                                         |

## Ellipse

### *Ellipse Child Elements*

| Element                | Type | Description                                                                                                                                                                 |
|------------------------|------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| ZAngle                 | 64f  | Z rotation to apply to ellipse (degrees).                                                                                                                                   |
| AsymmetryDetectionType | 32s  | Determine whether to use asymmetry detection and, if enabled, which dimension is the basis of detection. The possible values are:<br><br>0 – None<br>1 – Major<br>2 – Minor |
| Acceptance/Major/Min   | 64f  | Minimum major length (mm).                                                                                                                                                  |
| Acceptance/Major/Max   | 64f  | Maximum major length (mm).                                                                                                                                                  |
| Acceptance/Minor/Min   | 64f  | Minimum minor length (mm).                                                                                                                                                  |
| Acceptance/Minor/Max   | 64f  | Maximum minor length (mm).                                                                                                                                                  |

## Replay

Contains settings related to recording filtering.

## RecordingFiltering

### *RecordingFiltering Child Elements*

| Element              | Type       | Description                                                                                                                                                                   |
|----------------------|------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| ConditionCombineType | 32s        | 0 – Any: If any enabled condition is satisfied, the current frame is recorded.<br><br>1 – All: All enabled conditions must be satisfied for the current frame to be recorded. |
| Conditions           | Collection | A collection of <a href="#">AnyMeasurement</a> , <a href="#">AnyData</a> , or <a href="#">Measurement</a> conditions.                                                         |

## Conditions/AnyMeasurement

### Conditions/AnyMeasurement Elements

| Element | Type | Description                                                                                                                              |
|---------|------|------------------------------------------------------------------------------------------------------------------------------------------|
| Enabled | Bool | Indicates whether the condition is enabled.                                                                                              |
| Result  | 32s  | The measurement decision criteria to be included in the filter. Possible values are:<br>0 – Pass<br>1 – Fail<br>2 – Valid<br>3 – Invalid |

## Conditions/AnyData

### Conditions/AnyData Elements

| Element             | Type | Description                                                                                                                             |
|---------------------|------|-----------------------------------------------------------------------------------------------------------------------------------------|
| Enabled             | Bool | Indicates whether the condition is enabled.                                                                                             |
| RangeCountCase      | 32s  | The case under which to record data:<br>0 – Range count at or above threshold of valid data points.<br>1 – Range count below threshold. |
| RangeCountThreshold | 32u  | The threshold for the number of range points that are valid.                                                                            |

## Conditions/Measurement

### Conditions/Measurement Elements

| Element | Type | Description                                                                                                                                                  |
|---------|------|--------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Enabled | Bool | Indicates whether the condition is enabled.                                                                                                                  |
| Ids     | 32s  | The ID of the measurement to filter.                                                                                                                         |
| Result  | 32s  | The measurement decision criteria for the selected ID to be included in the filter. Possible values are:<br>0 – Pass<br>1 – Fail<br>2 – Valid<br>3 – Invalid |

## Streams/Stream (Read-only)

### Streams/Stream Child Elements

| Element | Type | Description                                                                                                |
|---------|------|------------------------------------------------------------------------------------------------------------|
| Step    | 32s  | The data step of the stream being described. Possible values are:<br>1 – Video<br>2 – Range<br>3 – Surface |

| Element    | Type       | Description                                                                                                                         |
|------------|------------|-------------------------------------------------------------------------------------------------------------------------------------|
|            |            | 4 – Section                                                                                                                         |
| Id         | 32u        | The stream ID.                                                                                                                      |
| TempoGroup | 32u        | Represents a stage in the data processing pipeline. The greater the number, the farther removed from the initial acquisition stage. |
| Sources    | Collection | A collection of Source elements as described below.                                                                                 |

#### Source Child Elements

| Element                  | Type       | Description                                                                                                                                   |
|--------------------------|------------|-----------------------------------------------------------------------------------------------------------------------------------------------|
| Id                       | 32s        | The ID of the data source. Possible values are:<br>0 – Top<br>1 – Bottom<br>2 – Top Left<br>3 – Top Right<br>4 – Top Bottom<br>5 – Left Right |
| Capability               | 32s        | The capability of the data stream source. Possible values are:<br>0 – Full<br>1 – Diagnostic only<br>2 – Virtual                              |
| Region                   | Region3d   | The region of the given stream source.                                                                                                        |
| AdditionalRegions        | Collection | Collection of additional regions (for example, for the second camera).                                                                        |
| AdditionalRegions/Region | Region3d   | Additional regions.                                                                                                                           |

## ToolOptions

The ToolOptions element contains a list of available tool types, their measurements, and settings for related information.

#### ToolOptions Child Elements

| Element      | Type       | Description                                                                   |
|--------------|------------|-------------------------------------------------------------------------------|
| <Tool Names> | Collection | A collection of tool name elements. An element for each tool type is present. |

#### Tool Name Child Elements

| Element            | Type       | Description                                    |
|--------------------|------------|------------------------------------------------|
| @displayName       | String     | Display name of the tool.                      |
| @isCustom          | Bool       | Reserved for future use.                       |
| MeasurementOptions | Collection | See <i>MeasurementOptions</i> on the next page |
| FeatureOptions     | Collection | See <i>FeatureOptions</i> on the next page.    |
| StreamOptions      | Collection | See <i>StreamOptions</i> on the next page.     |



## MeasurementOptions

### *MeasurementOptions Child Elements*

| Element             | Type       | Description                                                                            |
|---------------------|------------|----------------------------------------------------------------------------------------|
| <Measurement Names> | Collection | A collection of measurement name elements. An element for each measurement is present. |

### *<Measurement Name> Child Elements*

| Element      | Type   | Description                            |
|--------------|--------|----------------------------------------|
| @displayName | String | Display name of the tool.              |
| @minCount    | 32u    | Minimum number of instances in a tool. |
| @maxCount    | 32u    | Maximum number of instances in a tool. |

## FeatureOptions

### *FeatureOptions Child Elements*

| Element         | Type       | Description                                                                        |
|-----------------|------------|------------------------------------------------------------------------------------|
| <Feature Names> | Collection | A collection of feature name elements. An element for each measurement is present. |

### *<Feature Name> Child Elements*

| Element      | Type   | Description                                                                                                                                                               |
|--------------|--------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| @displayName | String | Display name of the feature.                                                                                                                                              |
| @minCount    | 32u    | Minimum number of instances in a tool.                                                                                                                                    |
| @maxCount    | 32u    | Maximum number of instances in a tool.                                                                                                                                    |
| @dataType    | String | The data type of the feature. One of: <ul style="list-style-type: none"><li>– PointFeature</li><li>– LineFeature</li><li>– CircleFeature</li><li>– PlaneFeature</li></ul> |

## StreamOptions

### *StreamOptions Child Elements*

| Element | Type | Description                                                                                                                                                                           |
|---------|------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| @step   | 32s  | The data step of the stream being described. Possible values are: <ul style="list-style-type: none"><li>1 – Video</li><li>2 – Range</li><li>3 – Surface</li><li>4 – Section</li></ul> |
| @ids    | CSV  | A list representing the available IDs associated with the given step.                                                                                                                 |

## Tools

The Tools element contains measurement tools. The following sections describe each tool and its available measurements.

### *Tools Child Elements*

| Element    | Type         | Description                                                        |
|------------|--------------|--------------------------------------------------------------------|
| @options   | String (CSV) | A list of the tools available in the currently selected scan mode. |
| <ToolType> | Section      | An element for each added tool.                                    |

## Profile Types

The following types are used by various measurement tools.

### **ProfileFeature**

An element of type ProfileFeature defines the settings for detecting a feature within an area of interest.

### *ProfileFeature Child Elements*

| Element       | Type                            | Description                                                                                                                                                                                                                                                                                    |
|---------------|---------------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Type          | 32s                             | Determine how the feature is detected within the area:<br>0 – Max Z<br>1 – Min Z<br>2 – Max X<br>3 – Min X<br>4 – Corner<br>5 – Average<br>6 – Rising Edge<br>7 – Falling Edge<br>8 – Any Edge<br>9 – Top Corner<br>10 – Bottom Corner<br>11 – Left Corner<br>12 – Right Corner<br>13 – Median |
| RegionEnabled | Bool                            | Indicates whether feature detection applies to the defined Region or to the entire active area.                                                                                                                                                                                                |
| Region        | <a href="#">ProfileRegion2D</a> | Element for feature detection area.                                                                                                                                                                                                                                                            |

### **ProfileLine**

An element of type ProfileLine defines measurement areas used to calculate a line.

### *ProfileLine Child Elements*

| Element     | Type         | Description                                                                                                                                             |
|-------------|--------------|---------------------------------------------------------------------------------------------------------------------------------------------------------|
| RegionCount | 32s          | Count of the regions.                                                                                                                                   |
| Regions     | (Collection) | The regions used to calculate a line. Contains one or two Region elements of type <a href="#">ProfileRegion2D</a> , with RegionEnabled fields for each. |

## ProfileRegion2d

An element of type ProfileRegion2d defines a rectangular area of interest.

### *ProfileRegion2d Child Elements*

| Element | Type | Description                                 |
|---------|------|---------------------------------------------|
| X       | 64f  | Setting for profile region X position (mm). |
| Z       | 64f  | Setting for profile region Z position (mm). |
| Width   | 64f  | Setting for profile region width (mm).      |
| Height  | 64f  | Setting for profile region height (mm).     |

## Surface Types

The following types are used by the various measurement tools.

## Region3D

An element of type Region3D defines a rectangular area of interest in 3D.

### *Region3D Child Elements*

| Element | Type | Description             |
|---------|------|-------------------------|
| X       | 64f  | Volume X position (mm). |
| Y       | 64f  | Volume Y position (mm). |
| Z       | 64f  | Volume Z position (mm). |
| Width   | 64f  | Volume width (mm).      |
| Length  | 64f  | Volume length (mm).     |
| Height  | 64f  | Volume height (mm).     |

## SurfaceFeature

An element of type SurfaceFeature defines the settings for detecting a feature within an area of interest.

### *SurfaceFeature Child Elements*

| Element       | Type                     | Description                                                                                                                                                                                                                                |
|---------------|--------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Type          | 32s                      | Setting to determine how the feature is detected within the area:<br>0 – Average (formerly Centroid 2d)<br>1 – Centroid (formerly Centroid 3d)<br>2 – X Max<br>3 – X Min<br>4 – Y Max<br>5 – Y Min<br>6 – Z Max<br>7 – Z Min<br>8 – Median |
| RegionEnabled | Boolean                  | Setting to enable/disable region:<br>0 – Disable<br>1 – Enable                                                                                                                                                                             |
| Region        | <a href="#">Region3D</a> | Element for feature detection volume.                                                                                                                                                                                                      |

## SurfaceRegion2d

An element of type SurfaceRegion2d defines a rectangular area of interest on the X-Y plane.

### SurfaceRegion2d Child Elements

| Element | Type | Description                                 |
|---------|------|---------------------------------------------|
| X       | 64f  | Setting for surface region X position (mm). |
| Y       | 64f  | Setting for surface region Y position (mm). |
| Width   | 64f  | Setting for region width (mm).              |
| Length  | 64f  | Setting for region length (mm).             |

## Geometric Feature Types

The Geometric Feature type is used by various measurement tools.

### Feature Child Elements

| Element    | Type       | Description                                                              |
|------------|------------|--------------------------------------------------------------------------|
| @id        | 32s        | The identifier of the geometric feature. -1 if unassigned.               |
| @dataType  | String     | The data type of the feature. One of:<br>- PointFeature<br>- LineFeature |
| @type      | String     | Type name of feature.                                                    |
| Name       | String     | The display name of the feature.                                         |
| Enabled    | Bool       | Whether the given feature output is enabled.                             |
| Parameters | Collection | Collection of GdkParam elements.                                         |

## Parameter Types

The following types are used by internal and custom (user-created) GDK-based tools.

### GDK Parameter Child Elements

| Element      | Type          | Description                                                                                                                                                                                                        |
|--------------|---------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| @label       | String        | Parameter label.                                                                                                                                                                                                   |
| @type        | String        | Type of parameter. It is one of the following (see tables below for elements found in each type):<br>- Bool<br>- Int<br>- Float<br>- ProfileRegion<br>- SurfaceRegion2d<br>- SurfaceRegion3d<br>- GeometricFeature |
| @options     | Variant (CSV) | Options available for this parameter.                                                                                                                                                                              |
| @optionNames | String (CSV)  | Names                                                                                                                                                                                                              |

*GDK Parameter Bool Type*

| Element | Type | Description                 |
|---------|------|-----------------------------|
|         | Bool | Boolean value of parameter. |

*GDK Parameter Int Type*

| Element | Type | Description                                 |
|---------|------|---------------------------------------------|
|         | 32s  | Integer value of parameter of integer type. |

*GDK Parameter Float Type*

| Element | Type | Description                        |
|---------|------|------------------------------------|
|         | 64f  | Floating point value of parameter. |

*GDK Parameter String Type*

| Element | Type   | Description                |
|---------|--------|----------------------------|
|         | String | String value of parameter. |

*GDK Parameter Profile Region Type*

| Element | Type | Description             |
|---------|------|-------------------------|
| X       | 64f  | X value of region.      |
| Z       | 64f  | Z value of region.      |
| Width   | 64f  | Width value of region.  |
| Height  | 64f  | Height value of region. |

*GDK Parameter Surface Region 2D Type*

| Element | Type | Description             |
|---------|------|-------------------------|
| X       | 64f  | X value of region.      |
| X       | 64f  | X value of region.      |
| Y       | 64f  | Y value of region.      |
| Width   | 64f  | Width value of region.  |
| Length  | 64f  | Length value of region. |

*GDK Parameter Surface Region 3D Type*

| Element | Type | Description             |
|---------|------|-------------------------|
| X       | 64f  | X value of region.      |
| Y       | 64f  | Y value of region.      |
| Z       | 64f  | Z value of region.      |
| Width   | 64f  | Width value of region.  |
| Length  | 64f  | Length value of region. |
| Height  | 64f  | Height value of region. |
| ZAngle  | 64f  | ZAngle value of region. |

*GDK Parameter Geometric Feature Type*

| Element | Type | Description                         |
|---------|------|-------------------------------------|
|         | 32s  | Geometric feature Id for parameter. |

## ProfileArea

A ProfileArea element defines settings for a profile area tool and one or more of its measurements.

### ProfileArea Child Elements

| Element                | Type                             | Description                                                                                                          |
|------------------------|----------------------------------|----------------------------------------------------------------------------------------------------------------------|
| Name                   | String                           | Tool name.                                                                                                           |
| Features               | Collection                       | Collection of geometric feature outputs available in the tool. See <i>ProfileArea</i> above.                         |
| Source                 | 32s                              | Profile source.                                                                                                      |
| Anchor\X               | String (CSV)                     | The X measurements (IDs) used for anchoring.                                                                         |
| Anchor\X.options       | String (CSV)                     | The X measurements (IDs) available for anchoring.                                                                    |
| Anchor\Z               | String (CSV)                     | The Z measurements (IDs) used for anchoring.                                                                         |
| Anchor\Z.options       | String (CSV)                     | The Z measurements (IDs) available for anchoring.                                                                    |
| StreamOptions          | Collection                       | A collection of <i>StreamOptions</i> on page 342 elements.                                                           |
| Stream\Step            | 32s                              | The stream source step. Possible values are:<br>1 – Video<br>2 – Range<br>3 – Surface<br>4 – Section                 |
| Stream\ld              | 32u                              | The stream source ID.                                                                                                |
| Type                   | Boolean                          | Area to measure:<br>0 – Object (convex shape above the baseline)<br>1 – Clearance (concave shape below the baseline) |
| Type.used              | Boolean                          | Whether or not field is used.                                                                                        |
| Baseline               | Boolean                          | Baseline type:<br>0 – X-axis<br>1 – Line                                                                             |
| Baseline.used          | Boolean                          | Whether or not field is used.                                                                                        |
| RegionEnabled          | Boolean                          | If enabled, the defined region is used for measurements. Otherwise, the full active area is used.                    |
| Region                 | <a href="#">ProfileRegion2d</a>  | Measurement region.                                                                                                  |
| Line                   | <a href="#">ProfileLine</a>      | Line definition when Baseline is set to Line.                                                                        |
| Measurements\Area      | Area tool measurement            | Area measurement.                                                                                                    |
| Measurements\CentroidX | Area tool measurement            | CentroidX measurement.                                                                                               |
| Measurements\CentroidZ | Area tool measurement            | CentroidZ measurement.                                                                                               |
| Features\CenterPoint   | <a href="#">GeometricFeature</a> | CenterPoint PointFeature.                                                                                            |

### Area Tool Measurement

| Element                 | Type    | Description                                                             |
|-------------------------|---------|-------------------------------------------------------------------------|
| @id                     | 32s     | Measurement ID. Optional (measurement disabled if not set).             |
| Name                    | String  | Measurement name.                                                       |
| Enabled                 | Boolean | Measurement enable state:<br>0 – Disable<br>1 – Enable                  |
| HoldEnabled             | Boolean | Output hold enable state:<br>0 – Disable<br>1 – Enable                  |
| SmoothingEnabled        | Boolean | Smoothing enable state:<br>0 – Disable<br>1 – Enable                    |
| PreserveInvalidsEnabled | Boolean | Preserve invalid measurements enable state<br>0 – Disable<br>1 – Enable |
| SmoothingWindow         | 32u     | Smoothing window.                                                       |
| Scale                   | 64f     | Output scaling factor.                                                  |
| Offset                  | 64f     | Output offset factor.                                                   |
| DecisionMin             | 64f     | Minimum decision threshold.                                             |
| DecisionMax             | 64f     | Maximum decision threshold.                                             |

### ProfileBoundingBox

A ProfileBoundingBox element defines settings for a profile bounding box tool and one or more of its measurements.

#### ProfileBoundingBox Child Elements

| Element          | Type         | Description                                                                                         |
|------------------|--------------|-----------------------------------------------------------------------------------------------------|
| Name             | String       | Tool name.                                                                                          |
| Features         | Collection   | Collection of geometric feature outputs available in the tool. See <i>ProfileBoundingBox</i> above. |
| Source           | 32s          | Profile source.                                                                                     |
| Anchor\X         | String (CSV) | The X measurements (IDs) used for anchoring.                                                        |
| Anchor\X.options | String (CSV) | The X measurements (IDs) available for anchoring.                                                   |
| Anchor\Z         | String (CSV) | The Z measurements (IDs) used for anchoring.                                                        |
| Anchor\Z.options | String (CSV) | The Z measurements (IDs) available for anchoring.                                                   |
| StreamOptions    | Collection   | A collection of <i>StreamOptions</i> on page 342 elements.                                          |
| Stream\Step      | 32s          | The stream source step. Possible values are:<br>1 – Video                                           |

| Element                  | Type                             | Description                                                                              |
|--------------------------|----------------------------------|------------------------------------------------------------------------------------------|
|                          |                                  | 2 – Range<br>3 – Surface<br>4 – Section                                                  |
| Stream\ld                | 32u                              | The stream source ID.                                                                    |
| RegionEnabled            | Bool                             | Whether or not to use the region. If the region is disabled, all available data is used. |
| Region                   | <a href="#">ProfileRegion2d</a>  | Measurement region.                                                                      |
| Measurements\X           | Bounding Box tool measurement    | X measurement.                                                                           |
| Measurements\Z           | Bounding Box tool measurement    | Z measurement.                                                                           |
| Measurements\Width       | Bounding Box tool measurement    | Width measurement.                                                                       |
| Measurements\Height      | Bounding Box tool measurement    | Height measurement.                                                                      |
| Measurements\GlobalX     | Bounding Box tool measurement    | GlobalX measurement                                                                      |
| Measurements\GlobalY     | Bounding Box tool measurement    | GlobalY measurement                                                                      |
| Measurements\GlobalAngle | Bounding Box tool measurement    | GlobalAngle measurement                                                                  |
| Features\CenterPoint     | <a href="#">GeometricFeature</a> | CenterPoint PointFeature.                                                                |
| Features\CornerPoint     | GeometricFeature                 | CornerPoint PointFeature.                                                                |

#### *Bounding Box Tool Measurement*

| Element                 | Type    | Description                                                 |
|-------------------------|---------|-------------------------------------------------------------|
| @id                     | 32s     | Measurement ID. Optional (measurement disabled if not set). |
| Name                    | String  | Measurement name.                                           |
| Enabled                 | Boolean | Measurement enable state:<br>0 – Disable<br>1 – Enable      |
| HoldEnabled             | Boolean | Output hold enable state:<br>0 – Disable<br>1 – Enable      |
| SmoothingEnabled        | Boolean | Smoothing enable state:<br>0 – Disable<br>1 – Enable        |
| PreserveInvalidsEnabled | Boolean | Preserve invalid measurements enable state                  |



| Element         | Type | Description                 |
|-----------------|------|-----------------------------|
|                 |      | 0 – Disable<br>1 – Enable   |
| SmoothingWindow | 32u  | Smoothing window.           |
| Scale           | 64f  | Output scaling factor.      |
| Offset          | 64f  | Output offset factor.       |
| DecisionMin     | 64f  | Minimum decision threshold. |
| DecisionMax     | 64f  | Maximum decision threshold. |

## ProfileBridgeValue

A ProfileBridgeValue element defines settings for a profile bridge value tool and one or more of its measurements.

|                                                                                   |                                                             |
|-----------------------------------------------------------------------------------|-------------------------------------------------------------|
|  | This measurement is only available on Gocator 2342 sensors. |
|-----------------------------------------------------------------------------------|-------------------------------------------------------------|

### ProfileBridgeValue Child Elements

| Element          | Type                            | Description                                                                                                                                                                   |
|------------------|---------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Name             | String                          | Tool name.                                                                                                                                                                    |
| Features         | Collection                      | Not used.                                                                                                                                                                     |
| Source           | 32s                             | Profile source.                                                                                                                                                               |
| Anchor\X         | String (CSV)                    | The X measurements (IDs) used for anchoring.                                                                                                                                  |
| Anchor\X.options | String (CSV)                    | The X measurements (IDs) available for anchoring.                                                                                                                             |
| Anchor\Z         | String (CSV)                    | The Z measurements (IDs) used for anchoring.                                                                                                                                  |
| Anchor\Z.options | String (CSV)                    | The Z measurements (IDs) available for anchoring.                                                                                                                             |
| StreamOptions    | Collection                      | A collection of <i>StreamOptions</i> on page 342 elements.                                                                                                                    |
| Stream\Step      | 32s                             | The stream source step. Possible values are:<br>1 – Video<br>2 – Range<br>3 – Surface<br>4 – Section                                                                          |
| Stream\ld        | 32u                             | The stream source ID.                                                                                                                                                         |
| RegionEnabled    | Boolean                         | Whether or not to use region. If region is disabled, all available data is used.                                                                                              |
| Region           | <a href="#">ProfileRegion2d</a> | Measurement region.                                                                                                                                                           |
| WindowSize       | 64f                             | A percentage of the profile point heights when ordered from lowest to highest in a histogram, starting from the highest points, to include in the bridge value calculation.   |
| WindowSkip       | 64f                             | A percentage of the profile point heights when ordered from lowest to highest in a histogram, starting from the highest points, to exclude from the bridge value calculation. |

| Element                  | Type                          | Description                                                                                                        |
|--------------------------|-------------------------------|--------------------------------------------------------------------------------------------------------------------|
|                          |                               | Combines with WindowSize to determine what portion of the profile points are used in the bridge value calculation. |
| MaxInvalid               | 64f                           | The maximum percentage of invalid points.                                                                          |
| NormalizeEnabled         | Boolean                       | Whether tilt normalization is enabled.                                                                             |
| MaxDifferential          | 64f                           | Maximum differential between the lowest and highest profile points (mm).                                           |
| MaxDifferential.min      | 64f                           | Maximum differential limit min (mm).                                                                               |
| MaxDifferential.max      | 64f                           | Maximum differential limit max (mm).                                                                               |
| Measurements\BridgeValue | Bridge Value tool measurement | Bridge Value measurement.                                                                                          |
| Measurements\Angle       | Bridge Value tool measurement | Angle measurement.                                                                                                 |

#### *BridgeValue Tool Measurement*

| Element                 | Type    | Description                                                             |
|-------------------------|---------|-------------------------------------------------------------------------|
| @id                     | 32s     | Measurement ID. Optional (measurement disabled if not set).             |
| Name                    | String  | Measurement name.                                                       |
| Enabled                 | Boolean | Measurement enable state:<br>0 – Disable<br>1 – Enable                  |
| HoldEnabled             | Boolean | Output hold enable state:<br>0 – Disable<br>1 – Enable                  |
| SmoothingEnabled        | Boolean | Smoothing enable state:<br>0 – Disable<br>1 – Enable                    |
| PreserveInvalidsEnabled | Boolean | Preserve invalid measurements enable state<br>0 – Disable<br>1 – Enable |
| SmoothingWindow         | 32u     | Smoothing window.                                                       |
| Scale                   | 64f     | Output scaling factor.                                                  |
| Offset                  | 64f     | Output offset factor.                                                   |
| DecisionMin             | 64f     | Minimum decision threshold.                                             |
| DecisionMax             | 64f     | Maximum decision threshold.                                             |

## ProfileCircle

A ProfileCircle element defines settings for a profile circle tool and one or more of its measurements.

### ProfileCircle Child Elements

| Element              | Type                             | Description                                                                                          |
|----------------------|----------------------------------|------------------------------------------------------------------------------------------------------|
| Name                 | String                           | Tool name.                                                                                           |
| Features             | Collection                       | Collection of geometric feature outputs available in the tool. See <i>ProfileCircle</i> above.       |
| Source               | 32s                              | Profile source.                                                                                      |
| Anchor\X             | String (CSV)                     | The X measurements (IDs) used for anchoring.                                                         |
| Anchor\X.options     | String (CSV)                     | The X measurements (IDs) available for anchoring.                                                    |
| Anchor\Z             | String (CSV)                     | The Z measurements (IDs) used for anchoring.                                                         |
| Anchor\Z.options     | String (CSV)                     | The Z measurements (IDs) available for anchoring.                                                    |
| StreamOptions        | Collection                       | A collection of <i>StreamOptions</i> on page 342 elements.                                           |
| Stream\Step          | 32s                              | The stream source step. Possible values are:<br>1 – Video<br>2 – Range<br>3 – Surface<br>4 – Section |
| Stream\ld            | 32u                              | The stream source ID.                                                                                |
| RegionEnabled        | Bool                             | Whether or not to use the region. If the region is disabled, all available data is used.             |
| Region               | <a href="#">ProfileRegion2d</a>  | Measurement region.                                                                                  |
| Measurements\X       | Circle tool measurement          | X measurement.                                                                                       |
| Measurements\Z       | Circle tool measurement          | Z measurement.                                                                                       |
| Measurements\Radius  | Circle tool measurement          | Radius measurement.                                                                                  |
| Features\CenterPoint | <a href="#">GeometricFeature</a> | CenterPoint PointFeature.                                                                            |

### Circle Tool Measurement

| Element     | Type    | Description                                                 |
|-------------|---------|-------------------------------------------------------------|
| @id         | 32s     | Measurement ID. Optional (measurement disabled if not set). |
| Name        | String  | Measurement name.                                           |
| Enabled     | Boolean | Measurement enable state:<br>0 – Disable<br>1 – Enable      |
| HoldEnabled | Boolean | Output hold enable state:                                   |

| Element                 | Type    | Description                                                             |
|-------------------------|---------|-------------------------------------------------------------------------|
|                         |         | 0 – Disable<br>1 – Enable                                               |
| SmoothingEnabled        | Boolean | Smoothing enable state:<br>0 – Disable<br>1 – Enable                    |
| PreserveInvalidsEnabled | Boolean | Preserve invalid measurements enable state<br>0 – Disable<br>1 – Enable |
| SmoothingWindow         | 32u     | Smoothing window.                                                       |
| Scale                   | 64f     | Output scaling factor.                                                  |
| Offset                  | 64f     | Output offset factor.                                                   |
| DecisionMin             | 64f     | Minimum decision threshold.                                             |
| DecisionMax             | 64f     | Maximum decision threshold.                                             |

## ProfileDimension

A ProfileDimension element defines settings for a profile dimension tool and one or more of its measurements.

### *ProfileDimension Child Elements*

| Element            | Type                           | Description                                                                                          |
|--------------------|--------------------------------|------------------------------------------------------------------------------------------------------|
| Name               | String                         | Tool name.                                                                                           |
| Features           | Collection                     | Not used.                                                                                            |
| Source             | 32s                            | Profile source.                                                                                      |
| Anchor\X           | String (CSV)                   | The X measurements (IDs) used for anchoring.                                                         |
| Anchor\X.options   | String (CSV)                   | The X measurements (IDs) available for anchoring.                                                    |
| Anchor\Z           | String (CSV)                   | The Z measurements (IDs) used for anchoring.                                                         |
| Anchor\Z.options   | String (CSV)                   | The Z measurements (IDs) available for anchoring.                                                    |
| StreamOptions      | Collection                     | A collection of <i>StreamOptions</i> on page 342 elements.                                           |
| Stream\Step        | 32s                            | The stream source step. Possible values are:<br>1 – Video<br>2 – Range<br>3 – Surface<br>4 – Section |
| Stream\ld          | 32u                            | The stream source ID.                                                                                |
| RefFeature         | <a href="#">ProfileFeature</a> | Reference measurement region.                                                                        |
| Feature            | <a href="#">ProfileFeature</a> | Measurement region.                                                                                  |
| Measurements\Width | Dimension tool measurement     | Width measurement.                                                                                   |

| Element               | Type                       | Description           |
|-----------------------|----------------------------|-----------------------|
| Measurements\Height   | Dimension tool measurement | Height measurement.   |
| Measurements\Distance | Dimension tool measurement | Distance measurement. |
| Measurements\CenterX  | Dimension tool measurement | CenterX measurement.  |
| Measurements\CenterZ  | Dimension tool measurement | CenterZ measurement.  |

#### *Dimension Tool Measurement*

| Element                                             | Type    | Description                                                                    |
|-----------------------------------------------------|---------|--------------------------------------------------------------------------------|
| @id                                                 | 32s     | Measurement ID. Optional (measurement disabled if not set).                    |
| Name                                                | String  | Measurement name.                                                              |
| Enabled                                             | Boolean | Measurement enable state:<br>0 – Disable<br>1 – Enable                         |
| HoldEnabled                                         | Boolean | Output hold enable state:<br>0 – Disable<br>1 – Enable                         |
| SmoothingEnabled                                    | Boolean | Smoothing enable state:<br>0 – Disable<br>1 – Enable                           |
| PreserveInvalidsEnabled                             | Boolean | Preserve invalid measurements enable state<br>0 – Disable<br>1 – Enable        |
| SmoothingWindow                                     | 32u     | Smoothing window.                                                              |
| Scale                                               | 64f     | Output scaling factor.                                                         |
| Offset                                              | 64f     | Output offset factor.                                                          |
| DecisionMin                                         | 64f     | Minimum decision threshold.                                                    |
| DecisionMax                                         | 64f     | Maximum decision threshold.                                                    |
| Absolute<br>(Width and Height<br>measurements only) | Boolean | Setting for selecting absolute or signed result:<br>0 – Signed<br>1 – Absolute |

### **ProfileGroove**

A ProfileGroove element defines settings for a profile groove tool and one or more of its measurements.

The profile groove tool is dynamic, meaning that it can contain multiple measurements of the same type in the Measurements element.

### *ProfileGroove Child Elements*

| Element            | Type                            | Description                                                                                          |
|--------------------|---------------------------------|------------------------------------------------------------------------------------------------------|
| Name               | String                          | Tool name.                                                                                           |
| Features           | Collection                      | Not used.                                                                                            |
| Source             | 32s                             | Profile source.                                                                                      |
| Anchor\X           | String (CSV)                    | The X measurements (IDs) used for anchoring.                                                         |
| Anchor\X.options   | String (CSV)                    | The X measurements (IDs) available for anchoring.                                                    |
| Anchor\Z           | String (CSV)                    | The Z measurements (IDs) used for anchoring.                                                         |
| Anchor\Z.options   | String (CSV)                    | The Z measurements (IDs) available for anchoring.                                                    |
| StreamOptions      | Collection                      | A collection of <i>StreamOptions</i> on page 342 elements.                                           |
| Stream\Step        | 32s                             | The stream source step. Possible values are:<br>1 – Video<br>2 – Range<br>3 – Surface<br>4 – Section |
| Stream\ld          | 32u                             | The stream source ID.                                                                                |
| Shape              | 32s                             | Shape:<br>0 – U-shape<br>1 – V-shape<br>2 – Open                                                     |
| MinDepth           | 64f                             | Minimum depth.                                                                                       |
| MinWidth           | 64f                             | Minimum width.                                                                                       |
| MaxWidth           | 64f                             | Maximum width.                                                                                       |
| RegionEnabled      | Bool                            | Whether or not to use the region. If the region is disabled, all available data is used.             |
| Region             | <a href="#">ProfileRegion2d</a> | Measurement region.                                                                                  |
| Measurements\X     | Groove tool measurement         | X measurement.                                                                                       |
| Measurements\Z     | Groove tool measurement         | Z measurement.                                                                                       |
| Measurements\Width | Groove tool measurement         | Width measurement.                                                                                   |
| Measurements\Depth | Groove tool measurement         | Depth measurement.                                                                                   |

### *Groove Tool Measurement*

| Element | Type   | Description                                                 |
|---------|--------|-------------------------------------------------------------|
| @id     | 32s    | Measurement ID. Optional (measurement disabled if not set). |
| Name    | String | Measurement name.                                           |

| Element                                 | Type    | Description                                                                                                                         |
|-----------------------------------------|---------|-------------------------------------------------------------------------------------------------------------------------------------|
| Enabled                                 | Boolean | Measurement enable state:<br>0 – Disable<br>1 – Enable                                                                              |
| HoldEnabled                             | Boolean | Output hold enable state:<br>0 – Disable<br>1 – Enable                                                                              |
| SmoothingEnabled                        | Boolean | Smoothing enable state:<br>0 – Disable<br>1 – Enable                                                                                |
| PreserveInvalidsEnabled                 | Boolean | Preserve invalid measurements enable state<br>0 – Disable<br>1 – Enable                                                             |
| SmoothingWindow                         | 32u     | Smoothing window.                                                                                                                   |
| Scale                                   | 64f     | Output scaling factor.                                                                                                              |
| Offset                                  | 64f     | Output offset factor.                                                                                                               |
| DecisionMin                             | 64f     | Minimum decision threshold.                                                                                                         |
| DecisionMax                             | 64f     | Maximum decision threshold.                                                                                                         |
| SelectType                              | 32s     | Method of selecting a groove when multiple grooves are found:<br>0 – Max depth<br>1 – Ordinal, from left<br>2 – Ordinal, from right |
| SelectIndex                             | 32s     | Index when SelectType is set to 1 or 2.                                                                                             |
| Location<br>(X and Z measurements only) | 32s     | Setting for groove location to return from:<br>0 – Bottom<br>1 – Left corner<br>2 – Right corner                                    |

## ProfileIntersect

A ProfileIntersect element defines settings for a profile intersect tool and one or more of its measurements.

### ProfileIntersect Child Elements

| Element  | Type       | Description                                                                                          |
|----------|------------|------------------------------------------------------------------------------------------------------|
| Name     | String     | Tool name.                                                                                           |
| Features | Collection | Collection of geometric feature outputs available in the tool.<br>See <i>ProfileIntersect</i> above. |
| Source   | 32s        | Profile source.                                                                                      |

| Element                 | Type                             | Description                                                                                          |
|-------------------------|----------------------------------|------------------------------------------------------------------------------------------------------|
| Anchor\X                | String (CSV)                     | The X measurements (IDs) used for anchoring.                                                         |
| Anchor\X.options        | String (CSV)                     | The X measurements (IDs) available for anchoring.                                                    |
| Anchor\Z                | String (CSV)                     | The Z measurements (IDs) used for anchoring.                                                         |
| Anchor\Z.options        | String (CSV)                     | The Z measurements (IDs) available for anchoring.                                                    |
| RefType                 | 32s                              | Reference line type:<br>0 – Fit<br>1 – X Axis                                                        |
| StreamOptions           | Collection                       | A collection of <i>StreamOptions</i> on page 342 elements.                                           |
| Stream\Step             | 32s                              | The stream source step. Possible values are:<br>1 – Video<br>2 – Range<br>3 – Surface<br>4 – Section |
| Stream\ld               | 32u                              | The stream source ID.                                                                                |
| RefLine                 | <a href="#">ProfileLine</a>      | Definition of reference line. Ignored if RefType is not 0.                                           |
| Line                    | <a href="#">ProfileLine</a>      | Definition of line.                                                                                  |
| Measurements\X          | Intersect tool measurement       | X measurement.                                                                                       |
| Measurements\Z          | Intersect tool measurement       | Z measurement.                                                                                       |
| Measurements\Angle      | Intersect tool measurement       | Angle measurement.                                                                                   |
| Features\IntersectPoint | <a href="#">GeometricFeature</a> | IntersectPoint PointFeature.                                                                         |
| Features\Line           | GeometricFeature                 | Line LineFeature.                                                                                    |
| Features\BaseLine       | GeometricFeature                 | BaseLine LineFeature.                                                                                |

#### *Intersect Tool Measurement*

| Element          | Type    | Description                                                 |
|------------------|---------|-------------------------------------------------------------|
| @id              | 32s     | Measurement ID. Optional (measurement disabled if not set). |
| Name             | String  | Measurement name.                                           |
| Enabled          | Boolean | Measurement enable state:<br>0 – Disable<br>1 – Enable      |
| HoldEnabled      | Boolean | Output hold enable state:<br>0 – Disable<br>1 – Enable      |
| SmoothingEnabled | Boolean | Smoothing enable state:                                     |



| Element                              | Type    | Description                                                                                                                     |
|--------------------------------------|---------|---------------------------------------------------------------------------------------------------------------------------------|
|                                      |         | 0 – Disable<br>1 – Enable                                                                                                       |
| PreserveInvalidsEnabled              | Boolean | Preserve invalid measurements enable state<br>0 – Disable<br>1 – Enable                                                         |
| SmoothingWindow                      | 32u     | Smoothing window.                                                                                                               |
| Scale                                | 64f     | Output scaling factor.                                                                                                          |
| Offset                               | 64f     | Output offset factor.                                                                                                           |
| DecisionMin                          | 64f     | Minimum decision threshold.                                                                                                     |
| DecisionMax                          | 64f     | Maximum decision threshold.                                                                                                     |
| Absolute<br>(Angle measurement only) | Boolean | Setting for selecting the angle range:<br>0 – A range of -90 to 90 degrees is used.<br>1 – A range of 0 to 180 degrees is used. |

## ProfileLine

A ProfileLine element defines settings for a profile line tool and one or more of its measurements.

### ProfileLine Child Elements

| Element          | Type                            | Description                                                                                          |
|------------------|---------------------------------|------------------------------------------------------------------------------------------------------|
| Name             | String                          | Tool name.                                                                                           |
| Features         | Collection                      | Collection of geometric feature outputs available in the tool.<br>See <i>ProfileLine</i> above.      |
| Source           | 32s                             | Profile source.                                                                                      |
| Anchor\X         | String (CSV)                    | The X measurements (IDs) used for anchoring.                                                         |
| Anchor\X.options | String (CSV)                    | The X measurements (IDs) available for anchoring.                                                    |
| Anchor\Z         | String (CSV)                    | The Z measurements (IDs) used for anchoring.                                                         |
| Anchor\Z.options | String (CSV)                    | The Z measurements (IDs) available for anchoring.                                                    |
| StreamOptions    | Collection                      | A collection of <i>StreamOptions</i> on page 342 elements.                                           |
| Stream\Step      | 32s                             | The stream source step. Possible values are:<br>1 – Video<br>2 – Range<br>3 – Surface<br>4 – Section |
| Stream\ld        | 32u                             | The stream source ID.                                                                                |
| RegionEnabled    | Bool                            | Whether or not to use the region. If the region is disabled, all available data is used.             |
| Region           | <a href="#">ProfileRegion2d</a> | Measurement region.                                                                                  |
| FittingRegions   | <a href="#">ProfileLine</a>     | ProfileLine describing regions to fit to.                                                            |

| Element                 | Type                             | Description                              |
|-------------------------|----------------------------------|------------------------------------------|
| FittingRegionsEnabled   | Bool                             | Whether the fitting regions are enabled. |
| Measurements\StdDev     | Line tool measurement            | StdDev measurement.                      |
| Measurements\MaxError   | Line tool measurement            | MaxError measurement.                    |
| Measurements\MinError   | Line tool measurement            | MinError measurement.                    |
| Measurements\Percentile | Line tool measurement            | Percentile measurement.                  |
| Measurements\Offset     | Line tool measurement            | Offset measurement.                      |
| Measurements\Angle      | Line tool measurement            | Angle measurement.                       |
| Measurements\MinErrorX  | Line tool measurement            | Minimum Error in X measurement.          |
| Measurements\MinErrorZ  | Line tool measurement            | Minimum Error in Z measurement.          |
| Measurements\MaxErrorX  | Line tool measurement            | Maximum Error in X measurement.          |
| Measurements\MaxErrorZ  | Line tool measurement            | Maximum Error in Z measurement.          |
| Features\Line           | <a href="#">GeometricFeature</a> | Line LineFeature.                        |
| Features\ErrorMinPoint  | GeometricFeature                 | ErrorMinPoint PointFeature.              |
| Features\ErrorMaxPoint  | GeometricFeature                 | ErrorMaxPoint PointFeature.              |

#### *Line Tool Measurement*

| Element                 | Type    | Description                                                 |
|-------------------------|---------|-------------------------------------------------------------|
| @id                     | 32s     | Measurement ID. Optional (measurement disabled if not set). |
| Name                    | String  | Measurement name.                                           |
| Enabled                 | Boolean | Measurement enable state:<br>0 – Disable<br>1 – Enable      |
| HoldEnabled             | Boolean | Output hold enable state:<br>0 – Disable<br>1 – Enable      |
| SmoothingEnabled        | Boolean | Smoothing enable state:<br>0 – Disable<br>1 – Enable        |
| PreserveInvalidsEnabled | Boolean | Preserve invalid measurements enable state                  |

| Element         | Type | Description                 |
|-----------------|------|-----------------------------|
|                 |      | 0 – Disable<br>1 – Enable   |
| SmoothingWindow | 32u  | Smoothing window.           |
| Scale           | 64f  | Output scaling factor.      |
| Offset          | 64f  | Output offset factor.       |
| DecisionMin     | 64f  | Minimum decision threshold. |
| DecisionMax     | 64f  | Maximum decision threshold. |
| Percent         | 64f  | Error percentile.           |

(Percentile measurement only)

## ProfilePanel

A ProfilePanel element defines settings for a profile panel tool and one or more of its measurements.

### ProfilePanel Child Elements

| Element               | Type                                  | Description                                                                                          |
|-----------------------|---------------------------------------|------------------------------------------------------------------------------------------------------|
| Name                  | String                                | Tool name.                                                                                           |
| Features              | Collection                            | Not used.                                                                                            |
| Source                | 32s                                   | Profile source.                                                                                      |
| Anchor\X              | String (CSV)                          | The X measurements (IDs) used for anchoring.                                                         |
| Anchor\X.options      | String (CSV)                          | The X measurements (IDs) available for anchoring.                                                    |
| Anchor\Z              | String (CSV)                          | The Z measurements (IDs) used for anchoring.                                                         |
| Anchor\Z.options      | String (CSV)                          | The Z measurements (IDs) available for anchoring.                                                    |
| StreamOptions         | Collection                            | A collection of <i>StreamOptions</i> on page 342 elements.                                           |
| Stream\Step           | 32s                                   | The stream source step. Possible values are:<br>1 – Video<br>2 – Range<br>3 – Surface<br>4 – Section |
| Stream\ld             | 32u                                   | The stream source ID.                                                                                |
| RefSide               | 32s                                   | Setting for reference side to use.                                                                   |
| MaxGapWidth           | 64f                                   | Setting for maximum gap width (mm).                                                                  |
| LeftEdge              | <a href="#">ProfilePanelEdge</a>      | Element for left edge configuration.                                                                 |
| RightEdge             | <a href="#">ProfilePanelEdge</a>      | Element for right edge configuration.                                                                |
| Measurements\Gap      | <a href="#">Gap/Flush measurement</a> | Gap measurement.                                                                                     |
| Measurements\Flush    | Gap/Flush measurement                 | Flush measurement.                                                                                   |
| Measurements\LeftGapX | Gap/Flush                             | Left Gap X measurement.                                                                              |

| Element                        | Type                  | Description                      |
|--------------------------------|-----------------------|----------------------------------|
|                                | measurement           |                                  |
| Measurements\LeftGapZ          | Gap/Flush measurement | Left Gap Z measurement.          |
| Measurements\LeftFlushX        | Gap/Flush measurement | Left Flush X measurement.        |
| Measurements\LeftFlushZ        | Gap/Flush measurement | Left Flush Z measurement.        |
| Measurements\LeftSurfaceAngle  | Gap/Flush measurement | Left Surface Angle measurement.  |
| Measurements\RightGapX         | Gap/Flush measurement | Right Gap X measurement.         |
| Measurements\RightGapZ         | Gap/Flush measurement | Right Gap Z measurement.         |
| Measurements\RightFlushX       | Gap/Flush measurement | Right Flush X measurement.       |
| Measurements\RightFlushZ       | Gap/Flush measurement | Right Flush Z measurement.       |
| Measurements\RightSurfaceAngle | Gap/Flush measurement | Right Surface Angle measurement. |

#### *ProfilePanelEdge*

| Element       | Type                            | Description                                                                              |
|---------------|---------------------------------|------------------------------------------------------------------------------------------|
| EdgeType      | 32s                             | Edge type:<br>0 – Tangent<br>1 – Corner                                                  |
| MinDepth      | 64f                             | Minimum depth.                                                                           |
| MaxVoidWidth  | 64f                             | Maximum void width.                                                                      |
| SurfaceWidth  | 64f                             | Surface width.                                                                           |
| SurfaceOffset | 64f                             | Surface offset.                                                                          |
| NominalRadius | 64f                             | Nominal radius.                                                                          |
| EdgeAngle     | 64f                             | Edge angle.                                                                              |
| RegionEnabled | Bool                            | Whether or not to use the region. If the region is disabled, all available data is used. |
| Region        | <a href="#">ProfileRegion2d</a> | Edge region.                                                                             |

#### *Gap/Flush Measurement*

| Element | Type    | Description                                                 |
|---------|---------|-------------------------------------------------------------|
| @id     | 32s     | Measurement ID. Optional (measurement disabled if not set). |
| Name    | String  | Measurement name.                                           |
| Enabled | Boolean | Measurement enable state:                                   |

| Element                              | Type    | Description                                                                    |
|--------------------------------------|---------|--------------------------------------------------------------------------------|
|                                      |         | 0 – Disable<br>1 – Enable                                                      |
| HoldEnabled                          | Boolean | Output hold enable state:<br>0 – Disable<br>1 – Enable                         |
| SmoothingEnabled                     | Boolean | Smoothing enable state:<br>0 – Disable<br>1 – Enable                           |
| PreserveInvalidsEnabled              | Boolean | Preserve invalid measurements enable state<br>0 – Disable<br>1 – Enable        |
| SmoothingWindow                      | 32u     | Smoothing window.                                                              |
| Scale                                | 64f     | Output scaling factor.                                                         |
| Offset                               | 64f     | Output offset factor.                                                          |
| DecisionMin                          | 64f     | Minimum decision threshold.                                                    |
| DecisionMax                          | 64f     | Maximum decision threshold.                                                    |
| Axis<br>(Gap measurement only)       | 32s     | Measurement axis:<br>0 – Edge<br>1 – Surface<br>2 – Distance                   |
| Absolute<br>(Flush measurement only) | Boolean | Setting for selecting absolute or signed result:<br>0 – Signed<br>1 – Absolute |

## ProfilePosition

A ProfilePosition element defines settings for a profile position tool and one or more of its measurements.

### ProfilePosition Child Elements

| Element          | Type         | Description                                                                                         |
|------------------|--------------|-----------------------------------------------------------------------------------------------------|
| Name             | String       | Tool name.                                                                                          |
| Features         | Collection   | Collection of geometric feature outputs available in the tool.<br>See <i>ProfilePosition</i> above. |
| Source           | 32s          | Profile source.                                                                                     |
| Anchor\X         | String (CSV) | The X measurements (IDs) used for anchoring.                                                        |
| Anchor\X.options | String (CSV) | The X measurements (IDs) available for anchoring.                                                   |
| Anchor\Z         | String (CSV) | The Z measurements (IDs) used for anchoring.                                                        |
| Anchor\Z.options | String (CSV) | The Z measurements (IDs) available for anchoring.                                                   |

| Element        | Type                                                     | Description                                                                                          |
|----------------|----------------------------------------------------------|------------------------------------------------------------------------------------------------------|
| StreamOptions  | Collection                                               | A collection of <i>StreamOptions</i> on page 342 elements.                                           |
| Stream\Step    | 32s                                                      | The stream source step. Possible values are:<br>1 – Video<br>2 – Range<br>3 – Surface<br>4 – Section |
| Stream\ld      | 32u                                                      | The stream source ID.                                                                                |
| Feature        | <a href="#">ProfileFeature</a>                           | Element for feature detection.                                                                       |
| Measurements\X | Position tool measurement                                | X measurement.                                                                                       |
| Measurements\Z | Position tool measurement                                | Z measurement.                                                                                       |
| Features\Point | GeometricF<br><a href="#">FeatureTypes.htm</a><br>eature | Point PointFeature                                                                                   |

#### *Position Tool Measurement*

| Element                 | Type    | Description                                                             |
|-------------------------|---------|-------------------------------------------------------------------------|
| id (attribute)          | 32s     | Measurement ID. Optional (measurement disabled if not set).             |
| Name                    | String  | Measurement name.                                                       |
| Enabled                 | Boolean | Measurement enable state:<br>0 – Disable<br>1 – Enable                  |
| HoldEnabled             | Boolean | Output hold enable state:<br>0 – Disable<br>1 – Enable                  |
| SmoothingEnabled        | Boolean | Smoothing enable state:<br>0 – Disable<br>1 – Enable                    |
| PreserveInvalidsEnabled | Boolean | Preserve invalid measurements enable state<br>0 – Disable<br>1 – Enable |
| SmoothingWindow         | 32u     | Smoothing window.                                                       |
| Scale                   | 64f     | Output scaling factor.                                                  |
| Offset                  | 64f     | Output offset factor.                                                   |
| DecisionMin             | 64f     | Minimum decision threshold.                                             |
| DecisionMax             | 64f     | Maximum decision threshold.                                             |

## ProfileRoundCorner

A ProfileRoundCorner element defines settings for a profile round corner tool and one or more of its measurements.

### ProfileRoundCorner Child Elements

| Element            | Type                             | Description                                                                                          |
|--------------------|----------------------------------|------------------------------------------------------------------------------------------------------|
| Name               | String                           | Tool name.                                                                                           |
| Features           | Collection                       | Not used.                                                                                            |
| Source             | 32s                              | Profile source.                                                                                      |
| Anchor\X           | String (CSV)                     | The X measurements (IDs) used for anchoring.                                                         |
| Anchor\X.options   | String (CSV)                     | The X measurements (IDs) available for anchoring.                                                    |
| Anchor\Z           | String (CSV)                     | The Z measurements (IDs) used for anchoring.                                                         |
| Anchor\Z.options   | String (CSV)                     | The Z measurements (IDs) available for anchoring.                                                    |
| StreamOptions      | Collection                       | A collection of <i>StreamOptions</i> on page 342 elements.                                           |
| Stream\Step        | 32s                              | The stream source step. Possible values are:<br>1 – Video<br>2 – Range<br>3 – Surface<br>4 – Section |
| Stream\ld          | 32u                              | The stream source ID.                                                                                |
| RefDirection       | 32s                              | Setting for reference side to use:<br>0 – Left<br>1 – Right                                          |
| Edge               | <a href="#">ProfilePanelEdge</a> | Element for edge configuration                                                                       |
| Measurements\X     | Round Corner tool measurement    | X measurement.                                                                                       |
| Measurements\Z     | Round Corner tool measurement    | Z measurement.                                                                                       |
| Measurements\Angle | Round Corner tool measurement    | Angle measurement.                                                                                   |

### ProfilePanelEdge

| Element       | Type | Description                             |
|---------------|------|-----------------------------------------|
| EdgeType      | 32s  | Edge type:<br>0 – Tangent<br>1 – Corner |
| MinDepth      | 64f  | Minimum depth.                          |
| MaxVoidWidth  | 64f  | Maximum void width.                     |
| SurfaceWidth  | 64f  | Surface width.                          |
| SurfaceOffset | 64f  | Surface offset.                         |

| Element       | Type                            | Description                                                                              |
|---------------|---------------------------------|------------------------------------------------------------------------------------------|
| NominalRadius | 64f                             | Nominal radius.                                                                          |
| EdgeAngle     | 64f                             | Edge angle.                                                                              |
| RegionEnabled | Bool                            | Whether or not to use the region. If the region is disabled, all available data is used. |
| Region        | <a href="#">ProfileRegion2d</a> | Edge region.                                                                             |

#### *Round Corner Tool Measurement*

| Element                 | Type    | Description                                                             |
|-------------------------|---------|-------------------------------------------------------------------------|
| id (attribute)          | 32s     | Measurement ID. Optional (measurement disabled if not set).             |
| Name                    | String  | Measurement name.                                                       |
| Enabled                 | Boolean | Measurement enable state:<br>0 – Disable<br>1 – Enable                  |
| HoldEnabled             | Boolean | Output hold enable state:<br>0 – Disable<br>1 – Enable                  |
| PreserveInvalidsEnabled | Boolean | Preserve invalid measurements enable state<br>0 – Disable<br>1 – Enable |
| SmoothingEnabled        | Boolean | Smoothing enable state:<br>0 – Disable<br>1 – Enable                    |
| SmoothingWindow         | 32u     | Smoothing window.                                                       |
| Scale                   | 64f     | Output scaling factor.                                                  |
| Offset                  | 64f     | Output offset factor.                                                   |
| DecisionMin             | 64f     | Minimum decision threshold.                                             |
| DecisionMax             | 64f     | Maximum decision threshold.                                             |

### **ProfileStrip**

A ProfileStrip element defines settings for a profile strip tool and one or more of its measurements.

The profile strip tool is dynamic, meaning that it can contain multiple measurements of the same type in the Measurements element.

#### *ProfileStrip Child Elements*

| Element  | Type       | Description |
|----------|------------|-------------|
| Name     | String     | Tool name.  |
| Features | Collection | Not used.   |



| Element          | Type                            | Description                                                                                          |
|------------------|---------------------------------|------------------------------------------------------------------------------------------------------|
| Source           | 32s                             | Profile source.                                                                                      |
| Anchor\X         | String (CSV)                    | The X measurements (IDs) used for anchoring.                                                         |
| Anchor\X.options | String (CSV)                    | The X measurements (IDs) available for anchoring.                                                    |
| Anchor\Z         | String (CSV)                    | The Z measurements (IDs) used for anchoring.                                                         |
| Anchor\Z.options | String (CSV)                    | The Z measurements (IDs) available for anchoring.                                                    |
| StreamOptions    | Collection                      | A collection of <i>StreamOptions</i> on page 342 elements.                                           |
| Stream\Step      | 32s                             | The stream source step. Possible values are:<br>1 – Video<br>2 – Range<br>3 – Surface<br>4 – Section |
| Stream\ld        | 32u                             | The stream source ID.                                                                                |
| BaseType         | 32s                             | Setting for the strip type:<br>0 – None<br>1 – Flat                                                  |
| LeftEdge         | Bitmask                         | Setting for the left edge conditions:<br>1 – Raising<br>2 – Falling<br>4 – Data End<br>8 – Void      |
| RightEdge        | Bitmask                         | Setting for the right edge conditions:<br>1 – Raising<br>2 – Falling<br>4 – Data End<br>8 – Void     |
| TiltEnabled      | Boolean                         | Setting for tilt compensation:<br>0 – Disabled<br>1 – Enabled                                        |
| SupportWidth     | 64f                             | Support width of edge (mm).                                                                          |
| TransitionWidth  | 64f                             | Transition width of edge (mm).                                                                       |
| MinWidth         | 64f                             | Minimum strip width (mm).                                                                            |
| MinHeight        | 64f                             | Minimum strip height (mm).                                                                           |
| MaxVoidWidth     | 64f                             | Void max (mm).                                                                                       |
| Region           | <a href="#">ProfileRegion2d</a> | Region containing the strip.                                                                         |
| Measurements\X   | Strip tool measurement          | X measurement.                                                                                       |

| Element             | Type                   | Description        |
|---------------------|------------------------|--------------------|
| Measurements\Z      | Strip tool measurement | Z measurement.     |
| Measurements\Width  | Strip tool measurement | Width measurement. |
| Measurements\Height | Strip tool measurement | Width measurement. |

#### *Strip Tool Measurement*

| Element                                          | Type    | Description                                                                                                                    |
|--------------------------------------------------|---------|--------------------------------------------------------------------------------------------------------------------------------|
| @id                                              | 32s     | Measurement ID. Optional (measurement disabled if not set).                                                                    |
| Name                                             | String  | Measurement name.                                                                                                              |
| Enabled                                          | Boolean | Measurement enable state:<br>0 – Disable<br>1 – Enable                                                                         |
| HoldEnabled                                      | Boolean | Output hold enable state:<br>0 – Disable<br>1 – Enable                                                                         |
| SmoothingEnabled                                 | Boolean | Smoothing enable state:<br>0 – Disable<br>1 – Enable                                                                           |
| PreserveInvalidsEnabled                          | Boolean | Preserve invalid measurements enable state<br>0 – Disable<br>1 – Enable                                                        |
| SmoothingWindow                                  | 32u     | Smoothing window.                                                                                                              |
| Scale                                            | 64f     | Output scaling factor.                                                                                                         |
| Offset                                           | 64f     | Output offset factor.                                                                                                          |
| DecisionMin                                      | 64f     | Minimum decision threshold.                                                                                                    |
| DecisionMax                                      | 64f     | Maximum decision threshold.                                                                                                    |
| SelectType                                       | 32s     | Method of selecting a groove when multiple grooves are found:<br>0 – Best<br>1 – Ordinal, from left<br>2 – Ordinal, from right |
| SelectIndex                                      | 32s     | Index when SelectType is set to 1 or 2.                                                                                        |
| Location<br>(X, Z, and Height measurements only) | 32s     | Setting for groove location to return from:<br>0 – Left<br>1 – Right<br>2 – Center                                             |

## Script

A Script element defines settings for a script measurement.

### *Script Child Elements*

| Element             | Type         | Description                      |
|---------------------|--------------|----------------------------------|
| Name                | String       | Tool name.                       |
| Code                | String       | Script code.                     |
| Measurements\Output | (Collection) | Dynamic list of Output elements. |

### *Output*

| Element | Type   | Description                                                 |
|---------|--------|-------------------------------------------------------------|
| @id     | 32s    | Measurement ID. Optional (measurement disabled if not set). |
| Name    | String | Measurement name.                                           |

## SurfaceBoundingBox

A SurfaceBoundingBox element defines settings for a surface bounding box tool and one or more of its measurements.

### *SurfaceBoundingBox Child Elements*

| Element               | Type         | Description                                                                                          |
|-----------------------|--------------|------------------------------------------------------------------------------------------------------|
| Name                  | String       | Tool name.                                                                                           |
| Features              | Collection   | Collection of geometric feature outputs available in the tool. See <i>SurfaceBoundingBox</i> above.  |
| Source                | 32s          | Surface source.                                                                                      |
| Anchor\X              | String (CSV) | The X measurements (IDs) used for anchoring.                                                         |
| Anchor\X.options      | String (CSV) | The X measurements (IDs) available for anchoring.                                                    |
| Anchor\Y              | String (CSV) | The Y measurements (IDs) used for anchoring.                                                         |
| Anchor\Y.options      | String (CSV) | The Y measurements (IDs) available for anchoring.                                                    |
| Anchor\Z              | String (CSV) | The Z measurements (IDs) used for anchoring.                                                         |
| Anchor\Z.options      | String (CSV) | The Z measurements (IDs) available for anchoring.                                                    |
| Anchor\ZAngle         | String (CSV) | The Z Angle measurements (IDs) used for anchoring.                                                   |
| Anchor\ZAngle.options | String (CSV) | The Z measurements (IDs) available for anchoring.                                                    |
| StreamOptions         | Collection   | A collection of <i>StreamOptions</i> on page 342 elements.                                           |
| Stream\Step           | 32s          | The stream source step. Possible values are:<br>1 – Video<br>2 – Range<br>3 – Surface<br>4 – Section |
| Stream\ld             | 32u          | The stream source ID.                                                                                |
| ZRotationEnabled      | Boolean      | Setting to enable/disable rotation of bounding box                                                   |

| Element                   | Type                             | Description                                                                                                                                                                      |
|---------------------------|----------------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| AsymmetryDetectionType    | 32s                              | Determine whether to use asymmetry detection and if enabled, which dimension would be the basis of detection.<br>The possible values are:<br>0 – None<br>1 – Length<br>2 – Width |
| RegionEnabled             | Boolean                          | Setting to enable/disable region.                                                                                                                                                |
| Region                    | <a href="#">Region3D</a>         | Measurement region.                                                                                                                                                              |
| Measurements\X            | Bounding Box tool measurement    | X measurement.                                                                                                                                                                   |
| Measurements\Y            | Bounding Box tool measurement    | Y measurement.                                                                                                                                                                   |
| Measurements\Z            | Bounding Box tool measurement    | Z measurement.                                                                                                                                                                   |
| Measurements\Width        | Bounding Box tool measurement    | Width measurement.                                                                                                                                                               |
| Measurements\Length       | BoundingBoxMeasurement           | Length measurement                                                                                                                                                               |
| Measurements\Height       | Bounding Box tool measurement    | Height measurement.                                                                                                                                                              |
| Measurements\ZAngle       | Bounding Box tool measurement    | ZAngle measurement.                                                                                                                                                              |
| Measurements\GlobalX      | Bounding Box tool measurement    | Global X measurement.                                                                                                                                                            |
| Measurements\GlobalY      | Bounding Box tool measurement    | Global Y measurement.                                                                                                                                                            |
| Measurements\GlobalZAngle | Bounding Box tool measurement    | Global Z Angle measurement.                                                                                                                                                      |
| Features\CenterPoint      | <a href="#">GeometricFeature</a> | CenterPoint PointFeature                                                                                                                                                         |

#### *Bounding Box Tool Measurement*

| Element        | Type    | Description                                                 |
|----------------|---------|-------------------------------------------------------------|
| id (attribute) | 32s     | Measurement ID. Optional (measurement disabled if not set). |
| Name           | String  | Measurement name.                                           |
| Enabled        | Boolean | Measurement enable state:<br>0 – Disable<br>1 – Enable      |
| HoldEnabled    | Boolean | Output hold enable state:<br>0 – Disable                    |

| Element                 | Type    | Description                                                             |
|-------------------------|---------|-------------------------------------------------------------------------|
|                         |         | 1 – Enable                                                              |
| SmoothingEnabled        | Boolean | Smoothing enable state:<br>0 – Disable<br>1 – Enable                    |
| PreserveInvalidsEnabled | Boolean | Preserve invalid measurements enable state<br>0 – Disable<br>1 – Enable |
| SmoothingWindow         | 32u     | Smoothing window.                                                       |
| Scale                   | 64f     | Output scaling factor.                                                  |
| Offset                  | 64f     | Output offset factor.                                                   |
| DecisionMin             | 64f     | Minimum decision threshold.                                             |
| DecisionMax             | 64f     | Maximum decision threshold.                                             |

## SurfaceCsHole

A SurfaceCsHole element defines settings for a surface countersunk hole tool and one or more of its measurements.

### SurfaceCsHole Child Elements

| Element               | Type         | Description                                                                                          |
|-----------------------|--------------|------------------------------------------------------------------------------------------------------|
| Name                  | String       | Tool name.                                                                                           |
| Features              | Collection   | Collection of geometric feature outputs available in the tool.<br>See <i>SurfaceCsHole</i> above.    |
| Source                | 32s          | Surface source.                                                                                      |
| Anchor\X              | String (CSV) | The X measurements (IDs) used for anchoring.                                                         |
| Anchor\X.options      | String (CSV) | The X measurements (IDs) available for anchoring.                                                    |
| Anchor\Y              | String (CSV) | The Y measurements (IDs) used for anchoring.                                                         |
| Anchor\Y.options      | String (CSV) | The Y measurements (IDs) available for anchoring.                                                    |
| Anchor\Z              | String (CSV) | The Z measurements (IDs) used for anchoring.                                                         |
| Anchor\Z.options      | String (CSV) | The Z measurements (IDs) available for anchoring.                                                    |
| Anchor\ZAngle         | String (CSV) | The Z Angle measurements (IDs) used for anchoring.                                                   |
| Anchor\ZAngle.options | String (CSV) | The Z measurements (IDs) available for anchoring.                                                    |
| StreamOptions         | Collection   | A collection of <i>StreamOptions</i> on page 342 elements.                                           |
| Stream\Step           | 32s          | The stream source step. Possible values are:<br>1 – Video<br>2 – Range<br>3 – Surface<br>4 – Section |
| Stream\ld             | 32u          | The stream source ID.                                                                                |

| Element                  | Type                              | Description                                                               |
|--------------------------|-----------------------------------|---------------------------------------------------------------------------|
| NominalBevelAngle        | 64f                               | Nominal bevel angle (mm).                                                 |
| NominalOuterRadius       | 64f                               | Nominal outer radius (mm).                                                |
| NominalInnerRadius       | 64f                               | Nominal inner radius (mm).                                                |
| BevelRadiusOffset        | 64f                               | Bevel radius offset (mm).                                                 |
| Shape                    | 32s                               | The shape of the countersunk hole:<br>0 – Cone<br>1 – Counterbore         |
| PartialDetectionEnabled  | Boolean                           | Setting to enable/disable partial detection:<br>0 – Disable<br>1 – Enable |
| RegionEnabled            | Boolean                           | Setting to enable/disable region:<br>0 – Disable<br>1 – Enable            |
| Region                   | <a href="#">Region3D</a>          | Measurement region.                                                       |
| RefRegionsEnabled        | Boolean                           | Setting to enable/disable reference regions:<br>0 – Disable<br>1 – Enable |
| RefRegionCount           | 32s                               | Count of the reference regions which are to be used                       |
| RefRegions               | (Collection)                      | Reference regions. Contains 2 <a href="#">SurfaceRegion2D</a> elements.   |
| AutoTiltEnabled          | Boolean                           | Setting to enable/disable tilt correction:<br>0 – Disable<br>1 – Enable   |
| TiltXAngle               | 64f                               | Setting for manual tilt correction angle X.                               |
| TiltYAngle               | 64f                               | Setting for manual tilt correction angle Y.                               |
| CurveFitEnabled          | Boolean                           | Setting to enable/disable curve fitting:<br>0 – Disable<br>1 – Enable     |
| CurveOrientation         | 64f                               | The orientation of the curvature, in degrees.                             |
| PlaneFitRangeEnabled     | Boolean                           | Setting to enable/disable the use of the plane fit range                  |
| PlaneFitRange            | 64f                               | Setting for the tolerance to use when doing the plane fit                 |
| Measurements\X           | Countersunk Hole tool measurement | X measurement.                                                            |
| Measurements\Y           | Countersunk Hole tool measurement | Y measurement.                                                            |
| Measurements\Z           | Countersunk Hole tool measurement | Z measurement.                                                            |
| Measurements\OuterRadius | Countersunk Hole tool             | Outer Radius measurement.                                                 |

| Element                       | Type                              | Description                   |
|-------------------------------|-----------------------------------|-------------------------------|
|                               | measurement                       |                               |
| Measurements\Depth            | Countersunk Hole tool measurement | Depth measurement.            |
| Measurements\BevelRadius      | Countersunk Hole tool measurement | Bevel Radius measurement.     |
| Measurements\BevelAngle       | Countersunk Hole tool measurement | Bevel Angle measurement.      |
| Measurements\XAngle           | Countersunk Hole tool measurement | X Angle measurement.          |
| Measurements\YAngle           | Countersunk Hole tool measurement | Y Angle measurement.          |
| Measurements\CounterboreDepth | Countersunk Hole tool measurement | CounterboreDepth measurement. |
| Features\CenterPoint          | <a href="#">GeometricFeature</a>  | CenterPoint PointFeature      |

#### *Countersunk Hole Tool Measurement*

| Element                 | Type       | Description                                                                                          |
|-------------------------|------------|------------------------------------------------------------------------------------------------------|
| id (attribute)          | 32s        | Measurement ID. Optional (measurement disabled if not set).                                          |
| Name                    | String     | Measurement name.                                                                                    |
| Features                | Collection | Collection of geometric feature outputs available in the tool. See <i>SurfaceCsHole</i> on page 370. |
| Enabled                 | Boolean    | Measurement enable state:<br>0 – Disable<br>1 – Enable                                               |
| HoldEnabled             | Boolean    | Output hold enable state:<br>0 – Disable<br>1 – Enable                                               |
| SmoothingEnabled        | Boolean    | Smoothing enable state:<br>0 – Disable<br>1 – Enable                                                 |
| PreserveInvalidsEnabled | Boolean    | Preserve invalid measurements enable state<br>0 – Disable<br>1 – Enable                              |
| SmoothingWindow         | 32u        | Smoothing window.                                                                                    |
| Scale                   | 64f        | Output scaling factor.                                                                               |
| Offset                  | 64f        | Output offset factor.                                                                                |
| DecisionMin             | 64f        | Minimum decision threshold.                                                                          |
| DecisionMax             | 64f        | Maximum decision threshold.                                                                          |

## SurfaceDimension

A SurfaceDimension element defines settings for a surface dimension tool and one or more of its measurements.

### *SurfaceDimension Child Elements*

| Element                    | Type                       | Description                                                                                          |
|----------------------------|----------------------------|------------------------------------------------------------------------------------------------------|
| Name                       | String                     | Tool name.                                                                                           |
| Features                   | Collection                 | Not used.                                                                                            |
| Source                     | 32s                        | Surface source.                                                                                      |
| Anchor\X                   | String (CSV)               | The X measurements (IDs) used for anchoring.                                                         |
| Anchor\X.options           | String (CSV)               | The X measurements (IDs) available for anchoring.                                                    |
| Anchor\Y                   | String (CSV)               | The Y measurements (IDs) used for anchoring.                                                         |
| Anchor\Y.options           | String (CSV)               | The Y measurements (IDs) available for anchoring.                                                    |
| Anchor\Z                   | String (CSV)               | The Z measurements (IDs) used for anchoring.                                                         |
| Anchor\Z.options           | String (CSV)               | The Z measurements (IDs) available for anchoring.                                                    |
| Anchor\ZAngle              | String (CSV)               | The Z Angle measurements (IDs) used for anchoring.                                                   |
| Anchor\ZAngle.options      | String (CSV)               | The Z measurements (IDs) available for anchoring.                                                    |
| StreamOptions              | Collection                 | A collection of <i>StreamOptions</i> on page 342 elements.                                           |
| Stream\Step                | 32s                        | The stream source step. Possible values are:<br>1 – Video<br>2 – Range<br>3 – Surface<br>4 – Section |
| Stream\ld                  | 32u                        | The stream source ID.                                                                                |
| Measurements\CenterX       | Dimension tool measurement | Center X measurement                                                                                 |
| Measurements\CenterY       | Dimension tool measurement | Center Y measurement                                                                                 |
| Measurements\CenterZ       | Dimension tool measurement | Center Z measurement                                                                                 |
| Measurements\Distance      | Dimension tool measurement | Distance measurement                                                                                 |
| Measurements\PlaneDistance | Dimension tool measurement | Plane Distance measurement                                                                           |
| Measurements\Height        | Dimension tool measurement | Height measurement                                                                                   |
| Measurements\Length        | Dimension tool measurement | Length measurement                                                                                   |
| Measurements\Width         | Dimension tool measurement | Width measurement                                                                                    |



### *Dimension Tool Measurement*

| Element                                                      | Type    | Description                                                                    |
|--------------------------------------------------------------|---------|--------------------------------------------------------------------------------|
| @id                                                          | 32s     | Measurement ID. Optional (measurement disabled if not set).                    |
| Name                                                         | String  | Measurement name.                                                              |
| Enabled                                                      | Boolean | Measurement enable state:<br>0 – Disable<br>1 – Enable                         |
| HoldEnabled                                                  | Boolean | Output hold enable state:<br>0 – Disable<br>1 – Enable                         |
| SmoothingEnabled                                             | Boolean | Smoothing enable state:<br>0 – Disable<br>1 – Enable                           |
| PreserveInvalidsEnabled                                      | Boolean | Preserve invalid measurements enable state<br>0 – Disable<br>1 – Enable        |
| SmoothingWindow                                              | 32u     | Smoothing window.                                                              |
| Scale                                                        | 64f     | Output scaling factor.                                                         |
| Offset                                                       | 64f     | Output offset factor.                                                          |
| DecisionMin                                                  | 64f     | Minimum decision threshold.                                                    |
| DecisionMax                                                  | 64f     | Maximum decision threshold.                                                    |
| Absolute<br>(Height, Length, and Width<br>measurements only) | Boolean | Setting for selecting absolute or signed result.<br>0 – Signed<br>1 – Absolute |

### **Tool**

A Tool element of type SurfaceEdge defines settings for a surface edge tool and one or more of its measurements.

### *SurfaceEdge Child Elements*

| Element          | Type         | Description                                       |
|------------------|--------------|---------------------------------------------------|
| @type            | String       | Type name of the tool.                            |
| @version         | String       | Version string for custom tool.                   |
| Name             | String       | Tool name.                                        |
| Source           | 32s          | Surface source.                                   |
| Anchor\X         | String (CSV) | The X measurements (IDs) used for anchoring.      |
| Anchor\X.options | String (CSV) | The X measurements (IDs) available for anchoring. |
| Anchor\Y         | String (CSV) | The Y measurements (IDs) used for anchoring.      |

| Element                           | Type                                    | Description                                                          |
|-----------------------------------|-----------------------------------------|----------------------------------------------------------------------|
| Anchor\Y.options                  | String (CSV)                            | The Y measurements (IDs) available for anchoring.                    |
| Anchor\Z                          | String (CSV)                            | The Z measurements (IDs) used for anchoring.                         |
| Anchor\Z.options                  | String (CSV)                            | The Z measurements (IDs) available for anchoring.                    |
| Parameters\Region                 | <a href="#">GdkParamSurfaceRegion3d</a> | Region Parameter.                                                    |
| Parameters\PathCount              | <a href="#">GdkParamInt</a>             | Number of paths.                                                     |
| Parameters\PathWidth              | <a href="#">GdkParamFloat</a>           | Path width.                                                          |
| Parameters\PathWidth.units        | String                                  | Units of path width (eg: mm).                                        |
| Parameters\SelectEdge             | GdkParamInt                             | Edge selection type. Is either:<br>0 – Best<br>1 – First<br>2 – Last |
| Parameters\EdgeDirection          | GdkParamInt                             | Edge direction type. Is either:<br>0 – Rising<br>1 – Falling         |
| Parameters\EdgeThreshold          | GdkParamFloat                           | Edge threshold value.                                                |
| Parameters\EdgeThreshold.units    | String                                  | Units of edge threshold (eg: mm).                                    |
| Parameters\IntensityThreshold     | GdkParamFloat                           | Intensity threshold value.                                           |
| Parameters\EdgeSmoothing          | GdkParamFloat                           | Edge smoothing value.                                                |
| Parameters\EdgeSmoothing.units    | String                                  | Units of edge smoothing (eg: mm).                                    |
| Parameters\EdgeMaxGap             | GdkParamFloat                           | Edge max gap value.                                                  |
| Parameters\EdgeMaxGap.units       | String                                  | Units of edge max gap (eg: mm).                                      |
| Parameters\FillBackground         | <a href="#">GdkParamBool</a>            | Fill background boolean                                              |
| Parameters\FillValue              | GdkParamFloat                           | Fill value value.                                                    |
| Parameters\FillValue.units        | String                                  | Units of fill value (eg: mm).                                        |
| Parameters\IntensityFillValue     | GdkParamFloat                           | Intensity fill value value.                                          |
| Parameters\IntensityFillValue.min | 8u                                      | Intensity fill value minimum value.                                  |
| Parameters\IntensityFillValue.max | 8u                                      | Intensity fill value maximum value.                                  |
| Parameters\FillValue.units        | String                                  | Units of fill value (eg: mm).                                        |
| Parameters\RenderDetail           | GdkParamBool                            | Render detail Boolean.                                               |
| Measurements\Measurement@type=X   | <a href="#">Edge Measurement</a>        | Base X measurement.                                                  |
| Measurements\Measurement          | Edge Measurement                        | Base Y measurement.                                                  |

| Element                                  | Type                        | Description                                                             |
|------------------------------------------|-----------------------------|-------------------------------------------------------------------------|
| @type=Y                                  |                             |                                                                         |
| Measurements\Measurement<br>@type=Z      | Edge Measurement            | Base Z measurement.                                                     |
| Measurements\Measurement<br>@type=ZAngle | Edge Measurement            | Base ZAngle measurement.                                                |
| Measurements\Measurement<br>@type=Height | Edge Measurement            | Base Height measurement.                                                |
| Features\Feature<br>@type=EdgeLine       | <a href="#">Gdk Feature</a> | EdgeLine line feature.                                                  |
| Features\Feature<br>@type=CenterPoint    | Gdk Feature                 | CenterPoint point feature.                                              |
| <b>Edge Measurement Child Elements</b>   |                             |                                                                         |
| @id                                      | 32s                         | Measurement ID. Optional (measurement disabled if not set).             |
| @type                                    | String                      | Type name of measurement.                                               |
| Name                                     | String                      | Measurement name.                                                       |
| Enabled                                  | Boolean                     | Measurement enable state:<br>0 – Disable<br>1 – Enable                  |
| HoldEnabled                              | Boolean                     | Output hold enable state:<br>0 – Disable<br>1 – Enable                  |
| SmoothingEnabled                         | Boolean                     | Smoothing enable state:<br>0 – Disable<br>1 – Enable                    |
| PreserveInvalidsEnabled                  | Boolean                     | Preserve invalid measurements enable state<br>0 – Disable<br>1 – Enable |
| SmoothingWindow                          | 32u                         | Smoothing window.                                                       |
| Scale                                    | 64f                         | Output scaling factor.                                                  |
| Offset                                   | 64f                         | Output offset factor.                                                   |
| DecisionMin                              | 64f                         | Minimum decision threshold.                                             |
| DecisionMax                              | 64f                         | Maximum decision threshold.                                             |

## SurfaceEllipse

A SurfaceEllipse element defines settings for a surface ellipse tool and one or more of its measurements.

### *SurfaceEllipse Child Elements*

| Element                | Type                             | Description                                                                                                                                                                  |
|------------------------|----------------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Name                   | String                           | Tool name.                                                                                                                                                                   |
| Features               | Collection                       | Collection of geometric feature outputs available in the tool. See <i>SurfaceEllipse</i> on the previous page.                                                               |
| Source                 | 32s                              | Surface source.                                                                                                                                                              |
| Anchor\X               | String (CSV)                     | The X measurements (IDs) used for anchoring.                                                                                                                                 |
| Anchor\X.options       | String (CSV)                     | The X measurements (IDs) available for anchoring.                                                                                                                            |
| Anchor\Y               | String (CSV)                     | The Y measurements (IDs) used for anchoring.                                                                                                                                 |
| Anchor\Y.options       | String (CSV)                     | The Y measurements (IDs) available for anchoring.                                                                                                                            |
| Anchor\Z               | String (CSV)                     | The Z measurements (IDs) used for anchoring.                                                                                                                                 |
| Anchor\Z.options       | String (CSV)                     | The Z measurements (IDs) available for anchoring.                                                                                                                            |
| Anchor\ZAngle          | String (CSV)                     | The Z Angle measurements (IDs) used for anchoring.                                                                                                                           |
| Anchor\ZAngle.options  | String (CSV)                     | The Z measurements (IDs) available for anchoring.                                                                                                                            |
| StreamOptions          | Collection                       | A collection of <i>StreamOptions</i> on page 342 elements.                                                                                                                   |
| Stream\Step            | 32s                              | The stream source step. Possible values are:<br>1 – Video<br>2 – Range<br>3 – Surface<br>4 – Section                                                                         |
| Stream\ld              | 32u                              | The stream source ID.                                                                                                                                                        |
| RegionEnabled          | Boolean                          | Setting to enable/disable region.                                                                                                                                            |
| Region                 | <a href="#">Region3D</a>         | Measurement region.                                                                                                                                                          |
| AsymmetryDetectionType | 32s                              | Determine whether to use asymmetry detection and if enabled, which dimension would be the basis of detection. The possible values are:<br>0 – None<br>1 – Major<br>2 – Minor |
| Measurements\Major     | Ellipse tool measurement         | Major measurement.                                                                                                                                                           |
| Measurements\Minor     | Ellipse tool measurement         | Minor measurement.                                                                                                                                                           |
| Measurements\Ratio     | Ellipse tool measurement         | Ratio measurement.                                                                                                                                                           |
| Measurements\ZAngle    | Ellipse tool measurement         | ZAngle measurement.                                                                                                                                                          |
| Features\CenterPoint   | <a href="#">GeometricFeature</a> | CenterPoint PointFeature                                                                                                                                                     |
| Features\MajorAxisLine | GeometricFeature                 | MajorAxisLine LineFeature                                                                                                                                                    |
| Features\MinroAxisLine | GeometricFeature                 | MinorAxisLine LineFeature                                                                                                                                                    |

### *Ellipse Tool Measurement*

| Element                 | Type    | Description                                                             |
|-------------------------|---------|-------------------------------------------------------------------------|
| @id                     | 32s     | Measurement ID. Optional (measurement disabled if not set).             |
| Name                    | String  | Measurement name.                                                       |
| Enabled                 | Boolean | Measurement enable state:<br>0 – Disable<br>1 – Enable                  |
| HoldEnabled             | Boolean | Output hold enable state:<br>0 – Disable<br>1 – Enable                  |
| SmoothingEnabled        | Boolean | Smoothing enable state:<br>0 – Disable<br>1 – Enable                    |
| PreserveInvalidsEnabled | Boolean | Preserve invalid measurements enable state<br>0 – Disable<br>1 – Enable |
| SmoothingWindow         | 32u     | Smoothing window.                                                       |
| Scale                   | 64f     | Output scaling factor.                                                  |
| Offset                  | 64f     | Output offset factor.                                                   |
| DecisionMin             | 64f     | Minimum decision threshold.                                             |
| DecisionMax             | 64f     | Maximum decision threshold.                                             |

### **SurfaceHole**

A SurfaceHole element defines settings for a surface hole tool and one or more of its measurements.

#### *SurfaceHole Child Elements*

| Element          | Type         | Description                                                                                  |
|------------------|--------------|----------------------------------------------------------------------------------------------|
| Name             | String       | Tool name.                                                                                   |
| Features         | Collection   | Collection of geometric feature outputs available in the tool. See <i>SurfaceHole</i> above. |
| Source           | 32s          | Surface source.                                                                              |
| Anchor\X         | String (CSV) | The X measurements (IDs) used for anchoring.                                                 |
| Anchor\X.options | String (CSV) | The X measurements (IDs) available for anchoring.                                            |
| Anchor\Y         | String (CSV) | The Y measurements (IDs) used for anchoring.                                                 |
| Anchor\Y.options | String (CSV) | The Y measurements (IDs) available for anchoring.                                            |
| Anchor\Z         | String (CSV) | The Z measurements (IDs) used for anchoring.                                                 |
| Anchor\Z.options | String (CSV) | The Z measurements (IDs) available for anchoring.                                            |
| Anchor\ZAngle    | String (CSV) | The Z Angle measurements (IDs) used for anchoring.                                           |

| Element                 | Type                     | Description                                                                                          |
|-------------------------|--------------------------|------------------------------------------------------------------------------------------------------|
| Anchor\ZAngle.options   | String (CSV)             | The Z measurements (IDs) available for anchoring.                                                    |
| StreamOptions           | Collection               | A collection of <i>StreamOptions</i> on page 342 elements.                                           |
| Stream\Step             | 32s                      | The stream source step. Possible values are:<br>1 – Video<br>2 – Range<br>3 – Surface<br>4 – Section |
| Stream\ld               | 32u                      | The stream source ID.                                                                                |
| NominalRadius           | 64f                      | Nominal radius (mm).                                                                                 |
| RadiusTolerance         | 64f                      | Radius tolerance (mm).                                                                               |
| PartialDetectionEnabled | Boolean                  | Setting to enable/disable partial detection:<br>0 – Disable<br>1 – Enable                            |
| DepthLimitEnabled       | Boolean                  | Setting to enable/disable depth limit:<br>0 – Disable<br>1 – Enable                                  |
| DepthLimit              | 64f                      | The depth limit relative to the surface. Data below this limit is ignored.                           |
| RegionEnabled           | Boolean                  | Setting to enable/disable region:<br>0 – Disable<br>1 – Enable                                       |
| Region                  | <a href="#">Region3D</a> | Measurement region.                                                                                  |
| RefRegionsEnabled       | Boolean                  | Setting to enable/disable reference regions:<br>0 – Disable<br>1 – Enable                            |
| RefRegionCount          | 32s                      | Count of the reference regions that are to be used.                                                  |
| RefRegions              | (Collection)             | Reference regions. Contains two RefRegion elements of type <a href="#">SurfaceRegion2D</a> .         |
| AutoTiltEnabled         | Boolean                  | Setting to enable/disable tilt correction:<br>0 – Disable<br>1 – Enable                              |
| TiltXAngle              | 64f                      | Setting for manual tilt correction angle X.                                                          |
| TiltYAngle              | 64f                      | Setting for manual tilt correction angle Y.                                                          |
| Measurements\X          | Hole tool measurement    | X measurement.                                                                                       |
| Measurements\Y          | Hole tool measurement    | Y measurement.                                                                                       |

| Element              | Type                             | Description              |
|----------------------|----------------------------------|--------------------------|
| Measurements\Z       | Hole tool measurement            | Z measurement.           |
| Measurements\Radius  | Hole tool measurement            | Radius measurement.      |
| Features\CenterPoint | <a href="#">GeometricFeature</a> | CenterPoint PointFeature |

#### *Hole Tool Measurement*

| Element                 | Type    | Description                                                             |
|-------------------------|---------|-------------------------------------------------------------------------|
| @id                     | 32s     | Measurement ID. Optional (measurement disabled if not set).             |
| Name                    | String  | Measurement name.                                                       |
| Enabled                 | Boolean | Measurement enable state:<br>0 – Disable<br>1 – Enable                  |
| HoldEnabled             | Boolean | Output hold enable state:<br>0 – Disable<br>1 – Enable                  |
| SmoothingEnabled        | Boolean | Smoothing enable state:<br>0 – Disable<br>1 – Enable                    |
| PreserveInvalidsEnabled | Boolean | Preserve invalid measurements enable state<br>0 – Disable<br>1 – Enable |
| SmoothingWindow         | 32u     | Smoothing window.                                                       |
| Scale                   | 64f     | Output scaling factor.                                                  |
| Offset                  | 64f     | Output offset factor.                                                   |
| DecisionMin             | 64f     | Minimum decision threshold.                                             |
| DecisionMax             | 64f     | Maximum decision threshold.                                             |

### **SurfaceOpening**

A SurfaceOpening element defines settings for a surface opening tool and one or more of its measurements.

#### *SurfaceOpening Child Elements*

| Element  | Type       | Description                                                                                     |
|----------|------------|-------------------------------------------------------------------------------------------------|
| Name     | String     | Tool name.                                                                                      |
| Features | Collection | Collection of geometric feature outputs available in the tool. See <i>SurfaceOpening</i> above. |
| Source   | 32s        | Surface source.                                                                                 |

| Element                 | Type         | Description                                                                                          |
|-------------------------|--------------|------------------------------------------------------------------------------------------------------|
| Anchor\X                | String (CSV) | The X measurements (IDs) used for anchoring.                                                         |
| Anchor\X.options        | String (CSV) | The X measurements (IDs) available for anchoring.                                                    |
| Anchor\Y                | String (CSV) | The Y measurements (IDs) used for anchoring.                                                         |
| Anchor\Y.options        | String (CSV) | The Y measurements (IDs) available for anchoring.                                                    |
| Anchor\Z                | String (CSV) | The Z measurements (IDs) used for anchoring.                                                         |
| Anchor\Z.options        | String (CSV) | The Z measurements (IDs) available for anchoring.                                                    |
| Anchor\ZAngle           | String (CSV) | The Z Angle measurements (IDs) used for anchoring.                                                   |
| Anchor\ZAngle.options   | String (CSV) | The Z measurements (IDs) available for anchoring.                                                    |
| StreamOptions           | Collection   | A collection of <i>StreamOptions</i> on page 342 elements.                                           |
| Stream\Step             | 32s          | The stream source step. Possible values are:<br>1 – Video<br>2 – Range<br>3 – Surface<br>4 – Section |
| Stream\ld               | 32u          | The stream source ID.                                                                                |
| Type                    | 32s          | Type of the opening:<br>0 – Rounded<br>1 – Slot                                                      |
| NominalWidth            | 64f          | Nominal width (mm).                                                                                  |
| NominalLength           | 64f          | Nominal length (mm).                                                                                 |
| NominalAngle            | 64f          | Nominal angle (degrees).                                                                             |
| NominalRadius           | 64f          | Nominal radius (mm).                                                                                 |
| WidthTolerance          | 64f          | Radius tolerance (mm).                                                                               |
| LengthTolerance         | 64f          | Length tolerance (mm).                                                                               |
| AngleTolerance          | 64f          | Angle tolerance (degrees).                                                                           |
| PartialDetectionEnabled | Boolean      | Setting to enable/disable partial detection:<br>0 – Disable<br>1 – Enable                            |
| DepthLimitEnabled       | Boolean      | Setting to enable/disable depth limit:<br>0 – Disable<br>1 – Enable                                  |
| DepthLimit              | 64f          | The depth limit relative to the surface. Data below this limit is ignored.                           |
| RegionEnabled           | Boolean      | Setting to enable/disable region:<br>0 – Disable<br>1 – Enable                                       |



| Element              | Type                             | Description                                                                                  |
|----------------------|----------------------------------|----------------------------------------------------------------------------------------------|
| Region               | <a href="#">Region3D</a>         | Measurement region.                                                                          |
| RefRegionsEnabled    | Boolean                          | Setting to enable/disable reference regions:<br>0 – Disable<br>1 – Enable                    |
| RefRegionCount       | 32s                              | Count of the reference regions that are to be used.                                          |
| RefRegions           | (Collection)                     | Reference regions. Contains two RefRegion elements of type <a href="#">SurfaceRegion2D</a> . |
| AutoTiltEnabled      | Boolean                          | Setting to enable/disable tilt correction:<br>0 – Disable<br>1 – Enable                      |
| TiltXAngle           | 64f                              | Setting for manual tilt correction angle X.                                                  |
| TiltYAngle           | 64f                              | Setting for manual tilt correction angle Y.                                                  |
| Measurements\X       | Opening tool measurement         | X measurement.                                                                               |
| Measurements\Y       | Opening tool measurement         | Y measurement.                                                                               |
| Measurements\Z       | Opening tool measurement         | Z measurement.                                                                               |
| Measurements\Width   | Opening tool measurement         | Width measurement.                                                                           |
| Measurements\Length  | Opening tool measurement         | Length measurement.                                                                          |
| Measurements\Angle   | Opening tool measurement         | Angle measurement.                                                                           |
| Features\CenterPoint | <a href="#">GeometricFeature</a> | CenterPoint PointFeature                                                                     |

#### *Opening Tool Measurement*

| Element          | Type    | Description                                                 |
|------------------|---------|-------------------------------------------------------------|
| id (attribute)   | 32s     | Measurement ID. Optional (measurement disabled if not set). |
| Name             | String  | Measurement name.                                           |
| Enabled          | Boolean | Measurement enable state:<br>0 – Disable<br>1 – Enable      |
| HoldEnabled      | Boolean | Output hold enable state:<br>0 – Disable<br>1 – Enable      |
| SmoothingEnabled | Boolean | Smoothing enable state:<br>0 – Disable                      |

| Element                 | Type    | Description                                                             |
|-------------------------|---------|-------------------------------------------------------------------------|
|                         |         | 1 – Enable                                                              |
| PreserveInvalidsEnabled | Boolean | Preserve invalid measurements enable state<br>0 – Disable<br>1 – Enable |
| SmoothingWindow         | 32u     | Smoothing window.                                                       |
| Scale                   | 64f     | Output scaling factor.                                                  |
| Offset                  | 64f     | Output offset factor.                                                   |
| DecisionMin             | 64f     | Minimum decision threshold.                                             |
| DecisionMax             | 64f     | Maximum decision threshold.                                             |

## SurfacePlane

A SurfacePlane element defines settings for a surface plane tool and one or more of its measurements.

### SurfacePlane Child Elements

| Element               | Type         | Description                                                                                          |
|-----------------------|--------------|------------------------------------------------------------------------------------------------------|
| Name                  | String       | Tool name.                                                                                           |
| Features              | Collection   | Not used.                                                                                            |
| Source                | 32s          | Surface source.                                                                                      |
| Anchor\X              | String (CSV) | The X measurements (IDs) used for anchoring.                                                         |
| Anchor\X.options      | String (CSV) | The X measurements (IDs) available for anchoring.                                                    |
| Anchor\Y              | String (CSV) | The Y measurements (IDs) used for anchoring.                                                         |
| Anchor\Y.options      | String (CSV) | The Y measurements (IDs) available for anchoring.                                                    |
| Anchor\Z              | String (CSV) | The Z measurements (IDs) used for anchoring.                                                         |
| Anchor\Z.options      | String (CSV) | The Z measurements (IDs) available for anchoring.                                                    |
| Anchor\ZAngle         | String (CSV) | The Z Angle measurements (IDs) used for anchoring.                                                   |
| Anchor\ZAngle.options | String (CSV) | The Z measurements (IDs) available for anchoring.                                                    |
| StreamOptions         | Collection   | A collection of <i>StreamOptions</i> on page 342 elements.                                           |
| Stream\Step           | 32s          | The stream source step. Possible values are:<br>1 – Video<br>2 – Range<br>3 – Surface<br>4 – Section |
| Stream\ld             | 32u          | The stream source ID.                                                                                |
| RegionsEnabled        | Boolean      | Setting to enable/disable regions:<br>0 – Disable<br>1 – Enable                                      |
| RegionCount           | 32s          | Count of the regions.                                                                                |
| Regions               | (Collection) | Measurement regions. Contains one or two Region                                                      |

| Element               | Type                   | Description                                 |
|-----------------------|------------------------|---------------------------------------------|
|                       |                        | elements of type <a href="#">Region3D</a> . |
| Measurements\XAngle   | Plane tool measurement | XAngle measurement.                         |
| Measurements\YAngle   | Plane tool measurement | YAngle measurement.                         |
| Measurements\ZOffset  | Plane tool measurement | ZOffset measurement.                        |
| Measurements\StdDev   | Plane tool measurement | Standard deviation measurement              |
| Measurements\MinError | Plane tool measurement | Minimum error measurement                   |
| Measurements\MaxError | Plane tool measurement | Maximum error measurement                   |

#### *Plane Tool Measurement*

| Element                 | Type    | Description                                                             |
|-------------------------|---------|-------------------------------------------------------------------------|
| id (attribute)          | 32s     | Measurement ID. Optional (measurement disabled if not set).             |
| Name                    | String  | Measurement name.                                                       |
| Enabled                 | Boolean | Measurement enable state:<br>0 – Disable<br>1 – Enable                  |
| HoldEnabled             | Boolean | Output hold enable state:<br>0 – Disable<br>1 – Enable                  |
| SmoothingEnabled        | Boolean | Smoothing enable state:<br>0 – Disable<br>1 – Enable                    |
| PreserveInvalidsEnabled | Boolean | Preserve invalid measurements enable state<br>0 – Disable<br>1 – Enable |
| SmoothingWindow         | 32u     | Smoothing window.                                                       |
| Scale                   | 64f     | Output scaling factor.                                                  |
| Offset                  | 64f     | Output offset factor.                                                   |
| DecisionMin             | 64f     | Minimum decision threshold.                                             |
| DecisionMax             | 64f     | Maximum decision threshold.                                             |

### **SurfacePosition**

A SurfacePosition element defines settings for a surface position tool and one or more of its measurements.

### *SurfacePosition Child Elements*

| Element               | Type                             | Description                                                                                                     |
|-----------------------|----------------------------------|-----------------------------------------------------------------------------------------------------------------|
| Name                  | String                           | Tool name.                                                                                                      |
| Features              | Collection                       | Collection of geometric feature outputs available in the tool. See <i>SurfacePosition</i> on the previous page. |
| Source                | 32s                              | Surface source.                                                                                                 |
| Anchor\X              | String (CSV)                     | The X measurements (IDs) used for anchoring.                                                                    |
| Anchor\X.options      | String (CSV)                     | The X measurements (IDs) available for anchoring.                                                               |
| Anchor\Y              | String (CSV)                     | The Y measurements (IDs) used for anchoring.                                                                    |
| Anchor\Y.options      | String (CSV)                     | The Y measurements (IDs) available for anchoring.                                                               |
| Anchor\Z              | String (CSV)                     | The Z measurements (IDs) used for anchoring.                                                                    |
| Anchor\Z.options      | String (CSV)                     | The Z measurements (IDs) available for anchoring.                                                               |
| Anchor\ZAngle         | String (CSV)                     | The Z Angle measurements (IDs) used for anchoring.                                                              |
| Anchor\ZAngle.options | String (CSV)                     | The Z measurements (IDs) available for anchoring.                                                               |
| StreamOptions         | Collection                       | A collection of <i>StreamOptions</i> on page 342 elements.                                                      |
| Stream\Step           | 32s                              | The stream source step. Possible values are:<br>1 – Video<br>2 – Range<br>3 – Surface<br>4 – Section            |
| Stream\ld             | 32u                              | The stream source ID.                                                                                           |
| Feature               | <a href="#">SurfaceFeature</a>   | Measurement feature.                                                                                            |
| Measurements\X        | Position tool measurement        | X measurement.                                                                                                  |
| Measurements\Y        | Position tool measurement        | Y measurement.                                                                                                  |
| Measurements\Z        | Position tool measurement        | Z measurement.                                                                                                  |
| Features\Point        | <a href="#">GeometricFeature</a> | Point PointFeature                                                                                              |

### *Position Tool Measurement*

| Element        | Type    | Description                                                 |
|----------------|---------|-------------------------------------------------------------|
| id (attribute) | 32s     | Measurement ID. Optional (measurement disabled if not set). |
| Name           | String  | Measurement name.                                           |
| Enabled        | Boolean | Measurement enable state:<br>0 – Disable<br>1 – Enable      |
| HoldEnabled    | Boolean | Output hold enable state:<br>0 – Disable                    |

| Element                 | Type    | Description                                                             |
|-------------------------|---------|-------------------------------------------------------------------------|
|                         |         | 1 – Enable                                                              |
| SmoothingEnabled        | Boolean | Smoothing enable state:<br>0 – Disable<br>1 – Enable                    |
| PreserveInvalidsEnabled | Boolean | Preserve invalid measurements enable state<br>0 – Disable<br>1 – Enable |
| SmoothingWindow         | 32u     | Smoothing window.                                                       |
| Scale                   | 64f     | Output scaling factor.                                                  |
| Offset                  | 64f     | Output offset factor.                                                   |
| DecisionMin             | 64f     | Minimum decision threshold.                                             |
| DecisionMax             | 64f     | Maximum decision threshold.                                             |

## SurfaceStud

A SurfaceStud element defines settings for a surface stud tool and one or more of its measurements.

### *SurfaceStud Child Elements*

| Element               | Type         | Description                                                                                                      |
|-----------------------|--------------|------------------------------------------------------------------------------------------------------------------|
| Name                  | String       | Tool name.                                                                                                       |
| Features              | Collection   | Collection of geometric feature outputs available in the tool.<br>See <i>Feature Child Elements</i> on page 388. |
| Source                | 32s          | Surface source.                                                                                                  |
| Anchor\X              | String (CSV) | The X measurements (IDs) used for anchoring.                                                                     |
| Anchor\X.options      | String (CSV) | The X measurements (IDs) available for anchoring.                                                                |
| Anchor\Y              | String (CSV) | The Y measurements (IDs) used for anchoring.                                                                     |
| Anchor\Y.options      | String (CSV) | The Y measurements (IDs) available for anchoring.                                                                |
| Anchor\Z              | String (CSV) | The Z measurements (IDs) used for anchoring.                                                                     |
| Anchor\Z.options      | String (CSV) | The Z measurements (IDs) available for anchoring.                                                                |
| Anchor\ZAngle         | String (CSV) | The Z Angle measurements (IDs) used for anchoring.                                                               |
| Anchor\ZAngle.options | String (CSV) | The Z measurements (IDs) available for anchoring.                                                                |
| StreamOptions         | Collection   | A collection of <i>StreamOptions</i> on page 342 elements.                                                       |
| Stream\Step           | 32s          | The stream source step. Possible values are:<br>1 – Video<br>2 – Range<br>3 – Surface<br>4 – Section             |
| Stream\ld             | 32u          | The stream source ID.                                                                                            |

| Element             | Type                     | Description                                                                                  |
|---------------------|--------------------------|----------------------------------------------------------------------------------------------|
| StudRadius          | 64f                      | Radius of stud (mm).                                                                         |
| StudHeight          | 64f                      | Height of stud (mm).                                                                         |
| BaseHeight          | 64f                      | Height of stud's base.                                                                       |
| TipHeight           | 64f                      | Height of stud's tip.                                                                        |
| RegionEnabled       | Boolean                  | Setting to enable/disable region.                                                            |
| Region              | <a href="#">Region3D</a> | Measurement region.                                                                          |
| RefRegionsEnabled   | Boolean                  | Setting to enable/disable reference regions:<br>0 – Disable<br>1 – Enable                    |
| RefRegionCount      | 32s                      | Count of the reference regions that are to be used.                                          |
| RefRegions          | (Collection)             | Reference regions. Contains two RefRegion elements of type <a href="#">SurfaceRegion2D</a> . |
| AutoTiltEnabled     | Boolean                  | Setting to enable/disable tilt correction:<br>0 – Disable<br>1 – Enable                      |
| TiltXAngle          | 64f                      | Setting for manual tilt correction angle X.                                                  |
| TiltYAngle          | 64f                      | Setting for manual tilt correction angle Y.                                                  |
| Measurements\BaseX  | Stud tool measurement    | BaseX measurement.                                                                           |
| Measurements\BaseY  | Stud tool measurement    | BaseY measurement.                                                                           |
| Measurements\BaseZ  | Stud tool measurement    | BaseZ measurement.                                                                           |
| Measurements\TipX   | Stud tool measurement    | TipX measurement.                                                                            |
| Measurements\TipY   | Stud tool measurement    | TipY measurement.                                                                            |
| Measurements\TipZ   | Stud tool measurement    | TipZ measurement.                                                                            |
| Measurements\Radius | Stud tool measurement    | Radius measurement.                                                                          |
| Features\TipPoint   | GeometricFeature         | TipPoint PointFeature                                                                        |
| Features\BasePoint  | GeometricFeature         | BasePoint PointFeature                                                                       |

#### *Stud Tool Measurement*

| Element        | Type   | Description                                                 |
|----------------|--------|-------------------------------------------------------------|
| id (attribute) | 32s    | Measurement ID. Optional (measurement disabled if not set). |
| Name           | String | Measurement name.                                           |

| Element                 | Type    | Description                                                             |
|-------------------------|---------|-------------------------------------------------------------------------|
| Enabled                 | Boolean | Measurement enable state:<br>0 – Disable<br>1 – Enable                  |
| HoldEnabled             | Boolean | Output hold enable state:<br>0 – Disable<br>1 – Enable                  |
| SmoothingEnabled        | Boolean | Smoothing enable state:<br>0 – Disable<br>1 – Enable                    |
| PreserveInvalidsEnabled | Boolean | Preserve invalid measurements enable state<br>0 – Disable<br>1 – Enable |
| SmoothingWindow         | 32u     | Smoothing window.                                                       |
| Scale                   | 64f     | Output scaling factor.                                                  |
| Offset                  | 64f     | Output offset factor.                                                   |
| DecisionMin             | 64f     | Minimum decision threshold.                                             |
| DecisionMax             | 64f     | Maximum decision threshold.                                             |
| RadiusOffset            | 64f     | Radius offset of the stud.<br>(Radius measurement only)                 |

#### Feature Child Elements

| Element   | Type   | Description                                                              |
|-----------|--------|--------------------------------------------------------------------------|
| @id       | 32s    | The identifier of the geometric feature. -1 if unassigned.               |
| @dataType | String | The data type of the feature. One of:<br>– PointFeature<br>– LineFeature |
| Name      | String | The display name of the feature.                                         |
| Enabled   | Bool   | Whether the given feature output is enabled.                             |

## SurfaceVolume

A SurfaceVolume element defines settings for a surface volume tool and one or more of its measurements.

#### SurfaceVolume Child Elements

| Element  | Type       | Description     |
|----------|------------|-----------------|
| Name     | String     | Tool name.      |
| Features | Collection | Not used.       |
| Source   | 32s        | Surface source. |

| Element                        | Type                     | Description                                                                                          |
|--------------------------------|--------------------------|------------------------------------------------------------------------------------------------------|
| Anchor\X                       | String (CSV)             | The X measurements (IDs) used for anchoring.                                                         |
| Anchor\X.options               | String (CSV)             | The X measurements (IDs) available for anchoring.                                                    |
| Anchor\Y                       | String (CSV)             | The Y measurements (IDs) used for anchoring.                                                         |
| Anchor\Y.options               | String (CSV)             | The Y measurements (IDs) available for anchoring.                                                    |
| Anchor\Z                       | String (CSV)             | The Z measurements (IDs) used for anchoring.                                                         |
| Anchor\Z.options               | String (CSV)             | The Z measurements (IDs) available for anchoring.                                                    |
| Anchor\ZAngle                  | String (CSV)             | The Z Angle measurements (IDs) used for anchoring.                                                   |
| Anchor\ZAngle.options          | String (CSV)             | The Z measurements (IDs) available for anchoring.                                                    |
| StreamOptions                  | Collection               | A collection of <i>StreamOptions</i> on page 342 elements.                                           |
| Stream\Step                    | 32s                      | The stream source step. Possible values are:<br>1 – Video<br>2 – Range<br>3 – Surface<br>4 – Section |
| Stream\ld                      | 32u                      | The stream source ID.                                                                                |
| RegionEnabled                  | Boolean                  | Setting to enable/disable region.                                                                    |
| Region                         | <a href="#">Region3D</a> | Measurement region.                                                                                  |
| Measurements\Volume            | Volume tool measurement  | Volume measurement.                                                                                  |
| Measurements\Area              | Volume tool measurement  | Area measurement.                                                                                    |
| Measurements\Thickness         | Volume tool measurement  | Thickness measurement.                                                                               |
| <b>Volume Tool Measurement</b> |                          |                                                                                                      |
| Element                        | Type                     | Description                                                                                          |
| id (attribute)                 | 32s                      | Measurement ID. Optional (measurement disabled if not set).                                          |
| Name                           | String                   | Measurement name.                                                                                    |
| Enabled                        | Boolean                  | Measurement enable state:<br>0 – Disable<br>1 – Enable                                               |
| HoldEnabled                    | Boolean                  | Output hold enable state:<br>0 – Disable<br>1 – Enable                                               |
| SmoothingEnabled               | Boolean                  | Smoothing enable state:<br>0 – Disable<br>1 – Enable                                                 |



| Element                                  | Type    | Description                                                                                                        |
|------------------------------------------|---------|--------------------------------------------------------------------------------------------------------------------|
| PreserveInvalidsEnabled                  | Boolean | Preserve invalid measurements enable state<br>0 – Disable<br>1 – Enable                                            |
| SmoothingWindow                          | 32u     | Smoothing window.                                                                                                  |
| Scale                                    | 64f     | Output scaling factor.                                                                                             |
| Offset                                   | 64f     | Output offset factor.                                                                                              |
| DecisionMin                              | 64f     | Minimum decision threshold.                                                                                        |
| DecisionMax                              | 64f     | Maximum decision threshold.                                                                                        |
| Location<br>(Thickness measurement only) | 32s     | Measurement type:<br>0 – Maximum<br>1 – Minimum<br>2 – 2D Centroid<br>3 – 3D Centroid<br>4 – Average<br>5 – Median |

## Tool

A Tool element of type FeatureDimension defines settings for a feature dimension tool and one or more of its measurements.

### Tool Child Elements

| Element                                 | Type                                     | Description                                       |
|-----------------------------------------|------------------------------------------|---------------------------------------------------|
| @type                                   | String                                   | Type name of the tool.                            |
| @version                                | String                                   | Version string for custom tool.                   |
| Name                                    | String                                   | Tool name.                                        |
| Source                                  | 32s                                      | Surface source.                                   |
| Anchor\X                                | String (CSV)                             | The X measurements (IDs) used for anchoring.      |
| Anchor\X.options                        | String (CSV)                             | The X measurements (IDs) available for anchoring. |
| Anchor\Y                                | String (CSV)                             | The Y measurements (IDs) used for anchoring.      |
| Anchor\Y.options                        | String (CSV)                             | The Y measurements (IDs) available for anchoring. |
| Anchor\Z                                | String (CSV)                             | The Z measurements (IDs) used for anchoring.      |
| Anchor\Z.options                        | String (CSV)                             | The Z measurements (IDs) available for anchoring. |
| Parameters\RefPoint                     | <a href="#">GdkParamGeometricFeature</a> | Reference point feature.                          |
| Parameters\Feature                      | GdkParamGeometricFeature                 | Reference feature.                                |
| Parameters\PathWidth                    | <a href="#">GdkParamFloat</a>            | Path width.                                       |
| Measurements\Measurement<br>@type=Width | <a href="#">Dimension Measurement</a>    | Width measurement.                                |
| Measurements\Measurement                | Dimension Measurement                    | Length measurement.                               |

| Element                                              | Type                  | Description                                                             |
|------------------------------------------------------|-----------------------|-------------------------------------------------------------------------|
| @type=Length                                         |                       |                                                                         |
| Measurements\Measurement<br>@type=Height             | Dimension Measurement | Width measurement.                                                      |
| Measurements\Measurement<br>@type=Distance           | Dimension Measurement | Distance measurement.                                                   |
| Measurements\Measurement<br>@type=PlaneDistance      | Dimension Measurement | Plane distance measurement.                                             |
| Measurements\Measurement<br>@type=CenterX            | Dimension Measurement | Center x measurement.                                                   |
| Measurements\Measurement<br>@type=CenterY            | Dimension Measurement | Center y measurement.                                                   |
| Measurements\Measurement<br>@type=CenterZ            | Dimension Measurement | Center z measurement.                                                   |
| <b><i>Dimension Measurement Child Elements</i></b>   |                       |                                                                         |
| @id                                                  | 32s                   | Measurement ID. Optional (measurement disabled if not set).             |
| @type                                                | String                | Type name of measurement.                                               |
| Name                                                 | String                | Measurement name.                                                       |
| Enabled                                              | Boolean               | Measurement enable state:<br>0 – Disable<br>1 – Enable                  |
| HoldEnabled                                          | Boolean               | Output hold enable state:<br>0 – Disable<br>1 – Enable                  |
| SmoothingEnabled                                     | Boolean               | Smoothing enable state:<br>0 – Disable<br>1 – Enable                    |
| PreserveInvalidsEnabled                              | Boolean               | Preserve invalid measurements enable state<br>0 – Disable<br>1 – Enable |
| SmoothingWindow                                      | 32u                   | Smoothing window.                                                       |
| Scale                                                | 64f                   | Output scaling factor.                                                  |
| Offset                                               | 64f                   | Output offset factor.                                                   |
| DecisionMin                                          | 64f                   | Minimum decision threshold.                                             |
| DecisionMax                                          | 64f                   | Maximum decision threshold.                                             |
| Parameters\WidthAbsolute<br>(Width measurement only) | GdkParamBool          | Absolute width enabled boolean.                                         |
| Parameters\LengthAbsolute                            | GdkParamBool          | Absolute length enabled boolean.                                        |

---

(Length measurement only)

|                           |              |                                  |
|---------------------------|--------------|----------------------------------|
| Parameters\HeightAbsolute | GdkParamBool | Absolute height enabled boolean. |
|---------------------------|--------------|----------------------------------|

(Height measurement only)

## Tool

A Tool element of type FeatureIntersect defines settings for a feature intersection tool and one or more of its measurements.

### Tool Child Elements

| Element                                 | Type                                     | Description                                       |
|-----------------------------------------|------------------------------------------|---------------------------------------------------|
| @type                                   | String                                   | Type name of the tool.                            |
| @version                                | String                                   | Version string for custom tool.                   |
| Name                                    | String                                   | Tool name.                                        |
| Source                                  | 32s                                      | Surface source.                                   |
| Anchor\X                                | String (CSV)                             | The X measurements (IDs) used for anchoring.      |
| Anchor\X.options                        | String (CSV)                             | The X measurements (IDs) available for anchoring. |
| Anchor\Y                                | String (CSV)                             | The Y measurements (IDs) used for anchoring.      |
| Anchor\Y.options                        | String (CSV)                             | The Y measurements (IDs) available for anchoring. |
| Anchor\Z                                | String (CSV)                             | The Z measurements (IDs) used for anchoring.      |
| Anchor\Z.options                        | String (CSV)                             | The Z measurements (IDs) available for anchoring. |
| Parameters\Line                         | <a href="#">GdkParamGeometricFeature</a> | Line feature input.                               |
| Parameters\RefLine                      | GdkParamGeometricFeature                 | Reference line feature input.                     |
| Measurements\Measurement<br>@type=X     | <a href="#">Intersect Measurement</a>    | X measurement.                                    |
| Measurements\Measurement<br>@type=Y     | Intersect Measurement                    | Y measurement.                                    |
| Measurements\Measurement<br>@type=Z     | Intersect Measurement                    | Z measurement.                                    |
| Measurements\Measurement<br>@type=Angle | Intersect Measurement                    | Angle measurement.                                |

### Intersect Measurement Child Elements

|             |         |                                                             |
|-------------|---------|-------------------------------------------------------------|
| @id         | 32s     | Measurement ID. Optional (measurement disabled if not set). |
| @type       | String  | Type name of measurement.                                   |
| Name        | String  | Measurement name.                                           |
| Enabled     | Boolean | Measurement enable state:<br>0 – Disable<br>1 – Enable      |
| HoldEnabled | Boolean | Output hold enable state:<br>0 – Disable                    |

|                         |             |                                                                          |
|-------------------------|-------------|--------------------------------------------------------------------------|
|                         |             | 1 – Enable                                                               |
| SmoothingEnabled        | Boolean     | Smoothing enable state:<br>0 – Disable<br>1 – Enable                     |
| PreserveInvalidsEnabled | Boolean     | Preserve invalid measurements enable state<br>0 – Disable<br>1 – Enable  |
| SmoothingWindow         | 32u         | Smoothing window.                                                        |
| Scale                   | 64f         | Output scaling factor.                                                   |
| Offset                  | 64f         | Output offset factor.                                                    |
| DecisionMin             | 64f         | Minimum decision threshold.                                              |
| DecisionMax             | 64f         | Maximum decision threshold.                                              |
| Parameters\AngleRange   | GdkParamInt | Angle range option choice. Is one of:<br>0 – -180 To 180<br>1 – 0 To 360 |

## Custom

A Custom element defines settings for a user-created GDK-based tool and one or more of its measurements.

### Custom Child Elements

| Element          | Type            | Description                                                                                               |
|------------------|-----------------|-----------------------------------------------------------------------------------------------------------|
| @type            | String          | Type name of the tool.                                                                                    |
| @version         | String          | Version string for custom tool.                                                                           |
| Name             | String          | Tool name.                                                                                                |
| Source           | 32s             | Surface source.                                                                                           |
| Anchor\X         | String (CSV)    | The X measurements (IDs) used for anchoring.                                                              |
| Anchor\X.options | String (CSV)    | The X measurements (IDs) available for anchoring.                                                         |
| Anchor\Y         | String (CSV)    | The Y measurements (IDs) used for anchoring.                                                              |
| Anchor\Y.options | String (CSV)    | The Y measurements (IDs) available for anchoring.                                                         |
| Anchor\Z         | String (CSV)    | The Z measurements (IDs) used for anchoring.                                                              |
| Anchor\Z.options | String (CSV)    | The Z measurements (IDs) available for anchoring.                                                         |
| Parameters       | GDK Parameter   | Collection of <a href="#">parameters</a> . The element name in the job file is the name of the parameter. |
| Measurements     | GDK Measurement | Collection of <a href="#">measurements</a> .                                                              |
| Features         | GDK Feature     | Collection of <a href="#">features</a> .                                                                  |

## Output

The Output element contains the following sub-elements: Ethernet, Serial, Analog, Digital0, and Digital1. Each of these sub-elements defines the output settings for a different type of Gocator output.

For all sub-elements, the source identifiers used for measurement outputs correspond to the measurement identifiers defined in each tool's Measurements element. For example, in the following XML, in the options attribute of the Measurements element, 2 and 3 are the identifiers of measurements that are enabled and available for output. The value of the Measurements element (that is, 2) means that only the measurement with id 2 (Profile Dimension Width) will be sent to output.

```
<ProfileDimension>    ...
  <Measurements>
    <Width id="2">    ...
    <Height id="3">   ...

<Output>
  <Ethernet>          ...
    <Measurements options="2,3">2</Measurements>
```

## Ethernet

The Ethernet element defines settings for Ethernet output.

In the Ethernet element, the source identifiers used for video, range, profile, and surface output, as well as range, profile, and surface intensity outputs, correspond to the *sensor* that provides the data. For example, in the XML below, the *options* attribute of the Profiles element shows that only two sources are available (see the table below for the meanings of these values). The value in this element—0—indicates that only data from that source will be sent to output.

```
<Output>
  <Ethernet>
    ...
    <Ranges options=""/>
    <Profiles options="0,1">0</Profiles>
    <Surfaces options=""/>
    ...
```

### Ethernet Child Elements

| Element        | Type    | Description                                                                                             |
|----------------|---------|---------------------------------------------------------------------------------------------------------|
| Protocol       | 32s     | Ethernet protocol:<br>0 – Gocator<br>1 – Modbus<br>2 – EtherNet/IP<br>3 – ASCII                         |
| TimeoutEnabled | Boolean | Enable or disable auto-disconnection timeout. Applies only to the Gocator protocol.                     |
| Timeout        | 64f     | Disconnection timeout (seconds). Used when TimeoutEnabled is true and the Gocator protocol is selected. |

| Element                  | Type      | Description                                                                                 |
|--------------------------|-----------|---------------------------------------------------------------------------------------------|
| Ascii                    | Section   | See <i>Ascii</i> on the next page.                                                          |
| EIP                      | Section   | See <i>EIP</i> on page 397.                                                                 |
| Modbus                   | Section   | See <i>Modbus</i> on page 397.                                                              |
| Videos                   | 32s (CSV) | Selected video sources:<br>0 – Top<br>1 – Bottom<br>2 – Top left<br>3 – Top right           |
| Videos.options           | 32s (CSV) | List of available video sources (see above).                                                |
| Ranges                   | 32s (CSV) | Selected range sources:<br>0 – Top<br>1 – Bottom<br>2 – Top left<br>3 – Top right           |
| Ranges.options           | 32s (CSV) | List of available range sources (see above).                                                |
| Profiles                 | 32s (CSV) | Selected profile sources:<br>0 – Top<br>1 – Bottom<br>2 – Top left<br>3 – Top right         |
| Profiles.options         | 32s (CSV) | List of available profile sources (see above).                                              |
| Surfaces                 | 32s (CSV) | Selected surface sources:<br>0 – Top<br>1 – Bottom<br>2 – Top left<br>3 – Top right         |
| Surfaces.options         | 32s (CSV) | List of available surface sources (see above).                                              |
| RangeIntensities         | 32s (CSV) | Selected range intensity sources.<br>0 – Top<br>1 – Bottom<br>2 – Top left<br>3 – Top right |
| RangeIntensities.options | 32s (CSV) | List of available range intensity sources (see above).                                      |
| ProfileIntensities       | 32s (CSV) | Selected profile intensity sources.<br>0 – Top<br>1 – Bottom                                |

| Element                    | Type      | Description                                                                                   |
|----------------------------|-----------|-----------------------------------------------------------------------------------------------|
|                            |           | 2 – Top left<br>3 – Top right                                                                 |
| ProfileIntensities.options | 32s (CSV) | List of available profile intensity sources (see above).                                      |
| SurfaceIntensities         | 32s (CSV) | Selected surface intensity sources:<br>0 – Top<br>1 – Bottom<br>2 – Top left<br>3 – Top right |
| SurfaceIntensities.options | 32s (CSV) | List of available surface intensity sources (see above).                                      |
| Measurements               | 32u (CSV) | Selected measurement sources.                                                                 |
| Measurements.options       | 32u (CSV) | List of available measurement sources.                                                        |
| Events                     | 32s (CSV) | CSV list of possible event options:<br>0 – Exposure Begins<br>1 – Exposure Ends               |
| Events.options             | 32s (CSV) | List of available event options (see above).                                                  |

## Ascii

### Ascii Child Elements

| Element             | Type   | Description                                                                                 |
|---------------------|--------|---------------------------------------------------------------------------------------------|
| Operation           | 32s    | Operation mode:<br>0 – Asynchronous<br>1 – Polled                                           |
| ControlPort         | 32u    | Control service port number.                                                                |
| HealthPort          | 32u    | Health service port number.                                                                 |
| DataPort            | 32u    | Data service port number.                                                                   |
| Delimiter           | String | Field delimiter.                                                                            |
| Terminator          | String | Line terminator.                                                                            |
| InvalidValue        | String | String for invalid output.                                                                  |
| CustomDataFormat    | String | Custom data format.                                                                         |
| CustomFormatEnabled | Bool   | Enables custom data format.                                                                 |
| StandardFormatMode  | 32u    | The formatting mode used if not a custom format:<br>0 – Standard<br>1 – Standard with Stamp |

## EIP

### *EIP Child Elements*

| Element                 | Type | Description                                                                                        |
|-------------------------|------|----------------------------------------------------------------------------------------------------|
| BufferEnabled           | Bool | Enables EtherNet/IP output buffering.                                                              |
| EndianOutputType        | 32s  | Endian output type:<br>0 – Big endian<br>1 – Little endian                                         |
| ImplicitOutputEnabled   | Bool | Enables Implicit (I/O) Messaging.                                                                  |
| ImplicitTriggerOverride | 32s  | Override requested trigger type by client:<br>0 – No override<br>1 – Cyclic<br>2 – Change of State |

## Modbus

### *Modbus Child Elements*

| Element       | Type | Description                      |
|---------------|------|----------------------------------|
| BufferEnabled | Bool | Enables Modbus output buffering. |

## Digital0 and Digital1

The Digital0 and Digital1 elements define settings for the Gocator's two digital outputs.

### *Digital0 and Digital1 Child Elements*

| Element         | Type | Description                                                                                                                                         |
|-----------------|------|-----------------------------------------------------------------------------------------------------------------------------------------------------|
| Event           | 32s  | Triggering event:<br>0 – None (disabled)<br>1 – Measurements<br>2 – Software<br>3 – Alignment state<br>4 – Acquisition start<br>5 – Acquisition end |
| SignalType      | 32s  | Signal type:<br>0 – Pulse<br>1 – Continuous                                                                                                         |
| ScheduleEnabled | Bool | Enables scheduling.                                                                                                                                 |
| PulseWidth      | 64f  | Pulse width (µs).                                                                                                                                   |
| PulseWidth.min  | 64f  | Minimum pulse width (µs).                                                                                                                           |
| PulseWidth.max  | 64f  | Maximum pulse width (µs).                                                                                                                           |
| PassMode        | 32s  | Measurement pass condition:<br>0 – AND of measurements is true                                                                                      |



| Element              | Type      | Description                                                       |
|----------------------|-----------|-------------------------------------------------------------------|
|                      |           | 1 – AND of measurements is false<br>2 – Always assert             |
| Delay                | 64f       | Output delay (µs or mm, depending on delay domain defined below). |
| DelayDomain          | 32s       | Output delay domain:<br>0 – Time (µs)<br>1 – Encoder (mm)         |
| Inverted             | Bool      | Whether the sent bits are flipped.                                |
| Measurements         | 32u (CSV) | Selected measurement sources.                                     |
| Measurements.options | 32u (CSV) | List of available measurement sources.                            |

## Analog

The Analog element defines settings for analog output.

The range of valid measurement values [DataScaleMin, DataScaleMax] is scaled linearly to the specified current range [CurrentMin, CurrentMax].

Only one Value or Decision source can be selected at a time.

### Analog Child Elements

| Element               | Type | Description                                                                  |
|-----------------------|------|------------------------------------------------------------------------------|
| Event                 | 32s  | Triggering event:<br>0 – None (disabled)<br>1 – Measurements<br>2 – Software |
| ScheduleEnabled       | Bool | Enables scheduling.                                                          |
| CurrentMin            | 64f  | Minimum current (mA).                                                        |
| CurrentMin.min        | 64f  | Minimum value of minimum current (mA).                                       |
| CurrentMin.max        | 64f  | Maximum value of minimum current (mA).                                       |
| CurrentMax            | 64f  | Maximum current (mA).                                                        |
| CurrentMax.min        | 64f  | Minimum value of maximum current (mA).                                       |
| CurrentMax.max        | 64f  | Maximum value of maximum current (mA).                                       |
| CurrentInvalidEnabled | Bool | Enables special current value for invalid measurement value.                 |
| CurrentInvalid        | 64f  | Current value for invalid measurement value (mA).                            |
| CurrentInvalid.min    | 64f  | Minimum value for invalid current (mA).                                      |
| CurrentInvalid.max    | 64f  | Maximum value for invalid current (mA).                                      |
| DataScaleMin          | 64f  | Measurement value corresponding to minimum current.                          |
| DataScaleMax          | 64f  | Measurement value corresponding to maximum current.                          |
| Delay                 | 64f  | Output delay (µs or mm, depending on delay domain defined below).            |
| DelayDomain           | 32s  | Output delay domain:                                                         |

| Element             | Type      | Description                            |
|---------------------|-----------|----------------------------------------|
|                     |           | 0 – Time (µs)<br>1 – Encoder (mm)      |
| Measurement         | 32u       | Selected measurement source.           |
| Measurement.options | 32u (CSV) | List of available measurement sources. |



The delay specifies the time or position at which the analog output activates. Upon activation, there is an additional delay before the analog output settles at the correct value.

## Serial

The Serial element defines settings for Serial output.

### Serial Child Elements

| Element              | Type      | Description                                 |
|----------------------|-----------|---------------------------------------------|
| Protocol             | 32s       | Serial protocol:<br>0 – ASCII<br>1 – Selcom |
| Protocol.options     | 32s (CSV) | List of available protocols.                |
| Selcom               | Section   | See <i>Selcom</i> below.                    |
| Ascii                | Section   | See <i>Ascii</i> on the next page.          |
| Measurements         | 32u (CSV) | Selected measurement sources.               |
| Measurements.options | 32u (CSV) | List of available measurement sources.      |

## Selcom

### Selcom Child Elements

| Element        | Type      | Description                                                                                    |
|----------------|-----------|------------------------------------------------------------------------------------------------|
| Rate           | 32u       | Output bit rate.                                                                               |
| Rate.options   | 32u (CSV) | List of available rates.                                                                       |
| Format         | 32s       | Output format:<br>0 – 12-bit<br>1 – 12-bit with search<br>2 – 14-bit<br>3 – 14-bit with search |
| Format.options | 32s (CSV) | List of available formats.                                                                     |
| DataScaleMin   | 64f       | Measurement value corresponding to minimum word value.                                         |
| DataScaleMax   | 64f       | Measurement value corresponding to maximum word value.                                         |
| Delay          | 64u       | Output delay in µs.                                                                            |

## Ascii

### Ascii Child Elements

| Element             | Type   | Description                                                                                 |
|---------------------|--------|---------------------------------------------------------------------------------------------|
| Delimiter           | String | Field delimiter.                                                                            |
| Terminator          | String | Line terminator.                                                                            |
| InvalidValue        | String | String for invalid output.                                                                  |
| CustomDataFormat    | String | Custom data format.                                                                         |
| CustomFormatEnabled | Bool   | Enables custom data format.                                                                 |
| StandardFormatMode  | 32u    | The formatting mode used if not a custom format:<br>0 – Standard<br>1 – Standard with Stamp |

## Transform

The transformation component contains information about the physical system setup that is used to:

- Transform data from sensor coordinate system to another coordinate system (e.g., world)
- Define encoder resolution for encoder-based triggering
- Define the travel offset (Y offset) between sensors for staggered operation

You can access the Transform component of the active job as an XML file, either using path notation, via "\_live.job/transform.xml", or directly via "\_live.tfm".

You can access the Transform component in user-created job files in non-volatile storage, for example, "productionRun01.job/transform.xml". You can only access transformations in user-created job files using path notation.

See the following sections for the elements contained in this component.

### Transformation Example:

```
<?xml version="1.0" encoding="UTF-8"?>
<Transform version="100">
  <EncoderResolution>1</EncoderResolution>
  <Speed>100</Speed>
  <Devices>
    <Device role="0">
      <X>-2.3650924829</X>
      <Y>0.0</Y>
      <Z>123.4966803469</Z>
      <XAngle>5.7478302588</XAngle>
      <YAngle>3.7078302555</XAngle>
      <ZAngle>2.7078302556</XAngle>
    </Device>
    <Device id="1">
```

```

    <X>0</X>
    <Y>0.0</Y>
    <Z>123.4966803469</Z>
    <XAngle>5.7478302588</XAngle>
    <YAngle>3.7078302555</XAngle>
    <ZAngle>2.7078302556</XAngle>
  </Device>
</Devices>
</Transform>

```

The Transform element contains the alignment record for both the Main and the Buddy sensor.

#### Transform Child Elements

| Element           | Type         | Description                                   |
|-------------------|--------------|-----------------------------------------------|
| @version          | 32u          | Major transform version (100).                |
| @versionMinor     | 32u          | Minor transform version (0).                  |
| EncoderResolution | 64f          | Encoder Resolution (mm/tick).                 |
| Speed             | 64f          | Travel Speed (mm/s).                          |
| Devices           | (Collection) | Contains two <a href="#">Device</a> elements. |

## Device

A Device element defines the transformation for a sensor. There is one entry element per sensor, identified by a unique role attribute (0 for main and 1 for buddy):

#### Device Child Elements

| Element | Type | Description                                                        |
|---------|------|--------------------------------------------------------------------|
| @role   | 32s  | Role of device described by this section:<br>0 – Main<br>1 – Buddy |
| X       | 64f  | Translation on the X axis (mm).                                    |
| Y       | 64f  | Translation on the Y axis (mm).                                    |
| Z       | 64f  | Translation on the Z axis (mm).                                    |
| XAngle  | 64f  | Rotation around the X axis (degrees).                              |
| YAngle  | 64f  | Rotation around the Y axis (degrees).                              |
| ZAngle  | 64f  | Rotation around the Z axis (degrees).                              |

The rotation (counter-clockwise in the X-Z plane) is performed before the translation.

## Part Models

Part models represent models created using the part matching feature.

You can access a model in the active job using path notation. For example, to access a model called scan.mdl, use "\_live.job/scan.mdl".

You can access part models in user-created job files in non-volatile storage, for example, "productionRun01.job/model1.mdl". You can only access part models in user-created job files using path notation.

See the following sections for the elements contained in a model.

Part models contain the following subcomponents. You can access the subcomponents using path notation, for example, "productionRun01.job/myModel.mdl/config.xml".

#### *Part Model Child Elements*

| Element       | Type                  | Description                                                                                 |
|---------------|-----------------------|---------------------------------------------------------------------------------------------|
| Configuration | config.xml            | Model configuration XML. It is always present. (See <i>Configuration</i> on the next page.) |
| Edge Points   | edge-height-top       | Edge points for the top heightmap. (See <i>Edge Points</i> below.)                          |
| Edge Points   | edge-height-bottom    | Edge points for the bottom heightmap.                                                       |
| Edge Points   | edge-intensity-top    | Edge points for the top intensity map.                                                      |
| Edge Points   | edge-intensity-bottom | Edge points for the bottom intensity map.                                                   |

The edge points file exists only when the model contains the source data for the edge points.

## Edge Points

#### *Edge Points Data*

| Field       | Type | Offset | Description                                       |
|-------------|------|--------|---------------------------------------------------|
| id          | 16s  | 0      | Sender ID<br>-1 – Part matching                   |
| source      | 8s   | 2      | Source<br>0 – Model<br>1 – Target                 |
| imageType   | 8s   | 3      | Image type<br>0 – Height map<br>1 – Intensity map |
| imageSource | 8s   | 4      | Image source<br>0 – Top<br>1 – Bottom             |
| width       | 32u  | 5      | Width of model space, in units of xScale          |
| length      | 32u  | 9      | Length of model space, un units of yScale         |
| xScale      | 32u  | 13     | X scale (nm)                                      |

| Field              | Type       | Offset | Description                                                                                                   |
|--------------------|------------|--------|---------------------------------------------------------------------------------------------------------------|
| yScale             | 32u        | 17     | Y scale (nm)                                                                                                  |
| xOffset            | 32s        | 21     | X offset (μm)                                                                                                 |
| yOffset            | 32s        | 25     | Y offset μm                                                                                                   |
| zAngle             | 32s        | 29     | Z rotation (microdegrees)                                                                                     |
| pointCount         | 32u        | 33     | Number of edge points                                                                                         |
| points[pointCount] | (32u, 32u) | 37     | Edge points collection. Each point is a tuple of x and y values, in units of xScale and yScale, respectively. |

## Configuration

Delete this text and replace it with your own content.

### Configuration Child Elements

| Element               | Type       | Description                                                                          |
|-----------------------|------------|--------------------------------------------------------------------------------------|
| @version              | 32u        | Major version (1).                                                                   |
| @versionMinor         | 32u        | Minor version (0).                                                                   |
| Edges                 | Collection | Collection of Edge items (described below).                                          |
| EdgeSensitivity       | 64f        | Sensitivity recorded during model edges generation (read-only).                      |
| TransformedDataRegion | Region3d   | Data region of the model.                                                            |
| ZAngle                | 64f        | Additional rotation applied to the model (degrees).                                  |
| TargetEdgeSensitivity | 64f        | Sensitivity used to generate target edges.                                           |
| ImageType             | 32s        | Selects type of image used to generate edges:<br>0 – Height map<br>1 – Intensity map |
| ImageType.options     | 32s (CSV)  | List of available image types.                                                       |

# Protocols

Gocator supports protocols for communicating with sensors over Ethernet (TCP/IP) and serial output. For a protocol to output data, it must be enabled and configured in the active job.

## Protocols Available over Ethernet

- [Gocator](#)
- [Modbus](#)
- [EtherNet/IP](#)
- [ASCII](#)

## Protocols Available over Serial

- [ASCII](#)
- [Selcom](#)

## Gocator Protocol

This section describes the TCP and UDP commands and data formats used by a client computer to communicate with Gocator sensors using the Gocator protocol. It also describes the connection types (Discovery, Control, Upgrade, Data, and Health), and data types. The protocol enables the client to:

- Discover Main and Buddy sensors on an IP network and re-configure their network addresses.
- Configure Main and Buddy sensors.
- Send commands to run sensors, provide software triggers, read/write files, etc.
- Receive data, health, and diagnostic messages.
- Upgrade firmware.



The Gocator 4.x firmware uses mm, mm<sup>2</sup>, mm<sup>3</sup>, and degrees as standard units. In all protocols, values are scaled by 1000, as values in the protocols are represented as integers. This results in effective units of mm/1000, mm<sup>2</sup>/1000, mm<sup>3</sup>/1000, and deg/1000 in the protocols.

To use the Gocator protocol, it must be enabled and configured in the active job.



Gocator sensors send UDP broadcasts over the network over the Internal Discovery channel (port 2016) at regular intervals during operation to perform peer discovery.



The Gocator SDK provides open source C language libraries that implement the network commands and data formats defined in this section. For more information, see *SDK* on page 488.

For information on configuring the protocol using the Web interface, see *Ethernet Output* on page 284.

For information on job file structures (for example, if you wish to create job files programmatically), see *Job Files* on page 319.

## Data Types

The table below defines the data types and associated type identifiers used in this section.

All values except for IP addresses are transmitted in little endian format (least significant byte first) unless stated otherwise. The bytes in an IP address "a.b.c.d" will always be transmitted in the order a, b, c, d (big endian).

### Data Types

| Type       | Description                        | Null Value                                |
|------------|------------------------------------|-------------------------------------------|
| char       | Character (8-bit, ASCII encoding)  | -                                         |
| byte       | Byte.                              | -                                         |
| 8s         | 8-bit signed integer.              | -128                                      |
| 8u         | 8-bit unsigned integer.            | 255U                                      |
| 16s        | 16-bit signed integer.             | -32768 (0x8000)                           |
| 16u        | 16-bit unsigned integer.           | 65535 (0xFFFF)                            |
| 32s        | 32-bit signed integer.             | -2147483648 (0x80000000)                  |
| 32u        | 32-bit unsigned integer.           | 4294967295 (0xFFFFFFFF)                   |
| 64s        | 64-bit signed integer.             | -9223372036854775808 (0x8000000000000000) |
| 64u        | 64-bit unsigned integer.           | 18446744073709551615 (0xFFFFFFFFFFFFFFFF) |
| 64f        | 64-bit floating point              | -1.7976931348623157e+308                  |
| Point16s   | Two 16-bit signed integers         | -                                         |
| Point64f   | Two 64-bit floating point values   | -                                         |
| Point3d64f | Three 64-bit floating point values | -                                         |
| Rect64f    | Four 64-bit floating point values  | -                                         |
| Rect3d64f  | Eight 64-bit floating point values | -                                         |

## Commands

The following sections describe the commands available on the Discovery (page 406), Control (page 409), and Upgrade (page 443) channels.

When a client sends a command over the Control or Upgrade channel, the sensor sends a reply whose identifier is the same as the command's identifier. The identifiers are listed in the tables of each of the commands.

### Status Codes

Each reply on the Discovery, Control, and Upgrade channels contains a *status* field containing a status code indicating the result of the command. The following status codes are defined:



### Status Codes

| Label                   | Value | Description                                   |
|-------------------------|-------|-----------------------------------------------|
| OK                      | 1     | Command succeeded.                            |
| Failed                  | 0     | Command failed.                               |
| Invalid State           | -1000 | Command is not valid in the current state.    |
| Item Not Found          | -999  | A required item (e.g., file) was not found.   |
| Invalid Command         | -998  | Command is not recognized.                    |
| Invalid Parameter       | -997  | One or more command parameters are incorrect. |
| Not Supported           | -996  | The operation is not supported.               |
| Simulation Buffer Empty | -992  | The simulation buffer is empty.               |

## Discovery Commands

Sensors ship with the following default network configuration:

| Setting     | Default            |
|-------------|--------------------|
| DHCP        | 0 (disabled)       |
| IP Address  | 192.168.1.10       |
| Subnet Mask | 255.255.255.0      |
| Gateway     | 0.0.0.0 (disabled) |

Use the [Get Address](#) and [Set Address](#) commands to modify a sensor's network configuration. These commands are UDP broadcast messages:

| Destination Address | Destination Port |
|---------------------|------------------|
| 255.255.255.255     | 3220             |

When a sensor accepts a discovery command, it will send a UDP broadcast response:

| Destination Address | Destination Port        |
|---------------------|-------------------------|
| 255.255.255.255     | Port of command sender. |

The use of UDP broadcasts for discovery enables a client computer to locate a sensor when the sensor and client are configured for different subnets. All you need to know is the serial number of the sensor in order to locate it on an IP network.

## Get Address

The Get Address command is used to discover Gocator sensors across subnets.

### Command

| Field  | Type | Offset | Description         |
|--------|------|--------|---------------------|
| length | 64s  | 0      | Command length.     |
| type   | 64s  | 8      | Command type (0x1). |

| Field     | Type | Offset | Description                                                                              |
|-----------|------|--------|------------------------------------------------------------------------------------------|
| signature | 64s  | 16     | Message signature (0x0000504455494D4C)                                                   |
| deviceld  | 64s  | 24     | Serial number of the device whose address information is queried. 0 selects all devices. |

#### *Reply*

| Field         | Type | Offset | Description                                 |
|---------------|------|--------|---------------------------------------------|
| length        | 64s  | 0      | Reply length.                               |
| type          | 64s  | 8      | Reply type (0x1001).                        |
| status        | 64s  | 16     | Operation status.                           |
| signature     | 64s  | 24     | Message signature (0x0000504455494D4C)      |
| deviceld      | 64s  | 32     | Serial number.                              |
| dhcpEnabled   | 64s  | 40     | 0 – Disabled 1 – Enabled                    |
| reserved[4]   | byte | 48     | Reserved.                                   |
| address[4]    | byte | 52     | The IP address in left to right order.      |
| reserved[4]   | byte | 56     | Reserved.                                   |
| subnetMask[4] | byte | 60     | The subnet mask in left to right order.     |
| reserved[4]   | byte | 64     | Reserved.                                   |
| gateway[4]    | byte | 68     | The gateway address in left to right order. |
| reserved[4]   | byte | 72     | Reserved.                                   |
| reserved[4]   | byte | 76     | Reserved.                                   |

### Set Address

The Set Address command modifies the network configuration of a Gocator sensor. On receiving the command, the Gocator will perform a reset. You should wait 30 seconds before re-connecting to the Gocator.

#### *Command*

| Field         | Type | Offset | Description                                                                              |
|---------------|------|--------|------------------------------------------------------------------------------------------|
| length        | 64s  | 0      | Command length.                                                                          |
| type          | 64s  | 8      | Command type (0x2).                                                                      |
| signature     | 64s  | 16     | Message signature (0x0000504455494D4C)                                                   |
| deviceld      | 64s  | 24     | Serial number of the device whose address information is queried. 0 selects all devices. |
| dhcpEnabled   | 64s  | 32     | 0 – Disabled 1 – Enabled                                                                 |
| reserved[4]   | byte | 40     | Reserved.                                                                                |
| address[4]    | byte | 44     | The IP address in left to right order.                                                   |
| reserved[4]   | byte | 48     | Reserved.                                                                                |
| subnetMask[4] | byte | 52     | The subnet mask in left to right order.                                                  |
| reserved[4]   | byte | 56     | Reserved.                                                                                |

| Field       | Type | Offset | Description                                 |
|-------------|------|--------|---------------------------------------------|
| gateway[4]  | byte | 60     | The gateway address in left to right order. |
| reserved[4] | byte | 64     | Reserved.                                   |
| reserved[4] | byte | 68     | Reserved.                                   |

#### Reply

| Field     | Type | Offset | Description                                                                    |
|-----------|------|--------|--------------------------------------------------------------------------------|
| length    | 64s  | 0      | Reply length.                                                                  |
| type      | 64s  | 8      | Reply type (0x1002).                                                           |
| status    | 64s  | 16     | Operation status. For a list of status codes, see <i>Commands</i> on page 405. |
| signature | 64s  | 24     | Message signature (0x0000504455494D4C).                                        |
| deviceld  | 64s  | 32     | Serial number.                                                                 |

### Get Info

The Get Info command is used to retrieve sensor information.

#### Command

| Field     | Type | Offset | Description                                                                              |
|-----------|------|--------|------------------------------------------------------------------------------------------|
| length    | 64s  | 0      | Command length.                                                                          |
| type      | 64s  | 8      | Command type (0x5).                                                                      |
| signature | 64s  | 16     | Message signature (0x0000504455494D4C).                                                  |
| deviceld  | 64s  | 24     | Serial number of the device whose address information is queried. 0 selects all devices. |

#### Reply

| Field         | Type | Offset | Description                                                                           |
|---------------|------|--------|---------------------------------------------------------------------------------------|
| length        | 64s  | 0      | Reply length.                                                                         |
| type          | 64s  | 8      | Reply type (0x1005).                                                                  |
| status        | 64s  | 16     | Operation status. For a list of status codes, see <i>Commands</i> on page 405.        |
| signature     | 64s  | 24     | Message signature (0x0000504455494D4C).                                               |
| attrCount     | 16u  | 32     | Byte count of the attributes (begins after this field and ends before propertyCount). |
| id            | 32u  | 34     | Serial number.                                                                        |
| version       | 32u  | 38     | Version as a 4-byte integer (encoded in little-endian).                               |
| uptime        | 64u  | 42     | Sensor uptime (microseconds).                                                         |
| ipNegotiation | byte | 50     | IP negotiation type:<br>0 – Static<br>1 – DHCP                                        |

| Field                         | Type                     | Offset | Description                               |
|-------------------------------|--------------------------|--------|-------------------------------------------|
| addressVersion                | byte                     | 51     | IP address version (always 4).            |
| address[4]                    | byte                     | 52     | IP address.                               |
| reserved[12]                  | byte                     | 56     | Reserved.                                 |
| prefixLength                  | 32u                      | 68     | Subnet prefix length (in number of bits). |
| gatewayVersion                | byte                     | 72     | Gateway address version (always 4).       |
| gatewayAddress[4]             | byte                     | 73     | Gateway address.                          |
| reserved[12]                  | byte                     | 77     | Reserved.                                 |
| controlPort                   | 16u                      | 89     | Control channel port.                     |
| upgradePort                   | 16u                      | 91     | Upgrade channel port.                     |
| healthPort                    | 16u                      | 93     | Health channel port.                      |
| dataPort                      | 16u                      | 95     | Data channel port.                        |
| webPort                       | 16u                      | 97     | Web server port.                          |
| propertyCount                 | 8u                       | 99     | Number of sensor ID properties.           |
| properties<br>[propertyCount] | <a href="#">Property</a> | 100    | List of sensor ID properties.             |

#### Property

| Field              | Type | Description          |
|--------------------|------|----------------------|
| nameLength         | 8u   | Length of the name.  |
| name[nameLength]   | char | Name string.         |
| valueLength        | 8u   | Length of the value. |
| value[valueLength] | char | Value string.        |

## Control Commands

A client sends control commands for most operations over the Control TCP channel (port 3190).

The Control channel and the Upgrade channel (port 3192) can be connected simultaneously. For more information on Upgrade commands, see *Upgrade Commands* on page 443.

### States

A Gocator system can be in one of three states: Conflict, Ready, or Running. The client sends the [Start](#) and [Stop](#) control commands to change the system's current state to Running and Ready, respectively. The sensor can also be configured to boot in either the Ready or Running state, by enabling or disabling autostart, respectively, using the [Set Auto Start Enabled](#) command.

In the Ready state, a sensor can be configured. In the Running state, a sensor responds to input signals, performs measurements, drives its outputs, and sends data messages to the client.

The state of the sensor can be retrieved using the [Get States](#) or [Get System Info](#) command.

The Conflict state indicates that a sensor has been configured with a Buddy sensor but the Buddy sensor is not present on the network. The sensor will not accept some commands until the [Set Buddy](#) command is used to remove the configured Buddy.

## Progressive Reply

Some commands send replies progressively, as multiple messages. This allows the sensor to stream data without buffering it first, and allows the client to obtain progress information on the stream.

A progressive reply begins with an initial, standard reply message. If the *status* field of the reply indicates success, the reply is followed by a series of “continue” reply messages.

A continue reply message contains a block of data of variable size, as well as status and progress information. The series of continue messages is ended by either an error, or a continue message containing 0 bytes of data.

## Protocol Version

The Protocol Version command returns the protocol version of the connected sensor.

### Command

| Field  | Type | Offset | Description                                  |
|--------|------|--------|----------------------------------------------|
| length | 32u  | 0      | Command size including this field, in bytes. |
| id     | 16u  | 4      | Command identifier (0x4511)                  |

### Reply

| Field        | Type | Offset | Description                                                                |
|--------------|------|--------|----------------------------------------------------------------------------|
| length       | 32u  | 0      | Reply size including this field, in bytes.                                 |
| id           | 16u  | 4      | Reply identifier (0x4511).                                                 |
| status       | 32s  | 6      | Reply status. For a list of status codes, see <i>Commands</i> on page 405. |
| majorVersion | 8u   | 10     | Major version.                                                             |
| minorVersion | 8u   | 11     | Minor version.                                                             |

## Get Address

The Get Address command is used to get a sensor address.

### Command

| Field  | Type | Offset | Description                                  |
|--------|------|--------|----------------------------------------------|
| length | 32u  | 0      | Command size including this field, in bytes. |
| id     | 16u  | 4      | Command identifier (0x3012)                  |

### Reply

| Field       | Type | Offset | Description                                                                |
|-------------|------|--------|----------------------------------------------------------------------------|
| length      | 32u  | 0      | Reply size including this field, in bytes.                                 |
| id          | 16u  | 4      | Reply identifier (0x3012).                                                 |
| status      | 32s  | 6      | Reply status. For a list of status codes, see <i>Commands</i> on page 405. |
| dhcpEnabled | byte | 10     | 0 – DHCP not used<br>1 – DHCP used                                         |

| Field         | Type | Offset | Description                               |
|---------------|------|--------|-------------------------------------------|
| address[4]    | byte | 11     | IP address (most significant byte first). |
| subnetMask[4] | byte | 15     | Subnet mask.                              |
| gateway[4]    | byte | 19     | Gateway address.                          |

## Set Address

The Set Address command modifies the network configuration of a Gocator sensor. On receiving the command, the Gocator will perform a reset. You should wait 30 seconds before re-connecting to the Gocator.

### Command

| Field         | Type | Offset | Description                                  |
|---------------|------|--------|----------------------------------------------|
| length        | 32u  | 0      | Command size including this field, in bytes. |
| id            | 16u  | 4      | Command identifier (0x3013)                  |
| dhcpEnabled   | byte | 6      | 0 – DHCP not used<br>1 – DHCP used           |
| address[4]    | byte | 7      | IP address (most significant byte first).    |
| subnetMask[4] | byte | 11     | Subnet mask.                                 |
| gateway[4]    | byte | 15     | Gateway address.                             |

### Reply

| Field  | Type | Offset | Description                                                                |
|--------|------|--------|----------------------------------------------------------------------------|
| length | 32u  | 0      | Reply size including this field, in bytes.                                 |
| id     | 16u  | 4      | Reply identifier (0x3013).                                                 |
| status | 32s  | 6      | Reply status. For a list of status codes, see <i>Commands</i> on page 405. |

## Get System Info

The Get System Info command reports information about the local node, remote nodes and assigned buddies.

Firmware version refers to the version of the Gocator's firmware installed on each individual sensor. The client can upgrade the Gocator's firmware by sending the Start Upgrade command (see *Start Upgrade* on page 444). Firmware upgrade files are available from the downloads section under the support tab on the LMI web site. For more information on getting the latest firmware, see *Firmware Upgrade* on page 87.

Every Gocator sensor contains factory backup firmware. If a firmware upgrade command fails (e.g., power is interrupted), the factory backup firmware will be loaded when the sensor is reset or power cycled. In this case, the sensors will fall back to the factory default IP address. To avoid IP address conflicts in a multi-sensor system, connect to one sensor at a time and re-attempt the firmware upgrade.

### Command

| Field  | Type | Offset | Description                                  |
|--------|------|--------|----------------------------------------------|
| length | 32u  | 0      | Command size including this field, in bytes. |
| id     | 16u  | 4      | Command identifier (0x4010)                  |

### Reply

| Field                       | Type           | Offset | Description                                |
|-----------------------------|----------------|--------|--------------------------------------------|
| length                      | 32u            | 0      | Reply size including this field, in bytes. |
| id                          | 16u            | 4      | Reply identifier (0x4010).                 |
| localInfoSize               | 16u            | 10     | Size of localInfo structure. Current: 52.  |
| localInfo                   | Device Info    | 12     | Info for this device.                      |
| remoteCount                 | 32u            | -      | Number of discovered sensors.              |
| remoteInfoSize              | 16u            | -      | Size of remoteInfo structure. Current 60.  |
| remoteInfo<br>[remoteCount] | Remote<br>Info | -      | List of info for discovered sensors.       |
| buddyInfoCount              | 32u            | -      | Number of buddies assigned (can be 0).     |
| buddyInfoSize               | 16u            | -      | Size of buddyInfo structure. Current: 8.   |
| Buddies[buddyCount]         | Buddy Info     | -      | List of info for the assigned buddies.     |

### Sensor Info

| Field              | Type | Offset | Description                                                                                                                           |
|--------------------|------|--------|---------------------------------------------------------------------------------------------------------------------------------------|
| deviceId           | 32u  | 0      | Serial number of the device.                                                                                                          |
| address[4]         | byte | 4      | IP address (most significant byte first).                                                                                             |
| modelName[32]      | char | 8      | Model name.                                                                                                                           |
| firmwareVersion[4] | byte | 40     | Firmware version (most significant byte first).                                                                                       |
| state              | 32s  | 44     | Sensor state<br>-1 – Conflict<br>0 – Ready<br>1 – Running<br>For more information on states, see <i>Control Commands</i> on page 409. |
| role               | 32s  | 48     | Sensor role<br>0 – Main<br>1 – Buddy                                                                                                  |

### Remote Info

| Field         | Type | Offset | Description                               |
|---------------|------|--------|-------------------------------------------|
| deviceId      | 32u  | 0      | Serial number of the device.              |
| address[4]    | byte | 4      | IP address (most significant byte first). |
| modelName[32] | char | 8      | Model name.                               |

| Field              | Type | Offset | Description                                                                                                                                                                                                                         |
|--------------------|------|--------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| firmwareVersion[4] | byte | 40     | Firmware version (most significant byte first).                                                                                                                                                                                     |
| state              | 32s  | 44     | Sensor state<br>-1 – Conflict<br>0 – Ready<br>1 – Running<br>For more information on states, see <i>Control Commands</i> on page 409.                                                                                               |
| role               | 32s  | 48     | Sensor role<br>0 – Main<br>1 – Buddy                                                                                                                                                                                                |
| mainId             | 32u  | 52     | Serial number of the main device, or zero.                                                                                                                                                                                          |
| buddyableStatus    | 32s  | 56     | Whether or not the device can be buddied:<br>1 – Can be buddied<br><br>Errors:<br>0 – Unbuddiable (General Error)<br>-100 – Already buddied<br>-99 – Invalid State (e.g. running)<br>-98 – Version Mismatch<br>-97 – Model Mismatch |

#### Buddy Info

| Field    | Type | Offset | Description                                                                                                                                                                                                                                |
|----------|------|--------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| deviceId | 32u  | 2      | Serial number of the device.                                                                                                                                                                                                               |
| state    | k32s | 6      | Buddy state<br>2 - Connecting<br>1 – Connected<br><br>Errors:<br>0 – Unbuddiable (General Error)<br>-100 – Already buddied<br>-99 – Invalid State (e.g. running)<br>-98 – Version Mismatch<br>-97 – Model Mismatch<br>-95 – Device Missing |

#### Get System Info



This version of the Get System Info command is deprecated. Use [Get System Info \(v2\)](#) instead.



The Get System Info command reports information for sensors that are visible in the system.

Firmware version refers to the version of the Gocator's firmware installed on each individual sensor. The client can upgrade the Gocator's firmware by sending the Start Upgrade command (see *Start Upgrade* on page 444). Firmware upgrade files are available from the downloads section under the support tab on the LMI web site. For more information on getting the latest firmware, see *Firmware Upgrade* on page 87.

Every Gocator sensor contains factory backup firmware. If a firmware upgrade command fails (e.g., power is interrupted), the factory backup firmware will be loaded when the sensor is reset or power cycled. In this case, the sensors will fall back to the factory default IP address. To avoid IP address conflicts in a multi-sensor system, connect to one sensor at a time and re-attempt the firmware upgrade.

#### Command

| Field  | Type | Offset | Description                                  |
|--------|------|--------|----------------------------------------------|
| length | 32u  | 0      | Command size including this field, in bytes. |
| id     | 16u  | 4      | Command identifier (0x4002)                  |

#### Reply

| Field                       | Type                        | Offset | Description                                                                |
|-----------------------------|-----------------------------|--------|----------------------------------------------------------------------------|
| length                      | 32u                         | 0      | Reply size including this field, in bytes.                                 |
| id                          | 16u                         | 4      | Reply identifier (0x4002).                                                 |
| status                      | 32s                         | 6      | Reply status. For a list of status codes, see <i>Commands</i> on page 405. |
| localInfo                   | <a href="#">Sensor Info</a> | 10     | Info for this device.                                                      |
| remoteCount                 | 32u                         | 66     | Number of discovered sensors.                                              |
| remoteInfo<br>[remoteCount] | <a href="#">Sensor Info</a> | 70     | List of info for discovered sensors.                                       |

#### Sensor Info

| Field              | Type | Offset | Description                                                                                                                           |
|--------------------|------|--------|---------------------------------------------------------------------------------------------------------------------------------------|
| deviceId           | 32u  | 0      | Serial number of the device.                                                                                                          |
| address[4]         | byte | 4      | IP address (most significant byte first).                                                                                             |
| modelName[32]      | char | 8      | Model name.                                                                                                                           |
| firmwareVersion[4] | byte | 40     | Firmware version (most significant byte first).                                                                                       |
| state              | 32s  | 44     | Sensor state<br>-1 – Conflict<br>0 – Ready<br>1 – Running<br>For more information on states, see <i>Control Commands</i> on page 409. |
| role               | 32s  | 48     | Sensor role                                                                                                                           |

| Field   | Type | Offset | Description                                                    |
|---------|------|--------|----------------------------------------------------------------|
|         |      |        | 0 – Main<br>1 – Buddy                                          |
| buddyId | 32s  | 52     | Serial number of paired device (main or buddy). 0 if unpaired. |

## Get States

The Get States command returns various system states.

### Command

| Field  | Type | Offset | Description                                  |
|--------|------|--------|----------------------------------------------|
| length | 32u  | 0      | Command size including this field, in bytes. |
| id     | 16u  | 4      | Command identifier (0x4525)                  |

### Reply

| Field              | Type | Offset | Description                                                                                                                           |
|--------------------|------|--------|---------------------------------------------------------------------------------------------------------------------------------------|
| length             | 32u  | 0      | Reply size including this field, in bytes.                                                                                            |
| id                 | 16u  | 4      | Reply identifier (0x4525).                                                                                                            |
| status             | 32s  | 6      | Reply status. For a list of status codes, see <i>Commands</i> on page 405.                                                            |
| count              | 32u  | 10     | Number of state variables.                                                                                                            |
| sensorState        | 32s  | 14     | Sensor state<br>-1 – Conflict<br>0 – Ready<br>1 – Running<br>For more information on states, see <i>Control Commands</i> on page 409. |
| loginState         | 32s  | 18     | Device login state<br>0 – No user<br>1 – Administrator<br>2 – Technician                                                              |
| alignmentReference | 32s  | 22     | Alignment reference<br>0 – Fixed<br>1 – Dynamic                                                                                       |
| alignmentState     | 32s  | 26     | Alignment state<br>0 – Unaligned<br>1 – Aligned                                                                                       |
| recordingEnabled   | 32s  | 30     | Whether or not recording is enabled<br>0 – Disabled<br>1 – Enabled                                                                    |
| playbackSource     | 32s  | 34     | Playback source                                                                                                                       |

| Field            | Type | Offset | Description                               |
|------------------|------|--------|-------------------------------------------|
|                  |      |        | 0 – Live data<br>1 – Recorded data        |
| uptimeSec        | 32s  | 38     | Uptime (whole seconds component)          |
| uptimeMicrosec   | 32s  | 42     | Uptime (remaining microseconds component) |
| playbackPos      | 32s  | 46     | Playback position                         |
| playbackCount    | 32s  | 50     | Playback frame count                      |
| autoStartEnabled | 32s  | 54     | Auto-start enable (boolean)               |

## Log In/Out

The Log In/Out command is used to log in or out of a sensor.

### Command

| Field        | Type | Offset | Description                                                                        |
|--------------|------|--------|------------------------------------------------------------------------------------|
| length       | 32u  | 0      | Command size including this field, in bytes.                                       |
| id           | 16u  | 4      | Command identifier (0x4003).                                                       |
| userType     | 32s  | 6      | Defines the user type<br>0 – None (log out)<br>1 – Administrator<br>2 – Technician |
| password[64] | char | 10     | Password (required for log-in only).                                               |

### Reply

| Field  | Type | Offset | Description                                                                |
|--------|------|--------|----------------------------------------------------------------------------|
| length | 32u  | 0      | Reply size including this field, in bytes.                                 |
| id     | 16u  | 4      | Reply identifier (0x4003).                                                 |
| status | 32s  | 6      | Reply status. For a list of status codes, see <i>Commands</i> on page 405. |

## Change Password

The Change Password command is used to change log-in credentials for a user.

### Command

| Field        | Type | Offset | Description                                                                        |
|--------------|------|--------|------------------------------------------------------------------------------------|
| length       | 32u  | 0      | Command size including this field, in bytes.                                       |
| id           | 16u  | 4      | Command identifier (0x4004).                                                       |
| user type    | 32s  | 6      | Defines the user type<br>0 – None (log out)<br>1 – Administrator<br>2 – Technician |
| password[64] | char | 10     | New password.                                                                      |

### Reply

| Field  | Type | Offset | Description                                                                |
|--------|------|--------|----------------------------------------------------------------------------|
| length | 32u  | 0      | Reply size including this field, in bytes.                                 |
| id     | 16u  | 4      | Reply identifier (0x4004).                                                 |
| status | 32s  | 6      | Reply status. For a list of status codes, see <i>Commands</i> on page 405. |



Passwords can only be changed if a user is logged in as an administrator.

## Assign Buddies

The Assign Buddies command is used to set the list of buddies assigned to the system.

This command can be used to both add and remove buddies by changing the list of buddies. A serial number of 0 can be used to add device slots that are not assigned a physical sensor. Collections associated with the devices (e.g. <Device> element in the configuration) grow or shrink accordingly. Items are added to or removed from the end of these collections. For example: the system starts with 2 devices, [A, B]. A new list [A, B, C] is sent. The configuration for A and B are preserved, and a new record is created for C. If now the system changes back to [A, B], the record for C is deleted. Adding or removing items in the middle of the list has the same behaviour. Example: the system starts with 3 devices, [A, B, C]. A new list [A, C] is sent. The configuration for B is now used for C, and the configuration for C is deleted. To ensure consistency when adding and removing devices, add only to the end of the list and remove using the Remove Buddies command.

### Command

| Field               | Type | Offset | Description                                         |
|---------------------|------|--------|-----------------------------------------------------|
| length              | 32u  | 0      | Command size including this field, in bytes.        |
| id                  | 16u  | 4      | Command identifier (0x4011).                        |
| buddyCount          | 32u  | 6      | Number of buddies or 0 to unbuddy all devices.      |
| buddies[buddyCount] | 32u  | 10     | Serial Numbers of the buddies to assign (can be 0). |

### Reply

| Field  | Type | Offset | Description                                                                |
|--------|------|--------|----------------------------------------------------------------------------|
| length | 32u  | 0      | Reply size including this field, in bytes.                                 |
| id     | 16u  | 4      | Reply identifier (0x4011).                                                 |
| status | 32s  | 6      | Reply status. For a list of status codes, see <i>Commands</i> on page 405. |

## Remove Buddies

The Remove Buddies command is used to remove one or more buddies using 0-based buddy indices.

Use this command to remove a buddy devices along with its associated configuration resources. If the system starts with 3 devices: [A, B, C], and this command is called to remove B, the configuration items for A and C remain unchanged.

### Command

| Field                | Type | Offset | Description                                                                                                                                   |
|----------------------|------|--------|-----------------------------------------------------------------------------------------------------------------------------------------------|
| length               | 32u  | 0      | Command size including this field, in bytes.                                                                                                  |
| id                   | 16u  | 4      | Command identifier (0x4013).                                                                                                                  |
| buddyCount           | 32u  | 6      | Number of buddies.                                                                                                                            |
| buddyIds[buddyCount] | 32u  | 10     | Indices of the buddies to remove. Note that the first buddy has index 0 (i.e. it's the index of buddies, not all devices including the main). |

### Reply

| Field  | Type | Offset | Description                                                                |
|--------|------|--------|----------------------------------------------------------------------------|
| length | 32u  | 0      | Reply size including this field, in bytes.                                 |
| id     | 16u  | 4      | Reply identifier (0x4013).                                                 |
| status | 32s  | 6      | Reply status. For a list of status codes, see <i>Commands</i> on page 405. |

## Set Buddy

The Set Buddy command is used to assign or unassign a Buddy sensor.

### Command

| Field   | Type | Offset | Description                                                     |
|---------|------|--------|-----------------------------------------------------------------|
| length  | 32u  | 0      | Command size including this field, in bytes.                    |
| id      | 16u  | 4      | Command identifier (0x4005).                                    |
| buddyId | 32u  | 6      | Id of the sensor to acquire as buddy. Set to 0 to remove buddy. |

### Reply

| Field  | Type | Offset | Description                                                                |
|--------|------|--------|----------------------------------------------------------------------------|
| length | 32u  | 0      | Reply size including this field, in bytes.                                 |
| id     | 16u  | 4      | Reply identifier (0x4005).                                                 |
| status | 32s  | 6      | Reply status. For a list of status codes, see <i>Commands</i> on page 405. |

## List Files

The List Files command returns a list of the files in the sensor's file system.

### Command

| Field         | Type | Offset | Description                                                                                                                                      |
|---------------|------|--------|--------------------------------------------------------------------------------------------------------------------------------------------------|
| length        | 32u  | 0      | Command size including this field, in bytes.                                                                                                     |
| id            | 16u  | 4      | Command identifier (0x101A).                                                                                                                     |
| extension[64] | char | 6      | Specifies the extension used to filter the list of files (does not include the "."). If an empty string is used, then no filtering is performed. |

### Reply

| Field                | Type | Offset | Description                                                                |
|----------------------|------|--------|----------------------------------------------------------------------------|
| length               | 32u  | 0      | Reply size including this field, in bytes.                                 |
| id                   | 16u  | 4      | Reply identifier (0x101A).                                                 |
| status               | 32s  | 6      | Reply status. For a list of status codes, see <i>Commands</i> on page 405. |
| count                | 32u  | 10     | Number of file names.                                                      |
| fileNames[count][64] | char | 14     | File names.                                                                |

## Copy File

The Copy File command copies a file from a source to a destination within the connected sensor (a .job file, a component of a job file, or another type of file; for more information, see *Job Files* on page 319).

To make a job active (to load it), copy a saved job to "\_live.job".

To "save" the active job, copy from "\_live.job" to another file.

### Command

| Field           | Type | Offset | Description                                  |
|-----------------|------|--------|----------------------------------------------|
| length          | 32u  | 0      | Command size including this field, in bytes. |
| id              | 16u  | 4      | Command identifier (0x101B).                 |
| source[64]      | char | 6      | Source file name.                            |
| destination[64] | char | 70     | Destination file name.                       |

### Reply

| Field  | Type | Offset | Description                                                                |
|--------|------|--------|----------------------------------------------------------------------------|
| length | 32u  | 0      | Reply size including this field, in bytes.                                 |
| id     | 16u  | 4      | Reply identifier (0x101B).                                                 |
| status | 32s  | 6      | Reply status. For a list of status codes, see <i>Commands</i> on page 405. |

## Read File

Downloads a file from the connected sensor (a .job file, a component of a job file, or another type of file; for more information, see *Job Files* on page 319).

To download the live configuration, pass "\_live.job" in the *name* field.

To read the configuration of the live configuration only, pass "\_live.job/config.xml" in the *name* field.

### Command

| Field    | Type | Offset | Description                                  |
|----------|------|--------|----------------------------------------------|
| length   | 32u  | 0      | Command size including this field, in bytes. |
| id       | 16u  | 4      | Command identifier (0x1007).                 |
| name[64] | char | 6      | Source file name.                            |

### Reply

| Field        | Type | Offset | Description                                                                |
|--------------|------|--------|----------------------------------------------------------------------------|
| length       | 32u  | 0      | Reply size including this field, in bytes.                                 |
| id           | 16u  | 4      | Reply identifier (0x1007).                                                 |
| status       | 32s  | 6      | Reply status. For a list of status codes, see <i>Commands</i> on page 405. |
| length       | 32u  | 10     | File length.                                                               |
| data[length] | byte | 14     | File contents.                                                             |

## Write File

The Write File command uploads a file to the connected sensor (a .job file, a component of a job file, or another type of file; for more information, see *Job Files* on page 319).

To make a job file live, write to "\_live.job". Except for writing to the live file, the file is permanently stored on the sensor.

### Command

| Field        | Type | Offset | Description                                  |
|--------------|------|--------|----------------------------------------------|
| length       | 32u  | 0      | Command size including this field, in bytes. |
| id           | 16u  | 4      | Command identifier (0x1006).                 |
| name[64]     | char | 6      | Source file name.                            |
| length       | 32u  | 70     | File length.                                 |
| data[length] | byte | 74     | File contents.                               |

### Reply

| Field  | Type | Offset | Description                                                                |
|--------|------|--------|----------------------------------------------------------------------------|
| length | 32u  | 0      | Reply size including this field, in bytes.                                 |
| id     | 16u  | 4      | Reply identifier (0x1006).                                                 |
| status | 32s  | 6      | Reply status. For a list of status codes, see <i>Commands</i> on page 405. |

## Delete File

The Delete File command removes a file from the connected sensor (a .job file, a component of a job file, or another type of file; for more information, see *Job Files* on page 319).

### Command

| Field    | Type | Offset | Description                                  |
|----------|------|--------|----------------------------------------------|
| length   | 32u  | 0      | Command size including this field, in bytes. |
| id       | 16u  | 4      | Command identifier (0x1008).                 |
| name[64] | char | 6      | Source file name.                            |

### Reply

| Field  | Type | Offset | Description                                                                |
|--------|------|--------|----------------------------------------------------------------------------|
| length | 32u  | 0      | Reply size including this field, in bytes.                                 |
| id     | 16u  | 4      | Reply identifier (0x1008).                                                 |
| status | 32s  | 6      | Reply status. For a list of status codes, see <i>Commands</i> on page 405. |

## User Storage Used

The User Storage Used command returns the amount of user storage that is used.

### Command

| Field  | Type | Offset | Description                                  |
|--------|------|--------|----------------------------------------------|
| length | 32u  | 0      | Command size including this field, in bytes. |
| id     | 16u  | 4      | Command identifier (0x1021).                 |

### Reply

| Field     | Type | Offset | Description                                |
|-----------|------|--------|--------------------------------------------|
| length    | 32u  | 0      | Reply size including this field, in bytes. |
| id        | 16u  | 4      | Reply identifier (0x1021).                 |
| status    | 32s  | 6      | Reply status.                              |
| spaceUsed | 64u  | 10     | The used storage space in bytes.           |

## User Storage Free

The User Storage Free command returns the amount of user storage that is free.

### Command

| Field  | Type | Offset | Description                                  |
|--------|------|--------|----------------------------------------------|
| length | 32u  | 0      | Command size including this field, in bytes. |
| id     | 16u  | 4      | Command identifier (0x1022).                 |

### Reply

| Field     | Type | Offset | Description                                |
|-----------|------|--------|--------------------------------------------|
| length    | 32u  | 0      | Reply size including this field, in bytes. |
| id        | 16u  | 4      | Reply identifier (0x1022).                 |
| status    | 32s  | 6      | Reply status.                              |
| spaceFree | 64u  | 10     | The free storage space in bytes.           |

## Get Default Job

The Get Default Job command gets the name of the job the sensor loads when it powers up.

### Command

| Field  | Type | Offset | Description                                  |
|--------|------|--------|----------------------------------------------|
| length | 32u  | 0      | Command size including this field, in bytes. |
| id     | 16u  | 4      | Command identifier (0x4100).                 |



### Reply

| Field    | Type | Offset | Description                                                                    |
|----------|------|--------|--------------------------------------------------------------------------------|
| length   | 32u  | 0      | Reply size including this field, in bytes.                                     |
| id       | 16u  | 4      | Reply identifier (0x4100).                                                     |
| status   | 32s  | 6      | Reply status. For a list of status codes, see <i>Commands</i> on page 405.     |
| name[64] | char | 10     | The file name (null-terminated) of the job the sensor loads when it powers up. |

## Set Default Job

The Set Default Job command sets the job the sensor loads when it powers up.

### Command

| Field        | Type | Offset | Description                                                                |
|--------------|------|--------|----------------------------------------------------------------------------|
| length       | 32u  | 0      | Command size including this field, in bytes.                               |
| id           | 16u  | 4      | Command identifier (0x4101).                                               |
| fileName[64] | char | 6      | File name (null-terminated) of the job the sensor loads when it powers up. |

### Reply

| Field  | Type | Offset | Description                                                                |
|--------|------|--------|----------------------------------------------------------------------------|
| length | 32u  | 0      | Reply size including this field, in bytes.                                 |
| id     | 16u  | 4      | Reply identifier (0x4101).                                                 |
| status | 32s  | 6      | Reply status. For a list of status codes, see <i>Commands</i> on page 405. |

## Get Loaded Job

The Get Loaded Job command returns the name and modified status of the currently loaded file.

### Command

| Field  | Type | Offset | Description                                  |
|--------|------|--------|----------------------------------------------|
| length | 32u  | 0      | Command size including this field, in bytes. |
| id     | 16u  | 4      | Command identifier (0x4512).                 |

### Reply

| Field        | Type | Offset | Description                                                                |
|--------------|------|--------|----------------------------------------------------------------------------|
| length       | 32u  | 0      | Reply size including this field, in bytes.                                 |
| id           | 16u  | 4      | Reply identifier (0x4512).                                                 |
| status       | 32s  | 6      | Reply status. For a list of status codes, see <i>Commands</i> on page 405. |
| fileName[64] | char | 10     | Name of the currently loaded job.                                          |
| changed      | 8u   | 74     | Whether or not the currently loaded job has been changed (1: yes; 0: no).  |

## Get Alignment Reference

The Get Alignment Reference command is used to get the sensor's alignment reference.

### Command

| Field  | Type | Offset | Description                                  |
|--------|------|--------|----------------------------------------------|
| length | 32u  | 0      | Command size including this field, in bytes. |
| id     | 16u  | 4      | Command identifier (0x4104).                 |

### Reply

| Field     | Type | Offset | Description                                                                |
|-----------|------|--------|----------------------------------------------------------------------------|
| length    | 32u  | 0      | Reply size including this field, in bytes.                                 |
| id        | 16u  | 4      | Reply identifier (0x4104).                                                 |
| status    | 32s  | 6      | Reply status. For a list of status codes, see <i>Commands</i> on page 405. |
| reference | 32s  | 10     | Alignment reference<br>0 – Fixed<br>1 – Dynamic                            |

## Set Alignment Reference

The Set Alignment Reference command is used to set the sensor's alignment reference.

### Command

| Field     | Type | Offset | Description                                     |
|-----------|------|--------|-------------------------------------------------|
| length    | 32u  | 0      | Command size including this field, in bytes.    |
| id        | 16u  | 4      | Command identifier (0x4103).                    |
| reference | 32s  | 6      | Alignment reference<br>0 – Fixed<br>1 – Dynamic |

### Reply

| Field  | Type | Offset | Description                                                                |
|--------|------|--------|----------------------------------------------------------------------------|
| length | 32u  | 0      | Reply size including this field, in bytes.                                 |
| id     | 16u  | 4      | Reply identifier (0x4103).                                                 |
| status | 32s  | 6      | Reply status. For a list of status codes, see <i>Commands</i> on page 405. |

## Clear Alignment

The Clear Alignment command clears sensor alignment.

### Command

| Field  | Type | Offset | Description                                  |
|--------|------|--------|----------------------------------------------|
| length | 32u  | 0      | Command size including this field, in bytes. |
| id     | 16u  | 4      | Command identifier (0x4102).                 |

### Reply

| Field  | Type | Offset | Description                                                                |
|--------|------|--------|----------------------------------------------------------------------------|
| length | 32u  | 0      | Reply size including this field, in bytes.                                 |
| id     | 16u  | 4      | Reply identifier (0x4102).                                                 |
| status | 32s  | 6      | Reply status. For a list of status codes, see <i>Commands</i> on page 405. |

## Get Timestamp

The Get Timestamp command retrieves the sensor's timestamp, in clock ticks. All devices in a system are synchronized with the system clock; this value can be used for diagnostic purposes, or used to synchronize the start time of the system.

### Command

| Field  | Type | Offset | Description                                  |
|--------|------|--------|----------------------------------------------|
| length | 32u  | 0      | Command size including this field, in bytes. |
| id     | 16u  | 4      | Command identifier (0x100A).                 |

### Reply

| Field     | Type | Offset | Description                                                                |
|-----------|------|--------|----------------------------------------------------------------------------|
| length    | 32u  | 0      | Reply size including this field, in bytes.                                 |
| id        | 16u  | 4      | Reply identifier (0x100A).                                                 |
| status    | 32s  | 6      | Reply status. For a list of status codes, see <i>Commands</i> on page 405. |
| timestamp | 64u  | 10     | Timestamp, in clock ticks.                                                 |

## Get Encoder

This command retrieves the current system encoder value.

### Command

| Field  | Type | Offset | Description                                  |
|--------|------|--------|----------------------------------------------|
| length | 32u  | 0      | Command size including this field, in bytes. |
| id     | 16u  | 4      | Command identifier (0x101C).                 |

### Reply

| Field   | Type | Offset | Description                                                                |
|---------|------|--------|----------------------------------------------------------------------------|
| length  | 32u  | 0      | Reply size including this field, in bytes.                                 |
| id      | 16u  | 4      | Reply identifier (0x101C).                                                 |
| status  | 32s  | 6      | Reply status. For a list of status codes, see <i>Commands</i> on page 405. |
| encoder | 64s  | 10     | Current encoder position, in ticks.                                        |

## Reset Encoder

The Reset Encoder command is used to reset the current encoder value.



The encoder value can be reset only when the encoder is connected directly to a sensor. When the encoder is connected to the master, the value cannot be reset via this command.

#### Command

| Field  | Type | Offset | Description                                  |
|--------|------|--------|----------------------------------------------|
| length | 32u  | 0      | Command size including this field, in bytes. |
| id     | 16u  | 4      | Command identifier (0x101E).                 |

#### Reply

| Field  | Type | Offset | Description                                                                |
|--------|------|--------|----------------------------------------------------------------------------|
| length | 32u  | 0      | Reply size including this field, in bytes.                                 |
| id     | 16u  | 4      | Reply identifier (0x101E).                                                 |
| status | 32s  | 6      | Reply status. For a list of status codes, see <i>Commands</i> on page 405. |

### Start

The Start command starts the sensor system (system enters the Running state). For more information on states, see *Control Commands* on page 409.

#### Command

| Field  | Type | Offset | Description                                  |
|--------|------|--------|----------------------------------------------|
| length | 32u  | 0      | Command size including this field, in bytes. |
| id     | 16u  | 4      | Command identifier (0x100D).                 |

#### Reply

| Field  | Type | Offset | Description                                                                |
|--------|------|--------|----------------------------------------------------------------------------|
| length | 32u  | 0      | Reply size including this field, in bytes.                                 |
| id     | 16u  | 4      | Reply identifier (0x100D).                                                 |
| status | 32s  | 6      | Reply status. For a list of status codes, see <i>Commands</i> on page 405. |

### Scheduled Start

The scheduled start command starts the sensor system (system enters the Running state) at target time or encoder value (depending on the trigger mode). For more information on states, see *Control Commands* on page 409.

#### Command

| Field  | Type | Offset | Description                                                                        |
|--------|------|--------|------------------------------------------------------------------------------------|
| length | 32u  | 0      | Command size – in bytes.                                                           |
| id     | 16u  | 4      | Command identifier (0x100F).                                                       |
| target | 64s  | 6      | Target scheduled start value (in ticks or $\mu$ s, depending on the trigger type). |

### Reply

| Field  | Type | Offset | Description                                                                |
|--------|------|--------|----------------------------------------------------------------------------|
| length | 32u  | 0      | Reply size – in bytes.                                                     |
| id     | 16u  | 4      | Reply identifier (0x100F).                                                 |
| status | 32s  | 6      | Reply status. For a list of status codes, see <i>Commands</i> on page 405. |

### Stop

The Stop command stops the sensor system (system enters the Ready state). For more information on states, see *Control Commands* on page 409.

### Command

| Field  | Type | Type | Description                                  |
|--------|------|------|----------------------------------------------|
| length | 32u  | 0    | Command size including this field, in bytes. |
| id     | 16u  | 4    | Command identifier (0x1001).                 |

### Reply

| Field  | Type | Offset | Description                                                                |
|--------|------|--------|----------------------------------------------------------------------------|
| length | 32u  | 0      | Reply size including this field, in bytes.                                 |
| id     | 16u  | 4      | Reply identifier (0x1001).                                                 |
| status | 32s  | 6      | Reply status. For a list of status codes, see <i>Commands</i> on page 405. |

### Get Auto Start Enabled

The Get Auto Start Enabled command returns whether the system automatically starts after booting.

### Command

| Field  | Type | Offset | Description                                  |
|--------|------|--------|----------------------------------------------|
| length | 32u  | 0      | Command size including this field, in bytes. |
| id     | 16u  | 4      | Command identifier (0x452C).                 |

### Reply

| Field  | Type | Offset | Description                                                                |
|--------|------|--------|----------------------------------------------------------------------------|
| length | 32u  | 0      | Reply size including this field, in bytes.                                 |
| id     | 16u  | 4      | Reply identifier (0x452C).                                                 |
| status | 32s  | 6      | Reply status. For a list of status codes, see <i>Commands</i> on page 405. |
| enable | 8u   | 10     | 0: disabled<br>1: enabled                                                  |

### Set Auto Start Enabled

The Set Auto Start Enabled command sets whether the system automatically starts after booting (enters Running state; for more information on states, see *Control Commands* on page 409).

#### Command

| Field  | Type | Offset | Description                                  |
|--------|------|--------|----------------------------------------------|
| length | 32u  | 0      | Command size including this field, in bytes. |
| id     | 16u  | 4      | Command identifier (0x452B).                 |
| enable | 8u   | 6      | 0: disabled<br>1: enabled                    |

#### Reply

| Field  | Type | Offset | Description                                                                |
|--------|------|--------|----------------------------------------------------------------------------|
| length | 32u  | 0      | Reply size including this field, in bytes.                                 |
| id     | 16u  | 4      | Reply identifier (0x452B).                                                 |
| status | 32s  | 6      | Reply status. For a list of status codes, see <i>Commands</i> on page 405. |

### Start Alignment

The Start Alignment command is used to start the alignment procedure on a sensor.

#### Command

| Field  | Type | Offset | Description                                  |
|--------|------|--------|----------------------------------------------|
| length | 32u  | 0      | Command size including this field, in bytes. |
| id     | 16u  | 4      | Command identifier (0x4600).                 |

#### Reply

| Field  | Type | Offset | Description                                                                                                                                                                                                                    |
|--------|------|--------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| length | 32u  | 0      | Reply size including this field, in bytes.                                                                                                                                                                                     |
| id     | 16u  | 4      | Reply identifier (0x4600).                                                                                                                                                                                                     |
| status | 32s  | 6      | Reply status. For a list of status codes, see <i>Commands</i> on page 405.                                                                                                                                                     |
| opId   | 32u  | 10     | Operation ID. Use this ID to correlate the command/reply on the Command channel with the correct <a href="#">Alignment Result</a> message on the Data channel. A unique ID is returned each time the client uses this command. |

### Start Exposure Auto-set

The Start Exposure Auto-set command is used to start the exposure auto-set procedure on a sensor.

#### Command

| Field  | Type | Offset | Description                                           |
|--------|------|--------|-------------------------------------------------------|
| length | 32u  | 0      | Command size including this field, in bytes.          |
| id     | 16u  | 4      | Command identifier (0x4601).                          |
| role   | 32s  | 6      | Role of sensors to auto-set.<br>0 – Main<br>1 – Buddy |

### Reply

| Field  | Type | Offset | Description                                                                                                                                                                                                                               |
|--------|------|--------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| length | 32u  | 0      | Reply size including this field, in bytes.                                                                                                                                                                                                |
| id     | 16u  | 4      | Reply identifier (0x4601).                                                                                                                                                                                                                |
| status | 32s  | 6      | Reply status. For a list of status codes, see <i>Commands</i> on page 405.                                                                                                                                                                |
| opId   | 32u  | 10     | Operation ID. Use this ID to correlate the command/reply on the Command channel with the correct <a href="#">Exposure Calibration Result</a> message on the Data channel. A unique ID is returned each time the client uses this command. |

## Software Trigger

The Software Trigger command causes the sensor to take a snapshot while in software mode and in the Running state.

### Command

| Field  | Type | Offset | Description                                  |
|--------|------|--------|----------------------------------------------|
| length | 32u  | 0      | Command size including this field, in bytes. |
| id     | 16u  | 4      | Command identifier (0x4510).                 |

### Reply

| Field  | Type | Offset | Description                                                                |
|--------|------|--------|----------------------------------------------------------------------------|
| length | 32u  | 0      | Reply size including this field, in bytes.                                 |
| id     | 16u  | 4      | Reply identifier (0x4510).                                                 |
| status | 32s  | 6      | Reply status. For a list of status codes, see <i>Commands</i> on page 405. |

## Schedule Digital Output

The Schedule Digital Output command schedules a digital output event. The digital output must be configured to accept software-scheduled commands and be in the Running state. For more information on setting up digital output, see *Digital Output* on page 288.

### Command

| Field  | Type | Offset | Description                                                                                                                                                                                                                                                                                                                          |
|--------|------|--------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| length | 32u  | 0      | Command size including this field, in bytes.                                                                                                                                                                                                                                                                                         |
| id     | 16u  | 4      | Command identifier (0x4518).                                                                                                                                                                                                                                                                                                         |
| index  | 16u  | 6      | Index of the output (starts from 0).                                                                                                                                                                                                                                                                                                 |
| target | 64s  | 8      | Specifies the time (clock ticks) when or position ( $\mu\text{m}$ ) at which the digital output event should happen.<br><br>The target value is ignored if <a href="#">ScheduleEnabled</a> is set to false. ( <b>Scheduled</b> is unchecked in <b>Digital</b> in the <b>Output</b> panel.) The output will be triggered immediately. |
| value  | 8u   | 16     | Specifies the target state:                                                                                                                                                                                                                                                                                                          |

| Field | Type | Offset | Description                                                                                      |
|-------|------|--------|--------------------------------------------------------------------------------------------------|
|       |      |        | 0 – Set to low (continuous)<br>1 – Set to high (continuous)<br>Ignored if output type is pulsed. |

#### Reply

| Field  | Type | Offset | Description                                                                |
|--------|------|--------|----------------------------------------------------------------------------|
| length | 32u  | 0      | Reply size including this field, in bytes.                                 |
| id     | 16u  | 4      | Reply identifier (0x4518).                                                 |
| status | 32s  | 6      | Reply status. For a list of status codes, see <i>Commands</i> on page 405. |

### Schedule Analog Output

The Schedule Analog Output command schedules an analog output event. The analog output must be configured to accept software-scheduled commands and be in the Running state. For information on setting up the analog output, see *Analog Output* on page 291.

#### Command

| Field  | Type | Offset | Description                                                                                                                                                                                                                                                                                                  |
|--------|------|--------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| length | 32u  | 0      | Command size including this field, in bytes.                                                                                                                                                                                                                                                                 |
| id     | 16u  | 4      | Command identifier (0x4519).                                                                                                                                                                                                                                                                                 |
| index  | 16u  | 6      | Index of the output. Must be 0.                                                                                                                                                                                                                                                                              |
| target | 64s  | 8      | Specifies the time (clock ticks) or position (encoder ticks) of when the event should happen.<br><br>The target value is ignored if <a href="#">ScheduleEnabled</a> is set to false. ( <b>Scheduled</b> is unchecked in <b>Analog</b> in the <b>Output</b> panel.) The output will be triggered immediately. |
| value  | 32s  | 16     | Output current (microamperes).                                                                                                                                                                                                                                                                               |

#### Reply

| Field  | Type | Offset | Description                                                                |
|--------|------|--------|----------------------------------------------------------------------------|
| length | 32u  | 0      | Reply size including this field, in bytes.                                 |
| id     | 16u  | 4      | Reply identifier (0x4519).                                                 |
| status | 32s  | 6      | Reply status. For a list of status codes, see <i>Commands</i> on page 405. |



The analog output takes about 75 us to reach 90% of the target value for a maximum change, then roughly another 40 us to settle completely.

### Ping

The Ping command can be used to test the control connection. This command has no effect on sensors.



### Command

| Field   | Type | Offset | Description                                  |
|---------|------|--------|----------------------------------------------|
| length  | 32u  | 0      | Command size including this field, in bytes. |
| id      | 16u  | 4      | Command identifier (0x100E).                 |
| timeout | 64u  | 6      | Timeout value (microseconds).                |

### Reply

| Field  | Type | Offset | Description                                                                |
|--------|------|--------|----------------------------------------------------------------------------|
| length | 32u  | 0      | Reply size including this field, in bytes.                                 |
| id     | 16u  | 4      | Reply identifier (0x100E).                                                 |
| status | 32s  | 6      | Reply status. For a list of status codes, see <i>Commands</i> on page 405. |



If a non-zero value is specified for timeout, the client must send another ping command before the timeout elapses; otherwise the server would close the connection. The timer is reset and updated with every command.

## Reset

The Reset command reboots the Main sensor and any Buddy sensors. All sensors will automatically reset 3 seconds after the reply to this command is transmitted.

### Command

| Field  | Type | Offset | Description                                  |
|--------|------|--------|----------------------------------------------|
| length | 32u  | 0      | Command size including this field, in bytes. |
| id     | 16u  | 4      | Command identifier (0x4300).                 |

### Reply

| Field  | Type | Offset | Description                                                                |
|--------|------|--------|----------------------------------------------------------------------------|
| length | 32u  | 0      | Reply size including this field, in bytes.                                 |
| id     | 16u  | 4      | Reply identifier (0x4300).                                                 |
| status | 32s  | 6      | Reply status. For a list of status codes, see <i>Commands</i> on page 405. |

## Backup

The Backup command creates a backup of all files stored on the connected sensor and downloads the backup to the client.

### Command

| Field  | Type | Offset | Description                                  |
|--------|------|--------|----------------------------------------------|
| length | 32u  | 0      | Command size including this field, in bytes. |
| id     | 16u  | 4      | Command identifier (0x1013).                 |

### Reply

| Field        | Type | Offset | Description                                                                |
|--------------|------|--------|----------------------------------------------------------------------------|
| length       | 32u  | 0      | Reply size including this field, in bytes.                                 |
| id           | 16u  | 4      | Reply identifier (0x1013).                                                 |
| status       | 32s  | 6      | Reply status. For a list of status codes, see <i>Commands</i> on page 405. |
| length       | 32u  | 10     | Data length.                                                               |
| data[length] | byte | 14     | Data content.                                                              |

## Restore

The Restore command uploads a backup file to the connected sensor and then restores all sensor files from the backup.

 The sensor must be reset or power-cycled before the restore operation can be completed.

### Command

| Field        | Type | Offset | Description                                  |
|--------------|------|--------|----------------------------------------------|
| length       | 32u  | 0      | Command size including this field, in bytes. |
| id           | 16u  | 4      | Command identifier (0x1014).                 |
| length       | 32u  | 6      | Data length.                                 |
| data[length] | byte | 10     | Data content.                                |

### Reply

| Field  | Type | Offset | Description                                                                |
|--------|------|--------|----------------------------------------------------------------------------|
| length | 32u  | 0      | Reply size including this field, in bytes.                                 |
| id     | 16u  | 4      | Reply identifier (0x1014).                                                 |
| status | 32s  | 6      | Reply status. For a list of status codes, see <i>Commands</i> on page 405. |

## Restore Factory

The Restore Factory command restores the connected sensor to factory default settings.

 The command erases the non-volatile memory of the main device.

This command has no effect on connected Buddy sensors.

Note that the sensor must be reset or power-cycled before the factory restore operation can be completed.

### Command

| Field  | Type | Offset | Description                                  |
|--------|------|--------|----------------------------------------------|
| length | 32u  | 0      | Command size including this field, in bytes. |
| id     | 16u  | 4      | Command identifier (0x4301).                 |

| Field   | Type | Offset | Description                                                                                        |
|---------|------|--------|----------------------------------------------------------------------------------------------------|
| resetip | 8u   | 6      | Specifies whether IP address should be restored to default:<br>0 – Do not reset IP<br>1 – Reset IP |

#### Reply

| Field  | Type | Offset | Description                                                                |
|--------|------|--------|----------------------------------------------------------------------------|
| length | 32u  | 0      | Reply size including this field, in bytes.                                 |
| id     | 16u  | 4      | Reply identifier (0x4301).                                                 |
| status | 32s  | 6      | Reply status. For a list of status codes, see <i>Commands</i> on page 405. |

### Get Recording Enabled

The Get Recording Enabled command retrieves whether recording is enabled.

#### Command

| Field  | Type | Offset | Description                                  |
|--------|------|--------|----------------------------------------------|
| length | 32u  | 0      | Command size including this field, in bytes. |
| id     | 16u  | 4      | Command identifier (0x4517).                 |

#### Reply

| Field  | Type | Offset | Description                                                                |
|--------|------|--------|----------------------------------------------------------------------------|
| length | 32u  | 0      | Reply size including this field, in bytes.                                 |
| id     | 16u  | 4      | Reply identifier (0x4517).                                                 |
| status | 32s  | 6      | Reply status. For a list of status codes, see <i>Commands</i> on page 405. |
| enable | 8u   | 10     | 0: disabled; 1: enabled.                                                   |

### Set Recording Enabled

The Set Recording Enabled command enables recording for replay later.

#### Command

| Field  | Type | Offset | Description                                  |
|--------|------|--------|----------------------------------------------|
| length | 32u  | 0      | Command size including this field, in bytes. |
| id     | 16u  | 4      | Command identifier (0x4516).                 |
| enable | 8u   | 6      | 0: disabled; 1: enabled.                     |

#### Reply

| Field  | Type | Offset | Description                                                                |
|--------|------|--------|----------------------------------------------------------------------------|
| length | 32u  | 0      | Reply size including this field, in bytes.                                 |
| id     | 16u  | 4      | Reply identifier (0x4516).                                                 |
| status | 32s  | 6      | Reply status. For a list of status codes, see <i>Commands</i> on page 405. |

## Clear Replay Data

The Clear Replay Data command clears the sensors replay data..

### Command

| Field  | Type | Offset | Description                                  |
|--------|------|--------|----------------------------------------------|
| length | 32u  | 0      | Command size including this field, in bytes. |
| id     | 16u  | 4      | Command identifier (0x4513).                 |

### Reply

| Field  | Type | Offset | Description                                                                |
|--------|------|--------|----------------------------------------------------------------------------|
| length | 32u  | 0      | Reply size including this field, in bytes.                                 |
| id     | 16u  | 4      | Reply identifier (0x4513).                                                 |
| status | 32s  | 6      | Reply status. For a list of status codes, see <i>Commands</i> on page 405. |

## Get Playback Source

The Get Playback Source command gets the data source for data playback.

### Command

| Field  | Type | Offset | Description                                  |
|--------|------|--------|----------------------------------------------|
| length | 32u  | 0      | Command size including this field, in bytes. |
| id     | 16u  | 4      | Command identifier (0x4524).                 |

### Reply

| Field  | Type | Offset | Description                                                                |
|--------|------|--------|----------------------------------------------------------------------------|
| length | 32u  | 0      | Reply size including this field, in bytes.                                 |
| id     | 16u  | 4      | Reply identifier (0x4524).                                                 |
| status | 32s  | 6      | Reply status. For a list of status codes, see <i>Commands</i> on page 405. |
| source | 32s  | 10     | Source<br>0 – Live<br>1 – Replay buffer                                    |

## Set Playback Source

The Set Playback Source command sets the data source for data playback.

### Command

| Field  | Type | Offset | Description                                  |
|--------|------|--------|----------------------------------------------|
| length | 32u  | 0      | Command size including this field, in bytes. |
| id     | 16u  | 4      | Command identifier (0x4523).                 |
| source | 32s  | 6      | Source<br>0 – Live<br>1 – Replay buffer      |

### Reply

| Field  | Type | Offset | Description                                                                |
|--------|------|--------|----------------------------------------------------------------------------|
| length | 32u  | 0      | Reply size including this field, in bytes.                                 |
| id     | 16u  | 4      | Reply identifier (0x4523).                                                 |
| status | 32s  | 6      | Reply status. For a list of status codes, see <i>Commands</i> on page 405. |

## Simulate

The Simulate command simulates the last frame if playback source is live, or the current frame if playback source is the replay buffer.

### Command

| Field  | Type | Offset | Description                                  |
|--------|------|--------|----------------------------------------------|
| length | 32u  | 0      | Command size including this field, in bytes. |
| id     | 16u  | 4      | Command identifier (0x4522).                 |

### Reply

| Field       | Type | Offset | Description                                                                |
|-------------|------|--------|----------------------------------------------------------------------------|
| length      | 32u  | 0      | Reply size including this field, in bytes.                                 |
| id          | 16u  | 4      | Reply identifier (0x4522).                                                 |
| status      | 32s  | 6      | Reply status. For a list of status codes, see <i>Commands</i> on page 405. |
| bufferValid | 8u   | 10     | Whether or not the buffer is valid.                                        |



A reply status of -996 means that the current configuration (mode, sensor type, etc.) does not support simulation.

A reply status of -992 means that the simulation buffer is empty. Note that the buffer can be valid even if the simulation buffer is actually empty due to optimization choices. This scenario means that the simulation buffer would be valid if data were recorded.

## Seek Playback

The Seek Playback command seeks to any position in the current playback dataset. The frame is then sent.

### Command

| Field  | Type | Offset | Description                                  |
|--------|------|--------|----------------------------------------------|
| length | 32u  | 0      | Command size including this field, in bytes. |
| id     | 16u  | 4      | Command identifier (0x4503).                 |
| frame  | 32u  | 6      | Frame index.                                 |

### Reply

| Field  | Type | Offset | Description                                |
|--------|------|--------|--------------------------------------------|
| length | 32u  | 0      | Reply size including this field, in bytes. |

| Field  | Type | Offset | Description                                                                |
|--------|------|--------|----------------------------------------------------------------------------|
| id     | 16u  | 4      | Reply identifier (0x4503).                                                 |
| status | 32s  | 6      | Reply status. For a list of status codes, see <i>Commands</i> on page 405. |

## Step Playback

The Step Playback command advances playback by one frame.

### Command

| Field     | Type | Offset | Description                                         |
|-----------|------|--------|-----------------------------------------------------|
| length    | 32u  | 0      | Command size including this field, in bytes.        |
| id        | 16u  | 4      | Command identifier (0x4501).                        |
| direction | 32s  | 6      | Define step direction<br>0 – Forward<br>1 – Reverse |

### Reply

| Field  | Type | Offset | Description                                                                |
|--------|------|--------|----------------------------------------------------------------------------|
| length | 32u  | 0      | Reply size including this field, in bytes.                                 |
| id     | 16u  | 4      | Reply identifier (0x4501).                                                 |
| status | 32s  | 6      | Reply status. For a list of status codes, see <i>Commands</i> on page 405. |



When the system is running in the Replay mode, this command advances replay data (playback) by one frame. This command returns an error if no live playback data set is loaded. You can use the [Copy File](#) command to load a replay data set to \_live.rec.

## Playback Position

The Playback Position command retrieves the current playback position.

### Command

| Field  | Type | Offset | Description                                  |
|--------|------|--------|----------------------------------------------|
| length | 32u  | 0      | Command size including this field, in bytes. |
| id     | 16u  | 4      | Command identifier (0x4502).                 |

### Reply

| Field       | Type | Offset | Description                                                                |
|-------------|------|--------|----------------------------------------------------------------------------|
| length      | 32u  | 0      | Reply size including this field, in bytes.                                 |
| id          | 16u  | 4      | Reply identifier (0x4502).                                                 |
| status      | 32s  | 6      | Reply status. For a list of status codes, see <i>Commands</i> on page 405. |
| Frame Index | 32u  | 10     | Current frame index (starts from 0).                                       |
| Frame Count | 32u  | 14     | Total number of available frames/objects.                                  |

## Clear Measurement Stats

The Clear Measurement Stats command clears the sensor's measurement statistics.

### Command

| Field  | Type | Offset | Description                                  |
|--------|------|--------|----------------------------------------------|
| length | 32u  | 0      | Command size including this field, in bytes. |
| id     | 16u  | 4      | Command identifier (0x4526).                 |

### Reply

| Field  | Type | Offset | Description                                                                |
|--------|------|--------|----------------------------------------------------------------------------|
| length | 32u  | 0      | Reply size including this field, in bytes.                                 |
| id     | 16u  | 4      | Reply identifier (0x4526).                                                 |
| status | 32s  | 6      | Reply status. For a list of status codes, see <i>Commands</i> on page 405. |

## Read Live Log

The Read Live Log command returns an XML file containing the log messages between the passed start and end indexes.

### Command

| Field  | Type | Offset | Description                                  |
|--------|------|--------|----------------------------------------------|
| length | 32u  | 0      | Command size including this field, in bytes. |
| id     | 16u  | 4      | Command identifier (0x101F).                 |
| Start  | 32u  | 6      | First log to read                            |
| End    | 32u  | 10     | Last log to read                             |

### Reply

| Field        | Type | Offset | Description                                |
|--------------|------|--------|--------------------------------------------|
| length       | 32u  | 0      | Reply size including this field, in bytes. |
| id           | 16u  | 4      | Reply identifier (0x101F).                 |
| status       | 32s  | 6      | Reply status.                              |
| length       | 32u  | 10     | File length                                |
| data[length] | byte | 14     | XML Log File                               |

## Clear Log

The Clear Log command clears the sensor's log.

### Command

| Field  | Type | Offset | Description                                  |
|--------|------|--------|----------------------------------------------|
| length | 32u  | 0      | Command size including this field, in bytes. |
| id     | 16u  | 4      | Command identifier (0x101D).                 |

### Reply

| Field  | Type | Offset | Description                                                                |
|--------|------|--------|----------------------------------------------------------------------------|
| length | 32u  | 0      | Reply size including this field, in bytes.                                 |
| id     | 16u  | 4      | Reply identifier (0x101D).                                                 |
| status | 32s  | 6      | Reply status. For a list of status codes, see <i>Commands</i> on page 405. |

## Simulate Unaligned

The Simulate Unaligned command simulates data before alignment transformation.

### Command

| Field  | Type | Offset | Description                                  |
|--------|------|--------|----------------------------------------------|
| length | 32u  | 0      | Command size including this field, in bytes. |
| id     | 16u  | 4      | Command identifier (0x452A).                 |

### Reply

| Field  | Type | Offset | Description                                                                |
|--------|------|--------|----------------------------------------------------------------------------|
| length | 32u  | 0      | Reply size including this field, in bytes.                                 |
| id     | 16u  | 4      | Reply identifier (0x452A).                                                 |
| status | 32s  | 6      | Reply status. For a list of status codes, see <i>Commands</i> on page 405. |

## Acquire

The Acquire command acquires a new scan.

### Command

| Field  | Type | Offset | Description                                  |
|--------|------|--------|----------------------------------------------|
| length | 32u  | 0      | Command size including this field, in bytes. |
| id     | 16u  | 4      | Command identifier (0x4528).                 |

### Reply

| Field  | Type | Offset | Description                                                                |
|--------|------|--------|----------------------------------------------------------------------------|
| length | 32u  | 0      | Reply size including this field, in bytes.                                 |
| id     | 16u  | 4      | Reply identifier (0x4528).                                                 |
| status | 32s  | 6      | Reply status. For a list of status codes, see <i>Commands</i> on page 405. |



The command returns after the scan has been captured and transmitted.

## Acquire Unaligned

The Acquire Unaligned command acquires a new scan without performing alignment transformation.



### Command

| Field  | Type | Offset | Description                                  |
|--------|------|--------|----------------------------------------------|
| length | 32u  | 0      | Command size including this field, in bytes. |
| id     | 16u  | 4      | Command identifier (0x4527).                 |

### Reply

| Field  | Type | Offset | Description                                                                |
|--------|------|--------|----------------------------------------------------------------------------|
| length | 32u  | 0      | Reply size including this field, in bytes.                                 |
| id     | 16u  | 4      | Reply identifier (0x4527).                                                 |
| status | 32s  | 6      | Reply status. For a list of status codes, see <i>Commands</i> on page 405. |



The command returns after the scan has been captured and transmitted.

## Create Model

The Create Model command creates a new part model from the active simulation scan.

### Command

| Field         | Type | Offset | Description                                    |
|---------------|------|--------|------------------------------------------------|
| length        | 32u  | 0      | Command size including this field, in bytes.   |
| id            | 16u  | 4      | Command identifier (0x4602).                   |
| modelName[64] | char | 6      | Name of the new model (without .mdl extension) |

### Reply

| Field  | Type | Offset | Description                                                                |
|--------|------|--------|----------------------------------------------------------------------------|
| length | 32u  | 0      | Reply size including this field, in bytes.                                 |
| id     | 16u  | 4      | Reply identifier (0x4602).                                                 |
| status | 32s  | 6      | Reply status. For a list of status codes, see <i>Commands</i> on page 405. |

## Detect Edges

The Detect Edges command detects and updates the edge points of a part model.

### Command

| Field         | Type | Offset | Description                                  |
|---------------|------|--------|----------------------------------------------|
| length        | 32u  | 0      | Command size including this field, in bytes. |
| id            | 16u  | 4      | Command identifier (0x4604).                 |
| modelName[64] | char | 6      | Name of the model (without .mdl extension)   |
| sensitivity   | 16u  | 70     | Sensitivity (in thousandths).                |

### *Reply*

| Field  | Type | Offset | Description                                                                |
|--------|------|--------|----------------------------------------------------------------------------|
| length | 32u  | 0      | Reply size including this field, in bytes.                                 |
| id     | 16u  | 4      | Reply identifier (0x4604).                                                 |
| status | 32s  | 6      | Reply status. For a list of status codes, see <i>Commands</i> on page 405. |

## Add Tool

The Add Tool command adds a tool to the live job.

### *Command*

| Field        | Type | Offset | Description                                   |
|--------------|------|--------|-----------------------------------------------|
| length       | 32u  | 0      | Command size including this field, in bytes.  |
| id           | 16u  | 4      | Command identifier (0x4530).                  |
| typeName[64] | char | 6      | Type name of the tool (e.g., ProfilePosition) |
| name[64]     | char | 70     | User-specified name for tool instance         |

### *Reply*

| Field  | Type | Offset | Description                                                                |
|--------|------|--------|----------------------------------------------------------------------------|
| length | 32u  | 0      | Reply size including this field, in bytes.                                 |
| id     | 16u  | 4      | Reply identifier (0x4530).                                                 |
| status | 32s  | 6      | Reply status. For a list of status codes, see <i>Commands</i> on page 405. |

## Add Measurement

The Add Measurement command adds a measurement to a tool instance.

### *Command*

| Field        | Type | Offset | Description                                                 |
|--------------|------|--------|-------------------------------------------------------------|
| length       | 32u  | 0      | Command size including this field, in bytes.                |
| id           | 16u  | 4      | Command identifier (0x4531).                                |
| toolIndex    | 32u  | 6      | Index of the tool instance the new measurement is added to. |
| typeName[64] | char | 10     | Type name of the measurement (for example, X).              |
| name[64]     | char | 74     | User-specified name of the measurement instance.            |

### *Reply*

| Field  | Type | Offset | Description                                                                |
|--------|------|--------|----------------------------------------------------------------------------|
| length | 32u  | 0      | Reply size including this field, in bytes.                                 |
| id     | 16u  | 4      | Reply identifier (0x4531).                                                 |
| status | 32s  | 6      | Reply status. For a list of status codes, see <i>Commands</i> on page 405. |



This command can only be used with dynamic tools (tools with a dynamic list of measurements). The maximum number of instances for a given measurement type can be found in the [ToolOptions](#) node. For dynamic tools, the maximum count is greater than one, while for static tools it is one.

## Read File (Progressive)

The progressive Read File command reads the content of a file as a stream.

This command returns an initial reply, followed by a series of "continue" replies if the initial reply's *status* field indicates success. The continue replies contain the actual data, and have 0x5000 as their identifier.

### Command

| Field    | Type | Offset | Description                                  |
|----------|------|--------|----------------------------------------------|
| length   | 32u  | 0      | Command size including this field, in bytes. |
| id       | 16u  | 4      | Command identifier (0x4529).                 |
| name[64] | char | 6      | Source file name.                            |

### Initial Reply

| Field         | Type | Offset | Description                                                                |
|---------------|------|--------|----------------------------------------------------------------------------|
| length        | 32u  | 0      | Reply size including this field, in bytes.                                 |
| id            | 16u  | 4      | Reply identifier (0x4529).                                                 |
| status        | 32s  | 6      | Reply status. For a list of status codes, see <i>Commands</i> on page 405. |
| progressTotal | 32u  | 10     | Progress indicating completion (100%).                                     |
| progress      | 32u  | 14     | Current progress.                                                          |

### Continue Reply

| Field         | Type | Offset | Description                                                                |
|---------------|------|--------|----------------------------------------------------------------------------|
| length        | 32u  | 0      | Reply size including this field, in bytes.                                 |
| id            | 16u  | 4      | Reply identifier (0x5000).                                                 |
| status        | 32s  | 6      | Reply status. For a list of status codes, see <i>Commands</i> on page 405. |
| progressTotal | 32u  | 10     | Progress indicating completion (100%).                                     |
| progress      | 32u  | 14     | Current progress.                                                          |
| size          | 32u  | 18     | Size of the chunk in bytes.                                                |
| data[size]    | byte | 22     | Chunk data.                                                                |

## Export CSV (Progressive)

The progressive Export CSV command exports replay data as a CSV stream.

This command returns an initial reply, followed by a series of "continue" replies if the initial reply's *status* field indicates success. The continue replies contain the actual data, and have 0x5000 as their identifier.

### Command

| Field  | Type | Offset | Description                                  |
|--------|------|--------|----------------------------------------------|
| length | 32u  | 0      | Command size including this field, in bytes. |
| id     | 16u  | 4      | Command identifier (0x4507).                 |

### Initial Reply

| Field         | Type | Offset | Description                                                                |
|---------------|------|--------|----------------------------------------------------------------------------|
| length        | 32u  | 0      | Reply size including this field, in bytes.                                 |
| id            | 16u  | 4      | Reply identifier (0x4507).                                                 |
| status        | 32s  | 6      | Reply status. For a list of status codes, see <i>Commands</i> on page 405. |
| progressTotal | 32u  | 10     | Progress indicating completion (100%).                                     |
| progress      | 32u  | 14     | Current progress.                                                          |

### Continue Reply

| Field         | Type | Offset | Description                                                                |
|---------------|------|--------|----------------------------------------------------------------------------|
| length        | 32u  | 0      | Reply size including this field, in bytes.                                 |
| id            | 16u  | 4      | Reply identifier (0x5000).                                                 |
| status        | 32s  | 6      | Reply status. For a list of status codes, see <i>Commands</i> on page 405. |
| progressTotal | 32u  | 10     | Progress indicating completion (100%).                                     |
| progress      | 32u  | 14     | Current progress.                                                          |
| size          | 32u  | 18     | Size of the chunk in bytes.                                                |
| data[size]    | byte | 22     | Chunk data.                                                                |



All recorded range or profile data is exported to the CSV stream. Only the current surface scan, as determined by the playback position, is exported to the CSV stream.

## Export Bitmap (Progressive)

The progressive Export Bitmap command exports replay data as a bitmap stream.

This command returns an initial reply, followed by a series of "continue" replies if the initial reply's *status* field indicates success. The continue replies contain the actual data, and have 0x5000 as their identifier.

### Command

| Field  | Type | Offset | Description                                       |
|--------|------|--------|---------------------------------------------------|
| length | 32u  | 0      | Command size including this field, in bytes.      |
| id     | 16u  | 4      | Command identifier (0x4508).                      |
| type   | 32s  | 6      | Data type:<br>0 – Range or video<br>1 – Intensity |
| source | 32s  | 10     | Data source to export.                            |

#### *Initial Reply*

| Field         | Type | Offset | Description                                                                |
|---------------|------|--------|----------------------------------------------------------------------------|
| length        | 32u  | 0      | Reply size including this field, in bytes.                                 |
| id            | 16u  | 4      | Reply identifier (0x4508).                                                 |
| status        | 32s  | 6      | Reply status. For a list of status codes, see <i>Commands</i> on page 405. |
| progressTotal | 32u  | 10     | Progress indicating completion (100%).                                     |
| progress      | 32u  | 14     | Current progress.                                                          |

#### *Continue Reply*

| Field         | Type | Offset | Description                                                                |
|---------------|------|--------|----------------------------------------------------------------------------|
| length        | 32u  | 0      | Reply size including this field, in bytes.                                 |
| id            | 16u  | 4      | Reply identifier (0x5000).                                                 |
| status        | 32s  | 6      | Reply status. For a list of status codes, see <i>Commands</i> on page 405. |
| progressTotal | 32u  | 10     | Progress indicating completion (100%).                                     |
| progress      | 32u  | 14     | Current progress.                                                          |
| size          | 32u  | 18     | Size of the chunk in bytes.                                                |
| data[size]    | byte | 22     | Chunk data.                                                                |

### Get Runtime Variable Count

The Get Runtime Variable Count command gets the number of runtime variables that can be accessed.

#### *Command*

| Field  | Type | Offset | Description                                  |
|--------|------|--------|----------------------------------------------|
| length | 32u  | 0      | Command size including this field, in bytes. |
| id     | 16u  | 4      | Command identifier (0x4537).                 |

#### *Reply*

| Field       | Type | Offset | Description                                |
|-------------|------|--------|--------------------------------------------|
| length      | 32u  | 0      | Reply size including this field, in bytes. |
| id          | 16u  | 4      | Reply identifier (0x4537).                 |
| status      | 32s  | 6      | Reply status.                              |
| valueLength | 32u  | 10     | The count of runtime variables.            |

### Set Runtime Variables

The Set Runtime Variables command sets the runtime variables at the given index for the given length.

#### *Command*

| Field  | Type | Offset | Description                                  |
|--------|------|--------|----------------------------------------------|
| length | 32u  | 0      | Command size including this field, in bytes. |

| Field          | Type | Offset | Description                                          |
|----------------|------|--------|------------------------------------------------------|
| id             | 16u  | 4      | Command identifier (0x4536).                         |
| index          | 32u  | 6      | The starting index of the variables to set.          |
| length         | 32u  | 10     | The number of values to set from the starting index. |
| values[length] | 32s  | 14     | The runtime variable values to set.                  |

#### Reply

| Field  | Type | Offset | Description                                |
|--------|------|--------|--------------------------------------------|
| length | 32u  | 0      | Reply size including this field, in bytes. |
| id     | 16u  | 4      | Reply identifier (0x4536).                 |
| status | 32s  | 6      | Reply status.                              |

### Get Runtime Variables

The Get Runtime Variables command gets the runtime variables for the given index and length.

#### Command

| Field  | Type | Offset | Description                                               |
|--------|------|--------|-----------------------------------------------------------|
| length | 32u  | 0      | Command size including this field, in bytes.              |
| id     | 16u  | 4      | Command identifier (0x4535).                              |
| index  | 32u  | 6      | The starting index of the variables to retrieve.          |
| length | 32u  | 10     | The number of values to retrieve from the starting index. |

#### Reply

| Field          | Type | Offset | Description                                         |
|----------------|------|--------|-----------------------------------------------------|
| length         | 32u  | 0      | Reply size including this field, in bytes.          |
| id             | 16u  | 4      | Reply identifier (0x4535).                          |
| status         | 32s  | 6      | Reply status.                                       |
| index          | 32u  | 10     | The starting index of the variables being returned. |
| length         | 32u  | 14     | The number of values being returned.                |
| values[length] | 32s  | 18     | The runtime variable values.                        |

### Upgrade Commands

A client sends firmware upgrade commands over the Upgrade TCP channel (port 3192).

The Control channel (port 3190) and the Upgrade channel can be connected simultaneously. For more information on Control commands, see *Control Commands* on page 409.

After connecting to a Gocator sensor, you can use the [Protocol Version](#) command to retrieve the protocol version. Protocol version refers to the version of the Gocator Protocol supported by the *connected sensor* (the sensor to which a command connection is established), and consists of major and minor parts. The minor part is updated when backward-compatible additions are made to the Gocator Protocol. The major part is updated when breaking changes are made to the Gocator Protocol.

## Start Upgrade

The Start Upgrade command begins a firmware upgrade for the sensors in a system. All sensors automatically reset 3 seconds after the upgrade process is complete.

### Command

| Field        | Type | Offset | Description                                  |
|--------------|------|--------|----------------------------------------------|
| length       | 64s  | 0      | Command size including this field, in bytes. |
| id           | 64s  | 8      | Command identifier (0x0000).                 |
| length       | 64s  | 16     | Length of the upgrade package (bytes).       |
| data[length] | byte | 24     | Upgrade package data.                        |

### Reply

| Field  | Type | Offset | Description                                                                |
|--------|------|--------|----------------------------------------------------------------------------|
| length | 64s  | 0      | Reply size including this field, in bytes.                                 |
| id     | 64s  | 8      | Reply identifier (0x0000).                                                 |
| status | 64s  | 16     | Reply status. For a list of status codes, see <i>Commands</i> on page 405. |

## Start Upgrade Extended

The Start Upgrade Extended command begins a firmware upgrade for the sensors in a system. All sensors automatically reset 3 seconds after the upgrade process is complete.

### Command

| Field          | Type | Offset | Description                                                    |
|----------------|------|--------|----------------------------------------------------------------|
| length         | 64s  | 0      | Command size including this field, in bytes.                   |
| id             | 64s  | 8      | Command identifier (0x0003).                                   |
| skipValidation | 64s  | 16     | Whether or not to skip validation (0 – do not skip, 1 – skip). |
| length         | 64s  | 24     | Length of the upgrade package (bytes).                         |
| data[length]   | byte | 32     | Upgrade package data.                                          |

### Reply

| Field  | Type | Offset | Description                                                                |
|--------|------|--------|----------------------------------------------------------------------------|
| length | 64s  | 0      | Reply size including this field, in bytes.                                 |
| id     | 64s  | 8      | Reply identifier (0x0003).                                                 |
| status | 64s  | 16     | Reply status. For a list of status codes, see <i>Commands</i> on page 405. |

## Get Upgrade Status

The Get Upgrade Status command determines the progress of a firmware upgrade.

### Command

| Field  | Type | Offset | Description                                  |
|--------|------|--------|----------------------------------------------|
| length | 64s  | 0      | Command size including this field, in bytes. |
| id     | 64s  | 8      | Command identifier (0x1)                     |

### Reply

| Field    | Type | Offset | Description                                                                                          |
|----------|------|--------|------------------------------------------------------------------------------------------------------|
| length   | 64s  | 0      | Reply size including this field, in bytes.                                                           |
| id       | 64s  | 8      | Reply identifier (0x1).                                                                              |
| status   | 64s  | 16     | Reply status. For a list of status codes, see <i>Commands</i> on page 405.                           |
| state    | 64s  | 24     | Upgrade state:<br>-1 – Failed<br>0 – Completed<br>1 – Running<br>2 – Completed, but should run again |
| progress | 64s  | 32     | Upgrade progress (valid when in the Running state)                                                   |

## Get Upgrade Log

The Get Upgrade Log command can retrieve an upgrade log in the event of upgrade problems.

### Command

| Field  | Type | Offset | Description                                  |
|--------|------|--------|----------------------------------------------|
| length | 64s  | 0      | Command size including this field, in bytes. |
| id     | 64s  | 8      | Command identifier (0x2)                     |

### Reply

| Field       | Type | Offset | Description                                                                |
|-------------|------|--------|----------------------------------------------------------------------------|
| length      | 64s  | 0      | Reply size including this field, in bytes.                                 |
| id          | 64s  | 8      | Reply identifier (0x2).                                                    |
| status      | 64s  | 16     | Reply status. For a list of status codes, see <i>Commands</i> on page 405. |
| length      | 64s  | 24     | Length of the log (bytes).                                                 |
| log[length] | char | 32     | Log content.                                                               |

## Results

The following sections describe the results (data and health) that Gocator sends.

### Data Results

A client can receive data messages from a Gocator sensor by connecting to the Data TCP channel (port 3196).

The Data channel and the Health channel (port 3194) can be connected at the same time. The sensor accepts multiple connections on each port. For more information on the Health channel, see *Health Results* on page 455.

Messages that are received on the Data and Health channels use a common structure, called Gocator Data Protocol (GDP). Each GDP message consists of a 6-byte header, containing *size* and *control* fields,



followed by a variable-length, message-specific content section. The structure of the GDP message is defined below.

#### *Gocator Data Protocol*

| Field   | Type | Offset | Description                                                                                             |
|---------|------|--------|---------------------------------------------------------------------------------------------------------|
| size    | 32u  | 0      | Count of bytes in message (including this field).                                                       |
| control | 16u  | 4      | Bit 15: Last Message flag<br>Bits 0-14: Message type identifier. (See individual data result sections.) |

GDP messages are always sent in groups. The Last Message flag in the *control* field is used to indicate the final message in a group. If there is only one message per group, this bit will be set in each message.

### Stamp

| Field     | Type  | Offset | Description                                                                                   |
|-----------|-------|--------|-----------------------------------------------------------------------------------------------|
| size      | 32u   | 0      | Count of bytes in message (including this field).                                             |
| control   | 16u   | 4      | Bit 15: Last message flag.<br>Bits 0-14: Message type identifier. For this message, set to 1. |
| count (C) | 32u   | 6      | Count of stamps in this message.                                                              |
| size      | 16u   | 10     | Stamp size, in bytes (min: 56, current: 56).                                                  |
| source    | 8u    | 12     | Source (0 – Main, 1 – Buddy).                                                                 |
| reserved  | 8u    | 13     | Reserved.                                                                                     |
| stamps[C] | Stamp | 14     | Array of stamps (see below).                                                                  |

#### *Stamp*

| Field        | Type | Offset | Description                                                                                                                                                                                                                                                                                                                                   |
|--------------|------|--------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| frameIndex   | 64u  | 0      | Frame index (counts up from zero).                                                                                                                                                                                                                                                                                                            |
| timestamp    | 64u  | 8      | Timestamp (µs).                                                                                                                                                                                                                                                                                                                               |
| encoder      | 64s  | 16     | Current encoder value (ticks).                                                                                                                                                                                                                                                                                                                |
| encoderAtZ   | 64s  | 24     | Encoder value latched at z/index mark (ticks).                                                                                                                                                                                                                                                                                                |
| status       | 64u  | 32     | Bit field containing various frame information:<br>Bit 0: sensor digital input state<br>Bit 4: master digital input state<br>Bit 8-9: inter-frame digital pulse trigger (Master digital input if master is connected, otherwise sensor digital input. Value is cleared after each frame and clamped at 3 if more than 3 pulses are received). |
| serialNumber | 32u  | 40     | Sensor serial number. (In a dual-sensor system, the serial number of the main sensor.)                                                                                                                                                                                                                                                        |
| reserved[2]  | 32u  | 44     | Reserved.                                                                                                                                                                                                                                                                                                                                     |

## Video

| Field          | Type       | Offset | Description                                                                                                           |
|----------------|------------|--------|-----------------------------------------------------------------------------------------------------------------------|
| size           | 32u        | 0      | Count of bytes in message (including this field).                                                                     |
| control        | 16u        | 4      | Bit 15: Last message flag.<br>Bits 0-14: Message type identifier. For this message, set to 2.                         |
| attributesSize | 16u        | 6      | Size of attributes, in bytes (min: 20, current: 20).                                                                  |
| height (H)     | 32u        | 8      | Image height, in pixels.                                                                                              |
| width (W)      | 32u        | 12     | Image width, in pixels.                                                                                               |
| pixelSize      | 8u         | 16     | Pixel size, in bytes.                                                                                                 |
| pixelFormat    | 8u         | 17     | Pixel format:<br>1 – 8-bit greyscale<br>2 – 8-bit color filter<br>3 – 8-bits-per-channel color (B, G, R, X)           |
| colorFilter    | 8u         | 18     | Color filter array alignment:<br>0 – None<br>1 – Bayer BG/GR<br>2 – Bayer GB/RG<br>3 – Bayer RG/GB<br>4 – Bayer GR/BG |
| source         | 8u         | 19     | Source<br>0 – Top<br>1 – Bottom<br>2 – Top Left<br>3 – Top Right                                                      |
| cameraIndex    | 8u         | 20     | Camera index.                                                                                                         |
| exposureIndex  | 8u         | 21     | Exposure index.                                                                                                       |
| exposure       | 32u        | 22     | Exposure (ns).                                                                                                        |
| flippedX       | 8u         | 26     | Indicates whether the video data must be flipped horizontally to match up with profile data.                          |
| flippedY       | 8u         | 27     | Indicates whether the video data must be flipped vertically to match up with profile data.                            |
| pixels[H][W]   | (Variable) | 28     | Image pixels. (Depends on pixelSize above.)                                                                           |

## Profile

| Field   | Type | Offset | Description                                       |
|---------|------|--------|---------------------------------------------------|
| size    | 32u  | 0      | Count of bytes in message (including this field). |
| control | 16u  | 4      | Bit 15: Last message flag.                        |

| Field         | Type     | Offset | Description                                                      |
|---------------|----------|--------|------------------------------------------------------------------|
|               |          |        | Bits 0-14: Message type identifier. For this message, set to 5.  |
| attributeSize | 16u      | 6      | Size of attributes, in bytes (min: 32, current: 32).             |
| count (C)     | 32u      | 8      | Number of profile arrays.                                        |
| width (W)     | 32u      | 12     | Number of points per profile array.                              |
| xScale        | 32u      | 16     | X scale (nm).                                                    |
| zScale        | 32u      | 20     | Z scale (nm).                                                    |
| xOffset       | 32s      | 24     | X offset (μm).                                                   |
| zOffset       | 32s      | 28     | Z offset (μm).                                                   |
| source        | 8u       | 32     | Source<br>0 – Top<br>1 – Bottom<br>2 – Top Left<br>3 – Top Right |
| exposure      | 32u      | 33     | Exposure (ns).                                                   |
| cameraIndex   | 8u       | 37     | Camera index.                                                    |
| reserved[2]   | 8u       | 38     | Reserved.                                                        |
| ranges[C][W]  | Point16s | 40     | Profile ranges.                                                  |

## Resampled Profile

| Field         | Type | Offset | Description                                                                                   |
|---------------|------|--------|-----------------------------------------------------------------------------------------------|
| size          | 32u  | 0      | Count of bytes in message (including this field).                                             |
| control       | 16u  | 4      | Bit 15: Last message flag.<br>Bits 0-14: Message type identifier. For this message, set to 6. |
| attributeSize | 16u  | 6      | Size of attributes, in bytes (min: 32, current: 32).                                          |
| count (C)     | 32u  | 8      | Number of profile arrays.                                                                     |
| width (W)     | 32u  | 12     | Number of points per profile array.                                                           |
| xScale        | 32u  | 16     | X scale (nm).                                                                                 |
| zScale        | 32u  | 20     | Z scale (nm).                                                                                 |
| xOffset       | 32s  | 24     | X offset (μm).                                                                                |
| zOffset       | 32s  | 28     | Z offset (μm).                                                                                |
| source        | 8u   | 32     | Source<br>0 – Top<br>1 – Bottom<br>2 – Top Left<br>3 – Top Right                              |

| Field        | Type | Offset | Description     |
|--------------|------|--------|-----------------|
| exposure     | 32u  | 33     | Exposure (ns).  |
| reserved[3]  | 8u   | 37     | Reserved.       |
| ranges[C][W] | 16s  | 40     | Profile ranges. |

## Profile Intensity

| Field          | Type | Offset | Description                                                                                   |
|----------------|------|--------|-----------------------------------------------------------------------------------------------|
| size           | 32u  | 0      | Count of bytes in message (including this field).                                             |
| control        | 16u  | 4      | Bit 15: Last message flag.<br>Bits 0-14: Message type identifier. For this message, set to 7. |
| attributesSize | 16u  | 6      | Size of attributes, in bytes (min: 24, current: 24).                                          |
| count (C)      | 32u  | 8      | Number of profile intensity arrays.                                                           |
| width (W)      | 32u  | 12     | Number of points per profile intensity array.                                                 |
| xScale         | 32u  | 16     | X scale (nm).                                                                                 |
| xOffset        | 32s  | 20     | X offset (μm).                                                                                |
| source         | 8u   | 24     | Source<br>0 – Top<br>1 – Bottom<br>2 – Top Left<br>3 – Top Right                              |
| exposure       | 32u  | 25     | Exposure (ns).                                                                                |
| reserved[3]    | 8u   | 29     | Reserved.                                                                                     |
| points[C][W]   | 8u   | 32     | Intensity arrays.                                                                             |

## Surface

| Field         | Type | Offset | Description                                                                                   |
|---------------|------|--------|-----------------------------------------------------------------------------------------------|
| size          | 32u  | 0      | Count of bytes in message (including this field).                                             |
| control       | 16u  | 4      | Bit 15: Last message flag.<br>Bits 0-14: Message type identifier. For this message, set to 8. |
| attributeSize | 16u  | 6      | Size of attributes, in bytes (min: 40, current: 40).                                          |
| length (L)    | 32u  | 8      | Surface length (rows).                                                                        |
| length (W)    | 32u  | 12     | Surface width (columns).                                                                      |
| xScale        | 32u  | 16     | X scale (nm).                                                                                 |
| yScale        | 32u  | 20     | Y scale (nm).                                                                                 |
| zScale        | 32u  | 24     | Z scale (nm).                                                                                 |
| xOffset       | 32s  | 28     | X offset (μm).                                                                                |

| Field        | Type | Offset | Description                                                      |
|--------------|------|--------|------------------------------------------------------------------|
| yOffset      | 32s  | 32     | Y offset (μm).                                                   |
| zOffset      | 32s  | 36     | Z offset (μm).                                                   |
| source       | 8u   | 40     | Source<br>0 – Top<br>1 – Bottom<br>2 – Top Left<br>3 – Top Right |
| exposure     | 32u  | 41     | Exposure (ns).                                                   |
| reserved[7]  | 8u   | 45     | Reserved.                                                        |
| ranges[L][W] | 16s  | 52     | Surface ranges.                                                  |

## Surface Intensity

| Field             | Type | Offset | Description                                                                                   |
|-------------------|------|--------|-----------------------------------------------------------------------------------------------|
| size              | 32u  | 0      | Count of bytes in message (including this field).                                             |
| control           | 16u  | 4      | Bit 15: Last message flag.<br>Bits 0-14: Message type identifier. For this message, set to 9. |
| attributeSize     | 16u  | 6      | Size of attributes, in bytes (min: 32, current: 32).                                          |
| length (L)        | 32u  | 8      | Surface length (rows).                                                                        |
| width (W)         | 32u  | 12     | Surface width (columns).                                                                      |
| xScale            | 32u  | 16     | X scale (nm).                                                                                 |
| yScale            | 32u  | 20     | Y scale (nm).                                                                                 |
| xOffset           | 32s  | 24     | X offset (μm).                                                                                |
| yOffset           | 32s  | 28     | Y offset (μm).                                                                                |
| source            | 8u   | 32     | Source<br>0 – Top<br>1 – Bottom<br>2 – Top Left<br>3 – Top Right                              |
| exposure          | 32u  | 33     | Exposure (ns).                                                                                |
| reserved[3]       | 8u   | 37     |                                                                                               |
| intensities[H][W] | 8u   | 40     | Surface intensities.                                                                          |

## Surface Section

| Field   | Type | Offset | Description                                       |
|---------|------|--------|---------------------------------------------------|
| size    | 32u  | 0      | Count of bytes in message (including this field). |
| control | 16u  | 4      | Bit 15: Last message flag.                        |

| Field         | Type | Offset | Description                                                      |
|---------------|------|--------|------------------------------------------------------------------|
|               |      |        | Bits 0-14: Message type identifier. For this message, set to 20. |
| attributeSize | 16u  | 6      | Size of attributes, in bytes (min: 45, current: 45).             |
| count (C)     | 32u  | 8      | Number of profile arrays.                                        |
| width (W)     | 32u  | 12     | Number of points per profile array.                              |
| xScale        | 32u  | 16     | X scale (nm).                                                    |
| zScale        | 32u  | 20     | Z scale (nm).                                                    |
| xOffset       | 32s  | 24     | X offset ( $\mu\text{m}$ ).                                      |
| zOffset       | 32s  | 28     | Z offset ( $\mu\text{m}$ ).                                      |
| source        | 8u   | 32     | Source<br>0 – Top<br>1 – Bottom<br>2 – Top Left<br>3 – Top Right |
| sectionId     | 32u  | 33     | Section Id                                                       |
| exposure      | 32u  | 37     | Exposure (ns).                                                   |
| poseAngle     | 32s  | 41     | Z angle of the pose (microdegrees).                              |
| poseX         | 32s  | 45     | X offset of the pose ( $\mu\text{m}$ )                           |
| poseY         | 32s  | 49     | Y offset of the pose ( $\mu\text{m}$ )                           |
| ranges[C][W]  | 16s  | 53     | Profile ranges.                                                  |



The pose field can be used to transform the section data into the surface frame of reference, via a rotation and then a translation.

## Surface Section Intensity

| Field          | Type | Offset | Description                                                                                    |
|----------------|------|--------|------------------------------------------------------------------------------------------------|
| size           | 32u  | 0      | Count of bytes in message (including this field).                                              |
| control        | 16u  | 4      | Bit 15: Last message flag.<br>Bits 0-14: Message type identifier. For this message, set to 21. |
| attributesSize | 16u  | 6      | Size of attributes, in bytes (min: 37, current: 37).                                           |
| count (C)      | 32u  | 8      | Number of profile intensity arrays                                                             |
| width (W)      | 32u  | 12     | Number of points per profile intensity array                                                   |
| xScale         | 32u  | 16     | X scale (nm).                                                                                  |
| xOffset        | 32s  | 20     | X offset ( $\mu\text{m}$ ).                                                                    |
| source         | 8u   | 24     | Source<br>0 – Top<br>1 – Bottom<br>2 – Top Left                                                |

| Field        | Type | Offset | Description                         |
|--------------|------|--------|-------------------------------------|
|              |      |        | 3 – Top Right                       |
| sectionId    | 32u  | 25     | Section Id.                         |
| exposure     | 32u  | 29     | Exposure (ns).                      |
| poseAngle    | 32s  | 33     | Z angle of the pose (microdegrees). |
| poseX        | 32s  | 37     | X offset of the pose (μm).          |
| poseY        | 32s  | 41     | Y offset of the pose (μm).          |
| points[C][W] | 8u   | 45     | Intensity arrays.                   |

## Measurement

| Field           | Type        | Offset | Description                                                                                    |
|-----------------|-------------|--------|------------------------------------------------------------------------------------------------|
| size            | 32u         | 0      | Count of bytes in message (including this field).                                              |
| control         | 16u         | 4      | Bit 15: Last message flag.<br>Bits 0-14: Message type identifier. For this message, set to 10. |
| count (C)       | 32u         | 6      | Count of measurements in this message.                                                         |
| reserved[2]     | 8u          | 10     | Reserved.                                                                                      |
| id              | 16u         | 12     | Measurement identifier.                                                                        |
| measurements[C] | Measurement | 14     | Array of measurements (see below).                                                             |

### Measurement

| Field       | Type | Offset | Description                                                                                                                                         |
|-------------|------|--------|-----------------------------------------------------------------------------------------------------------------------------------------------------|
| value       | 32s  | 0      | Measurement value.                                                                                                                                  |
| decision    | 8u   | 4      | Measurement decision bitmask.<br>Bit 0:<br>1 – Pass<br>0 – Fail<br>Bits 1-7:<br>0 – Measurement value OK<br>1 – Invalid value<br>2 – Invalid anchor |
| reserved[3] | 8u   | 5      | Reserved.                                                                                                                                           |

## Operation Result

| Field   | Type | Offset | Description                                                                                    |
|---------|------|--------|------------------------------------------------------------------------------------------------|
| size    | 32u  | 0      | Count of bytes in message (including this field).                                              |
| control | 16u  | 4      | Bit 15: Last message flag.<br>Bits 0-14: Message type identifier. For this message, set to 11. |

| Field          | Type | Offset | Description                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     |
|----------------|------|--------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| attributesSize | 16u  | 6      | Size of attributes, in bytes (min: 8, current: 8).                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              |
| opId           | 32u  | 8      | Operation ID.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   |
| status         | 32s  | 12     | Operation status.<br>1 – OK<br>0 – General failure<br>-1 – No data in the field of view for stationary alignment<br>-2 – No profiles with sufficient data for line fitting for travel alignment<br>-3 – Invalid target detected. Examples include:<br>- Calibration disk diameter too small.<br>- Calibration disk touches both sides of the field of view.<br>- Too few valid data points after outlier rejection.<br>-4 – Target detected in an unexpected position.<br>-5 – No reference hole detected in bar alignment.<br>-6 – No change in encoder value during travel calibration<br>-988 – User aborted<br>-993 – Timed out<br>-997 – Invalid parameter |

### Exposure Calibration Result

| Field          | Type | Offset | Description                                                                                    |
|----------------|------|--------|------------------------------------------------------------------------------------------------|
| size           | 32u  | 0      | Count of bytes in message (including this field).                                              |
| control        | 16u  | 4      | Bit 15: Last message flag.<br>Bits 0-14: Message type identifier. For this message, set to 12. |
| attributesSize | 16u  | 6      | Size of attributes, in bytes (min: 12, current: 12).                                           |
| opId           | 32u  | 8      | Operation ID.                                                                                  |
| status         | 32s  | 12     | Operation status.                                                                              |
| exposure       | 32s  | 16     | Exposure result (ns).                                                                          |

### Edge Match Result

| Field    | Type | Offset | Description                                                                                    |
|----------|------|--------|------------------------------------------------------------------------------------------------|
| size     | 32u  | 0      | Count of bytes in message (including this field).                                              |
| control  | 16u  | 4      | Bit 15: Last message flag.<br>Bits 0-14: Message type identifier. For this message, set to 16. |
| decision | byte | 6      | Overall match decision.                                                                        |
| xOffset  | 32s  | 7      | Target x offset in model space (µm).                                                           |



| Field           | Type | Offset | Description                                      |
|-----------------|------|--------|--------------------------------------------------|
| yOffset         | 32s  | 11     | Target y offset in model space (μm).             |
| zAngle          | 32s  | 15     | Target z rotation in model space (microdegrees). |
| quality         | 32s  | 19     | Match quality (thousandth).                      |
| qualityDecision | byte | 23     | Quality match decision.                          |
| reserved[2]     | byte | 24     | Reserved.                                        |

### Bounding Box Match Result

| Field          | Type | Offset | Description                                                                                    |
|----------------|------|--------|------------------------------------------------------------------------------------------------|
| size           | 32u  | 0      | Count of bytes in message (including this field).                                              |
| control        | 16u  | 4      | Bit 15: Last message flag.<br>Bits 0-14: Message type identifier. For this message, set to 17. |
| decision       | byte | 6      | Overall match decision.                                                                        |
| xOffset        | 32s  | 7      | Target x offset in model space (μm).                                                           |
| yOffset        | 32s  | 11     | Target y offset in model space (μm).                                                           |
| zAngle         | 32s  | 15     | Target z rotation in model space (microdegrees).                                               |
| width          | 32s  | 19     | Width axis length (μm)                                                                         |
| widthDecision  | 8u   | 23     | Width axis decision.                                                                           |
| length         | 32s  | 24     | Length axis length (μm)                                                                        |
| lengthDecision | 8u   | 28     | Length axis decision.                                                                          |

### Ellipse Match Result

| Field         | Type | Offset | Description                                                                                    |
|---------------|------|--------|------------------------------------------------------------------------------------------------|
| size          | 32u  | 0      | Count of bytes in message (including this field).                                              |
| control       | 16u  | 4      | Bit 15: Last message flag.<br>Bits 0-14: Message type identifier. For this message, set to 18. |
| decision      | byte | 6      | Overall match decision.                                                                        |
| xOffset       | 32s  | 7      | Target x offset in model space (μm).                                                           |
| yOffset       | 32s  | 11     | Target y offset in model space (μm).                                                           |
| zAngle        | 32s  | 15     | Target z rotation in model space (microdegrees).                                               |
| minor         | 32s  | 19     | Minor axis length (μm)                                                                         |
| minorDecision | 8u   | 23     | Minor axis decision.                                                                           |
| major         | 32s  | 24     | Major axis length (μm)                                                                         |
| majorDecision | 8u   | 28     | Major axis decision.                                                                           |

## Feature Point

| Field   | Type | Offset | Description                                                                                    |
|---------|------|--------|------------------------------------------------------------------------------------------------|
| size    | 32u  | 0      | Count of bytes in message (including this field).                                              |
| control | 16u  | 4      | Bit 15: Last message flag.<br>Bits 0-14: Message type identifier. For this message, set to 24. |
| id      | 16u  | 6      | Feature Id                                                                                     |
| Point.x | 64u  | 14     | X Coordinate of Point (Scaled by 10 <sup>6</sup> )                                             |
| Point.y | 64u  | 22     | Y Coordinate of Point (Scaled by 10 <sup>6</sup> )                                             |
| Point.z | 64u  | 30     | Z Coordinate of Point (Scaled by 10 <sup>6</sup> )                                             |

## Feature Line

| Field       | Type | Offset | Description                                                                                    |
|-------------|------|--------|------------------------------------------------------------------------------------------------|
| size        | 32u  | 0      | Count of bytes in message (including this field).                                              |
| control     | 16u  | 4      | Bit 15: Last message flag.<br>Bits 0-14: Message type identifier. For this message, set to 25. |
| id          | 16u  | 6      | Feature Id                                                                                     |
| Point.x     | 64u  | 14     | X Coordinate of Point (Scaled by 10 <sup>6</sup> )                                             |
| Point.y     | 64u  | 22     | Y Coordinate of Point (Scaled by 10 <sup>6</sup> )                                             |
| Point.z     | 64u  | 30     | Z Coordinate of Point (Scaled by 10 <sup>6</sup> )                                             |
| Direction.x | 64u  | 38     | X Component of Direction Vector (Scaled by 10 <sup>6</sup> )                                   |
| Direction.y | 64u  | 46     | Y Component of Direction Vector (Scaled by 10 <sup>6</sup> )                                   |
| Direction.z | 64u  | 54     | Z Component of Direction Vector (Scaled by 10 <sup>6</sup> )                                   |

## Health Results

A client can receive health messages from a Gocator sensor by connecting to the Health TCP channel (port 3194).

The Data channel (port 3196) and the Health channel can be connected at the same time. The sensor accepts multiple connections on each port. For more information on the Data channel, see *Data Results* on page 445.

Messages that are received on the Data and Health channels use a common structure, called Gocator Data Protocol (GDP). Each GDP message consists of a 6-byte header, containing *size* and *control* fields, followed by a variable-length, message-specific content section. The structure of the GDP message is defined below.

### *Gocator Data Protocol*

| Field   | Type | Offset | Description                                                                                             |
|---------|------|--------|---------------------------------------------------------------------------------------------------------|
| size    | 32u  | 0      | Count of bytes in message (including this field).                                                       |
| control | 16u  | 4      | Bit 15: Last Message flag<br>Bits 0-14: Message type identifier. (See individual data result sections.) |

GDP messages are always sent in groups. The Last Message flag in the *control* field is used to indicate the final message in a group. If there is only one message per group, this bit will be set in each message.

A Health Result contains a single data block for health *indicators*. Each indicator reports the current status of some aspect of the sensor system, such as CPU usage or network throughput.

#### Health Result Header

| Field         | Type      | Offset | Description                                                                 |
|---------------|-----------|--------|-----------------------------------------------------------------------------|
| size          | 32u       | 0      | Count of bytes in message (including this field).                           |
| control       | 16u       | 4      | Bit 15: Last message flag.<br>Bits 0-14: Message type identifier. Always 0. |
| count (C)     | 32u       | 6      | Count of indicators in this message.                                        |
| source        | 8u        | 10     | Source (0 – Main, 1 – Buddy).                                               |
| reserved[3]   | 8u        | 11     | Reserved                                                                    |
| indicators[C] | Indicator | 14     | Array of indicators (see format below).                                     |

The health indicators block contains a 2-dimensional array of indicator data. Each row in the array has the following format:

#### Indicator Format

| Field    | Type | Offset | Description                                                                   |
|----------|------|--------|-------------------------------------------------------------------------------|
| id       | 32u  | 0      | Unique indicator identifier (see <i>Health Indicators</i> below table below). |
| instance | 32u  | 4      | Indicator instance.                                                           |
| value    | 64s  | 8      | Value (identifier-specific meaning).                                          |

The following health indicators are defined for Gocator sensor systems.



When a sensor is accelerated, some health indicators report values from the *PC* that is accelerating the sensor, or a combination of both. In the table below, values are reported from the sensor unless otherwise indicated.



Undocumented indicators may be included in addition to the indicators defined below.

#### Health Indicators

| Indicator            | ID   | Instance | Value                                               |
|----------------------|------|----------|-----------------------------------------------------|
| Encoder Value        | 1003 | -        | Current system encoder tick.                        |
| Encoder Frequency    | 1005 | -        | Current system encoder frequency (ticks/s).         |
| App Version          | 2000 | -        | Firmware application version.                       |
| Uptime               | 2017 | -        | Time elapsed since node boot-up or reset (seconds). |
| Laser safety status  | 1010 | -        | 0 if laser is disabled; 1 if enabled.               |
| Internal Temperature | 2002 | -        | Internal temperature (centidegrees Celsius).        |

| Indicator             | ID                         | Instance     | Value                                                                                              |
|-----------------------|----------------------------|--------------|----------------------------------------------------------------------------------------------------|
| Projector Temperature | 2404                       | -            | Projector module temperature (centidegrees Celsius).<br>Only available on projector based devices. |
| Control Temperature   | 2028                       | -            | Control module temperature (centidegrees Celsius).<br>Available only on 3B-class devices.          |
| Memory Usage          | 2003                       | -            | Amount of memory currently used (bytes).                                                           |
| Memory Capacity       | 2004                       | -            | Total amount of memory available (bytes).                                                          |
| Storage Usage         | 2005                       | -            | Amount of non-volatile storage used (bytes).                                                       |
| Storage Capacity      | 2006                       | -            | Total amount of non-volatile storage available (bytes).                                            |
| CPU Usage             | 2007                       | -            | CPU usage (percentage of maximum).                                                                 |
| Net Out Capacity      | 2009                       | -            | Total available outbound network throughput (bytes/s).                                             |
| Net Out Link Status   | 2034                       | -            | Current Ethernet link status.                                                                      |
| Sync Source*          | 2043                       | -            | Gocator synchronization source.<br>1 - FireSync Master device<br>2 - Sensor                        |
| Digital Inputs*       | 2024                       | -            | Current digital input status (one bit per input).                                                  |
| Event Count           | 2102                       | -            | Total number of events triggered.                                                                  |
| Camera Search Count   | 2217                       | -            | Number of search states. (Only important when tracking is enabled.)                                |
| Camera Trigger Drops  | 2201                       | -            | Number of dropped triggers.                                                                        |
| Analog Output Drops   | 21014<br>(previously 2501) | Output Index | Number of dropped outputs.                                                                         |
| Digital Output Drops  | 21015<br>(previously 2601) | Output Index | Number of dropped outputs.                                                                         |
| Serial Output Drops   | 21016<br>(previously 2701) | Output Index | Number of dropped outputs.                                                                         |
| Sensor State*         | 20000                      | -            | Gocator sensor state.<br>-1 – Conflict<br>0 – Ready<br>1 – Running                                 |
| Current Sensor Speed* | 20001                      | -            | Current sensor speed. (Hz)                                                                         |
| Maximum Speed*        | 20002                      | -            | The sensor's maximum speed.                                                                        |

| Indicator                | ID    | Instance                  | Value                                                                                                                                                    |
|--------------------------|-------|---------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------|
| Spot Count*              | 20003 | -                         | Number of found spots in the last profile.                                                                                                               |
| Max Spot Count*          | 20004 | -                         | Maximum number of spots that can be found.                                                                                                               |
| Scan Count*              | 20005 | -                         | Number of surfaces detected from a top device.                                                                                                           |
| Master Status*           | 20006 | 0 for main<br>1 for buddy | Master connection status:<br>0 – Not connected<br>1 – Connected<br><br>The indicator with instance = buddy does not exist if the buddy is not connected. |
| Cast Start State*        | 20007 |                           | The state of the second digital input. (NOTE: Only available on XLine capable licensed devices)                                                          |
| Laser Overheat*          | 20020 | -                         | Indicates whether laser overheat has occurred.<br>0 – Has not overheated<br>1 – Has overheated<br><br>Only available on certain 3B laser devices.        |
| Laser Overheat Duration* | 20021 | -                         | The length of time in which the laser overheating state occurred.<br><br>Only available on certain 3B laser devices.                                     |
| Playback Position*       | 20023 | -                         | The current replay playback position.                                                                                                                    |
| Playback Count*          | 20024 | -                         | The number of frames present in the replay.                                                                                                              |
| FireSync Version         | 20600 | -                         | The FireSync version used by the Gocator build.                                                                                                          |
| Processing Drops**       | 21000 | -                         | Number of dropped frames. The sum of various processing drop related indicators.                                                                         |
| Last IO Latency          | 21001 | -                         | Last delay from camera exposure to when rich IO scheduling occurs. Valid only if rich IO is enabled.                                                     |
| Max IO Latency           | 21002 | -                         | Maximum delay from camera exposure to when rich IO scheduling occurs. Valid only if rich IO is enabled. Reset on start.                                  |
| Ethernet Output          | 21003 | -                         | Number of bytes transmitted.                                                                                                                             |
| Ethernet Rate            | 21004 | -                         | The average number of bytes per second being transmitted.                                                                                                |
| Ethernet Drops           | 21005 | -                         | Number of dropped Ethernet packets.                                                                                                                      |
| Digital Output Pass      | 21006 | Output Index              | Number of pass digital output pulse.                                                                                                                     |
| Digital Output Fail      | 21007 | Output Index              | Number of fail digital output pulse.                                                                                                                     |
| Trigger Drops**          | 21010 |                           | Number of dropped triggers. The sum of various triggering-related drop indicators.                                                                       |
| Output Drops**           | 21011 |                           | Number of dropped output data. The sum of all output drops (analog, digital, serial, host server,                                                        |

| Indicator              | ID    | Instance       | Value                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            |
|------------------------|-------|----------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
|                        |       |                | and ASCII server).                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               |
| Host Server Drops**    | 21012 |                | The number of bytes dropped by the host data server. Not currently emitted.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      |
| ASCII Server Drops**   | 21013 |                | The number of bytes dropped by the ASCII Ethernet data server. Not currently emitted.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            |
| Range Valid Count**    | 21100 | -              | Number of valid ranges.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          |
| Range Invalid Count**  | 21101 | -              | Number of invalid ranges.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        |
| Anchor Invalid Count** | 21200 | -              | Number of frames with anchoring invalid.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         |
| Z-Index Drop Count     | 22000 | -              | The number of dropped surfaces due to a lack of z-encoder pulse during rotational part detection.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                |
| Value                  | 30000 | Measurement ID | Measurement Value.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               |
| Pass                   | 30001 | Measurement ID | Number of pass decision.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         |
| Fail                   | 30002 | Measurement ID | Number of fail decision.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         |
| Max                    | 30003 | Measurement ID | Maximum measurement value.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       |
| Min                    | 30004 | Measurement ID | Minimum measurement value.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       |
| Average                | 30005 | Measurement ID | Average measurement value.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       |
| Std. Dev.              | 30006 | Measurement ID | Measurement value standard deviation.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            |
| Invalid Count          | 30007 | Measurement ID | Number of invalid values.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        |
| Overflow               | 30008 | Measurement ID | <p>Number of times this measurement has overflown on any output. Multiple simultaneous overflows result in only a single increment to this counter. Overflow conditions include:</p> <ul style="list-style-type: none"> <li>-Value exceeds bit representation available for given protocol</li> <li>-Analog output (mA) falls outside of acceptable range (0-20 mA)</li> </ul> <p>When a measurement value overflow occurs, the value is set to the null value appropriate for the given protocol's measurement value output type. The Overflow health indicator increments.</p> |
| Tool Run Time          | 22004 | Tool Index     | The most recent time taken to execute the tool.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  |

\* When the sensor is accelerated, the indicator's value is reported from the accelerating PC.

\*\* When the sensor is accelerated, the indicator's value is the sum of the values reported from the sensor and the accelerating PC.

# Modbus Protocol

Modbus is designed to allow industrial equipment such as Programmable Logic Controllers (PLCs), sensors, and physical input/output devices to communicate over an Ethernet network.

Modbus embeds a Modbus frame into a TCP frame in a simple manner. This is a connection-oriented transaction, and every query expects a response.

This section describes the Modbus TCP commands and data formats. Modbus TCP communication lets the client:

- Switch jobs.
- Align and run sensors.
- Receive measurement results, sensor states, and stamps.

To use the Modbus protocol, it must be enabled and configured in the active job.



The Gocator 4.x firmware uses mm, mm<sup>2</sup>, mm<sup>3</sup>, and degrees as standard units. In all protocols, values are scaled by 1000, as values in the protocols are represented as integers. This results in effective units of mm/1000, mm<sup>2</sup>/1000, mm<sup>3</sup>/1000, and deg/1000 in the protocols.

If buffering is enabled with the Modbus protocol, the PLC must read the Buffer Advance output register (see *State* on page 463) to advance the queue before reading the measurement results.

For information on configuring the protocol using the Web interface, see *Ethernet Output* on page 284.

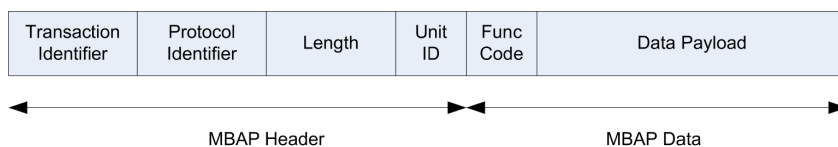
## Concepts

A PLC sends a command to start each Gocator. The PLC then periodically queries each Gocator for its latest measurement results. In Modbus terminology, the PLC is a Modbus Client. Each Gocator is a Modbus Server which serves the results to the PLC.

The Modbus protocol uses TCP for connection and messaging. The PLC makes a TCP connection to the Gocator on port 502. Control and data messages are communicated on this TCP connection. Up to eight clients can be connected to the Gocator simultaneously. A connection closes after 10 minutes of inactivity.

## Messages

All Modbus TCP messages consist of an MBAP header (Modbus Application Protocol), a function code, and a data payload.



The MBAP header contains the following fields:

#### *Modbus Application Protocol Header*

| Field          | Length (Bytes) | Description                                                                                                                           |
|----------------|----------------|---------------------------------------------------------------------------------------------------------------------------------------|
| Transaction ID | 2              | Used for transaction pairing. The Modbus Client sets the value and the Server (Gocator) copies the value into its responses.          |
| Protocol ID    | 1              | Always set to 0.                                                                                                                      |
| Length         | 1              | Byte count of the rest of the message, including the Unit identifier and data fields.                                                 |
| Unit ID        | 1              | Used for intra-system routing purpose. The Modbus Client sets the value and the Server (Gocator) copies the value into its responses. |

Modbus Application Protocol Specification describes the standard function codes in detail. Gocator supports the following function codes:

#### *Modbus Function Code*

| Function Code | Name                     | Data Size (bits) | Description                                  |
|---------------|--------------------------|------------------|----------------------------------------------|
| 3             | Read Holding Registers   | 16               | Read multiple data values from the sensor.   |
| 4             | Read Input Registers     | 16               | Read multiple data values from the sensor.   |
| 6             | Write Single Register    | 16               | Send a command or parameter to the sensor.   |
| 16            | Write Multiple Registers | 16               | Send a command and parameters to the sensor. |

The data payload contains the registers that can be accessed by Modbus TCP messages. If a message accesses registers that are invalid, a reply with an exception is returned. Modbus Application Protocol Specification defines the exceptions and describes the data payload format for each function code.

The Gocator data includes 16-bit, 32-bit, and 64-bit data. All data are sent in big endian format, with the 32-bit and 64-bit data spread out into two and four consecutive registers.

#### *32-bit Data Format*

| Register | Name          | Bit Position |
|----------|---------------|--------------|
| 0        | 32-bit Word 1 | 31 .. 16     |
| 1        | 32-bit Word 0 | 15 .. 0      |

#### *64-bit Data Format*

| Register | Name          | Bit Position |
|----------|---------------|--------------|
| 0        | 64-bit Word 3 | 63 .. 48     |
| 1        | 64-bit Word 2 | 47 .. 32     |
| 2        | 64-bit Word 1 | 31 .. 16     |
| 3        | 64-bit Word 0 | 15 .. 0      |

## Registers

Modbus registers are 16 bits wide and are either control registers or output registers.

Control registers are used to control the sensor states (e.g., start, stop, or calibrate a sensor).



The output registers report the sensor states, stamps, and measurement values and decisions. You can read multiple output registers using a single Read Holding Registers or a single Read Input Registers command. Likewise, you can control the state of the sensor using a single Write Multiple Register command.

Control registers are write-only, and output registers are read-only.

#### Register Map Overview

| Register Address | Name                     | Read/Write | Description                                                                                                         |
|------------------|--------------------------|------------|---------------------------------------------------------------------------------------------------------------------|
| 0 - 124          | Control Registers        | WO         | Registers for Modbus commands. See <i>Control Registers</i> below for detailed descriptions.                        |
| 300 - 899        | Sensor States            | RO         | Report sensor states. See <i>State</i> on the next page for detailed descriptions.                                  |
| 900 - 999        | Stamps                   | RO         | Return stamps associated with each profile or surface. See <i>State</i> on the next page for detailed descriptions. |
| 1000 - 1060      | Measurements & Decisions | RO         | 20 measurement and decision pairs. See <i>Measurement Registers</i> on page 465 for detailed descriptions.          |

## Control Registers

Control registers are used to operate the sensor. Register 0 stores the command to be executed. Registers 1 to 21 contain parameters for the commands. The Gocator executes a command when the value in Register 0 is changed. To set the parameters before a command is executed, you should set up the parameters and the command using a single Multiple Write register command.

#### Control Register Map

| Register Address | Name             | Read/Write | Description                                                                                                                                                                             |
|------------------|------------------|------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 0                | Command Register | WO         | Command register. See the Command Register Values table below for more information.                                                                                                     |
| 1 – 21           | Job Filename     | WO         | Null-terminated filename.<br>Each 16-bit register holds a single character.<br>Only used for Load Job Command.<br>Specifies the complete filename, including the file extension ".job". |

The values used for the Command Register are described below.

#### Command Register Values

| Value | Name                      | Description                                                             |
|-------|---------------------------|-------------------------------------------------------------------------|
| 0     | Stop running              | Stop the sensor. No effect if sensor is already stopped.                |
| 1     | Start Running             | Start the sensor. No effect if sensor is already started.               |
| 2     | Align (stationary target) | Start the alignment process. State register 301 will be set to 1 (busy) |

| Value | Name                  | Description                                                                                                                                                 |
|-------|-----------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------|
|       |                       | until the alignment process is complete.                                                                                                                    |
| 3     | Align (moving target) | Start alignment process and also calibrate encoder resolution. State register 301 will be set to 1 (busy) until the motion calibration process is complete. |
| 4     | Clear Alignment       | Clear the alignment.                                                                                                                                        |
| 5     | Load Job              | Activate a job file. Registers 1 - 21 specify the filename.                                                                                                 |
| 6     | Set Runtime Variables | Registers 1 through 9 are used to set the values of all four runtime variables.                                                                             |

## Output Registers

Output registers are used to output states, stamps, and measurement results. Each register address holds a 16-bit data value.

### State

State registers report the current sensor state.

#### State Register Map

| Register Address | Name                    | Type | Description                                                                                                                                   |
|------------------|-------------------------|------|-----------------------------------------------------------------------------------------------------------------------------------------------|
| 300              | Stopped / Running       |      | Sensor State:<br>0 - Stopped<br>1 - Running                                                                                                   |
| 301              | Busy                    |      | Busy State:<br>0 - Not busy<br>1 - Busy<br><br>Registers 302 to 363 below are only valid when the Busy State is not Busy                      |
| 302              | Alignment State         |      | Current Alignment State:<br>0 - Not aligned<br>1 - Aligned                                                                                    |
| 303 – 306        | Encoder Value           | 64s  | Current Encoder value (ticks).                                                                                                                |
| 307 – 310        | Time                    | 64s  | Current time (µs).                                                                                                                            |
| 311              | Job File Name Length    | 16u  | Number of characters in the current job file name.                                                                                            |
| 312 – 371        | Live Job Name           |      | Current Job Name.<br><br>Name of currently loaded job file. Does not include the extension. Each 16-bit register contains a single character. |
| 375              | Runtime Variable 0 High | 32s  | Runtime variable value                                                                                                                        |
| 376              | Runtime Variable 0 Low  |      |                                                                                                                                               |
| ...              | ...                     | ...  | ...                                                                                                                                           |
| 381              | Runtime Variable 3 High | 32s  | Runtime variable value                                                                                                                        |
| 382              | Runtime Variable 3 Low  |      |                                                                                                                                               |

## Stamp

Stamps contain trigger timing information used for synchronizing a PLC's actions. A PLC can also use this information to match up data from multiple Gocator sensors.

In Profile mode, the stamps are updated after each profile is processed. In Surface mode, the stamps are updated after each surface has been processed.

### Stamp Register Map

| Register Address | Name             | Type | Description                                                                                                                                                                                                                              |
|------------------|------------------|------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 976              | Buffer Advance   |      | If buffering is enabled this address must be read by the PLC Modbus client first to advance the buffer. After the buffer advance read operation, the Modbus client can read the updated Measurements & Decisions in addresses 1000-1060. |
| 977              | Buffer Counter   |      | Number of buffered messages currently in the queue.                                                                                                                                                                                      |
| 978              | Buffer Overflow  |      | Buffer Overflow Indicator:<br>0 - No overflow<br>1 - Overflow                                                                                                                                                                            |
| 979              | Inputs           |      | Digital input state.                                                                                                                                                                                                                     |
| 980              | zPosition High   | 64s  | Encoder value when the index is last triggered.                                                                                                                                                                                          |
| 981              | zPosition        |      |                                                                                                                                                                                                                                          |
| 982              | zPosition        |      |                                                                                                                                                                                                                                          |
| 983              | zPosition Low    |      |                                                                                                                                                                                                                                          |
| 984              | Exposure High    | 32u  | Laser exposure ( $\mu$ s).                                                                                                                                                                                                               |
| 985              | Exposure Low     |      |                                                                                                                                                                                                                                          |
| 986              | Temperature High | 32u  | Sensor temperature in degrees Celcius * 100 (centidegrees).                                                                                                                                                                              |
| 987              | Temperature Low  |      |                                                                                                                                                                                                                                          |
| 988              | Position High    | 64s  | Encoder position                                                                                                                                                                                                                         |
| 989              | Position         |      |                                                                                                                                                                                                                                          |
| 990              | Position         |      |                                                                                                                                                                                                                                          |
| 991              | Position Low     |      |                                                                                                                                                                                                                                          |
| 992              | Time Low         | 64u  | Timestamp ( $\mu$ s).                                                                                                                                                                                                                    |
| 993              | Time             |      |                                                                                                                                                                                                                                          |
| 994              | Time             |      |                                                                                                                                                                                                                                          |
| 995              | Time Low         |      |                                                                                                                                                                                                                                          |
| 996              | Frame Index High | 64u  | Frame counter. Each new sample is assigned a frame number.                                                                                                                                                                               |
| 997              | Frame Index      |      |                                                                                                                                                                                                                                          |

| Register Address | Name           | Type | Description |
|------------------|----------------|------|-------------|
| 998              | Frame Index    |      |             |
| 999              | Fame Index Low |      |             |

## Measurement Registers

Measurement results are reported in pairs of values and decisions. Measurement values are 32 bits wide and decisions are 8 bits wide.

The measurement ID defines the register address of each pair. The register address of the first word can be calculated as  $(1000 + 3 * ID)$ . For example, a measurement with ID set to 4 can be read from registers 1012 (high word) and, 1013 (low word), and the decision at 1015.

In Profile mode, the measurement results are updated after each profile is processed. In Surface mode, the measurement results are updated after each discrete part has been processed.

### Measurement Register Map

| Register Address | Name                | Type | Description                                                                                                                                                    |
|------------------|---------------------|------|----------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 1000             | Measurement 0 High  | 32s  | Measurement value in $\mu\text{m}$ (0x80000000 if invalid)                                                                                                     |
| 1001             | Measurement 0 Low   |      |                                                                                                                                                                |
| 1002             | Decision 0          | 16u  | Measurement decision. A bit mask, where:<br>Bit 0:<br>1 - Pass<br>0 - Fail<br>Bits 1-7:<br>0 - Measurement value OK<br>1 - Invalid value<br>2 - Invalid anchor |
| 1003             | Measurement 1 High  |      |                                                                                                                                                                |
| 1004             | Measurement 1 Low   |      |                                                                                                                                                                |
| 1005             | Decision 1          |      |                                                                                                                                                                |
| 1006             | Measurement 2 High  |      |                                                                                                                                                                |
| 1007             | Measurement 2 Low   |      |                                                                                                                                                                |
| 1008             | Decision 2          |      |                                                                                                                                                                |
| ...              | ...                 | ...  | ...                                                                                                                                                            |
| 1057             | Measurement 19 High |      |                                                                                                                                                                |
| 1058             | Measurement 19 Low  |      |                                                                                                                                                                |
| 1059             | Decision 19         |      |                                                                                                                                                                |

# EtherNet/IP Protocol

EtherNet/IP is an industrial protocol that allows bidirectional data transfer with PLCs. It encapsulates the object-oriented Common Industrial Protocol (CIP).

This section describes the EtherNet/IP messages and data formats. EtherNet/IP communication enables the client to:

- Switch jobs.
- Align and run sensors.
- Receive sensor states, stamps, and measurement results.

To use the EtherNet/IP protocol, it must be enabled and configured in the active job.



The Gocator 4.x firmware uses mm, mm<sup>2</sup>, mm<sup>3</sup>, and degrees as standard units. In all protocols, values are scaled by 1000, as values in the protocols are represented as integers. This results in effective units of mm/1000, mm<sup>2</sup>/1000, mm<sup>3</sup>/1000, and deg/1000 in the protocols.

For information on configuring the protocol using the Web interface, see *Ethernet Output* on page 284.

## Concepts

To EtherNet/IP-enabled devices on the network, the sensor information is seen as a collection of objects, which have attributes that can be queried.

Gocator supports all required objects, such as the Identity object, TCP/IP object, and Ethernet Link object. In addition, assembly objects are used for sending sensor and sample data and receiving commands. There are three assembly objects: the command assembly (32 bytes), the sensor state assembly (100 bytes), and the sample state assembly object (380 bytes). The data attribute (0x03) of the assembly objects is a byte array containing information about the sensor. The data attribute can be accessed with the GetAttribute and SetAttribute commands.

The PLC sends a command to start a Gocator. The PLC then periodically queries the attributes of the assembly objects for its latest measurement results. In EtherNet/IP terminology, the PLC is a scanner and the Gocator is an adapter.

The Gocator supports unconnected or connected explicit messaging (with TCP). Implicit I/O messaging is supported as an advanced setting. For more information, see [http://lmi3d.com/sites/default/files/APPNOTE\\_Implicit\\_Messaging\\_with\\_Allen-Bradley\\_PLCs.pdf](http://lmi3d.com/sites/default/files/APPNOTE_Implicit_Messaging_with_Allen-Bradley_PLCs.pdf).

The default EtherNet/IP ports are used. Port 44818 is used for TCP connections and UDP queries (e.g., list Identity requests). Port 2222 for UDP I/O Messaging is not supported.

## Basic Object

### Identity Object (Class 0x01)

| Attribute | Name          | Type                  | Value        | Description                                        | Access |
|-----------|---------------|-----------------------|--------------|----------------------------------------------------|--------|
| 1         | Vendor ID     | UINT                  | 1256         | ODVA-provided vendor ID                            | Get    |
| 2         | Device Type   | UINT                  | 43           | Device type                                        | Get    |
| 3         | Product Code  | UINT                  | 2000         | Product code                                       | Get    |
| 4         | Revision      | USINT<br>USINT        | x.x          | Byte 0 - Major revision<br>Byte 1 - Minor revision | Get    |
| 6         | Serial number | UDINT                 | 32-bit value | Sensor serial number                               | Get    |
| 7         | Product Name  | SHORT<br>STRING<br>32 | "Gocator"    | Gocator product name                               | Get    |

### TCP/IP Object (Class 0xF5)

The TCP/IP Object contains read-only network configuration attributes such as IP Address. TCP/IP configuration via Ethernet/IP is not supported. See Volume 2, Chapter 5-3 of the CIP Specification for a complete listing of TCP/IP object attributes.

| Attribute | Name                     | Type                        | Value | Description                                                                                                                                                                                   | Access |
|-----------|--------------------------|-----------------------------|-------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--------|
| 1         | Status                   | UDINT                       | 0     | TCP interface status                                                                                                                                                                          | Get    |
| 2         | Configuration Capability | UINT                        | 0     |                                                                                                                                                                                               | Get    |
| 3         | Configuration Control    | UINT                        | 0     | Product code                                                                                                                                                                                  | Get    |
| 4         | Physical Link Object     | Structure (See description) |       | See 5.3.3.2.4 of CIP Specification Volume 2:<br>Path size (UINT)<br>Path (Padded EPATH)                                                                                                       | Get    |
| 5         | Interface Configuration  | Structure (See description) |       | See 5.3.3.2.5 of CIP Specification Volume 2:<br>IP address (UDINT)<br>Network mask (UDINT)<br>Gateway address (UDINT)<br>Name server (UDINT)<br>Secondary name (UDINT)<br>Domain name (UDINT) | Get    |

### Ethernet Link Object (Class 0xF6)

The Ethernet Link Object contains read-only attributes such as MAC Address (Attribute 3). See Volume 2, Chapter 5-4 of the CIP Specification for a complete listing of Ethernet Link object attributes.

| Attribute | Name             | Type              | Value | Description                                                                                                                                             | Access |
|-----------|------------------|-------------------|-------|---------------------------------------------------------------------------------------------------------------------------------------------------------|--------|
| 1         | Interface Speed  | UDINT             | 1000  | Ethernet interface data rate (mbps)                                                                                                                     | Get    |
| 2         | Interface Flags  | UDINT             |       | See 5.4.3.2.1 of CIP Specification Volume 2:<br>Bit 0: Link Status<br>0 – Inactive<br>1 – Active<br>Bit 1: Duplex<br>0 – Half Duplex<br>1 – Full Duplex | Get    |
| 3         | Physical Address | Array of 6 USINTs |       | MAC address (for example: 00 16 20 00 2E 42)                                                                                                            | Get    |

## Assembly Object (Class 0x04)

The Gocator Ethernet/IP object model includes the following assembly objects: Command, Sensor State, and Sample State.

All assembly object instances are static. Data in a data byte array in an assembly object are stored in the big endian format.

### Command Assembly

The command assembly object is used to start, stop, and align the sensor, and also to switch jobs on the sensor.

#### Command Assembly

| Information       | Value                     |
|-------------------|---------------------------|
| Class             | 0x4                       |
| Instance          | 0x310                     |
| Attribute Number  | 3                         |
| Length            | 32 bytes                  |
| Supported Service | 0x10 (SetAttributeSingle) |

Attributes 1 and 2 are not implemented, as they are not required for the static assembly object.

#### Attribute 3

| Attribute | Name    | Type       | Value     | Description                                                                                 | Access   |
|-----------|---------|------------|-----------|---------------------------------------------------------------------------------------------|----------|
| 3         | Command | Byte Array | See Below | Command parameters<br>Byte 0 - Command.<br>See table below for specification of the values. | Get, Set |

#### Command Definitions

| Value | Name         | Description                                                 |
|-------|--------------|-------------------------------------------------------------|
| 0     | Stop running | Stop the sensor. No action if the sensor is already stopped |

| Value | Name                 | Description                                                                                                                                                     |
|-------|----------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 1     | Start Running        | Start the sensor. No action if the sensor is already started.                                                                                                   |
| 2     | Stationary Alignment | Start the stationary alignment process. Byte 1 of the sensor state assembly will be set to 1 (busy) until the alignment process is complete, then back to zero. |
| 3     | Moving Alignment     | Start the moving alignment process. Byte 1 of the sensor state assembly will be set to 1 (busy) until the alignment process is complete, then back to zero.     |
| 4     | Clear Alignment      | Clear the alignment.                                                                                                                                            |
| 5     | Load Job             | Load the job. Set bytes 1-31 to the file name (one character per byte, including the extension).                                                                |

## Runtime Variable Configuration Assembly

The runtime variable configuration assembly object contains the sensor's intended runtime variables.

### *Runtime Variable Configuration Assembly*

| Information       | Value                     |
|-------------------|---------------------------|
| Class             | 0x04                      |
| Instance          | 0x311                     |
| Attribute Number  | 3                         |
| Length            | 64 bytes                  |
| Supported Service | 0x10 (SetAttributeSingle) |

### *Attribute 3*

| Attribute | Name    | Type       | Value     | Description                                                             | Access |
|-----------|---------|------------|-----------|-------------------------------------------------------------------------|--------|
| 3         | Command | Byte Array | See below | Runtime variable configuration information. See below for more details. | Get    |

### *Sensor State Information*

| Byte  | Name               | Type | Description                                                   |
|-------|--------------------|------|---------------------------------------------------------------|
| 0-3   | Runtime Variable 0 | 32s  | Stores the intended value of the Runtime Variable at index 0. |
| 4-7   | Runtime Variable 1 | 32s  | Stores the intended value of the Runtime Variable at index 1. |
| 8-11  | Runtime Variable 2 | 32s  | Stores the intended value of the Runtime Variable at index 2. |
| 12-15 | Runtime Variable 3 | 32s  | Stores the intended value of the Runtime Variable at index 3. |
| 16-63 | Reserved           |      |                                                               |



## Sensor State Assembly

The sensor state assembly object contains the sensor's states, such as the current sensor temperature, frame count, and encoder values.

### *Sensor State Assembly*

| Information       | Value                     |
|-------------------|---------------------------|
| Class             | 0x04                      |
| Instance          | 0x320                     |
| Attribute Number  | 3                         |
| Length            | 100 bytes                 |
| Supported Service | 0x0E (GetAttributeSingle) |

Attributes 1 and 2 are not implemented, as they are not required for the static assembly object.

### *Attribute 3*

| Attribute | Name    | Type       | Value     | Description                                           | Access |
|-----------|---------|------------|-----------|-------------------------------------------------------|--------|
| 3         | Command | Byte Array | See below | Sensor state information. See below for more details. | Get    |

### *Sensor State Information*

| Byte  | Name                        | Type | Description                                                                                                                                                  |
|-------|-----------------------------|------|--------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 0     | Sensor's state              |      | Sensor state:<br>0 - Ready<br>1 - Running                                                                                                                    |
| 1     | Command in progress         |      | Command busy status:<br>0 - Not busy<br>1 - Busy performing the last command<br><br>Bytes 2 to 43 below are only valid when there is no command in progress. |
| 2     | Alignment state             |      | Alignment status:<br>0 - Not aligned<br>1 - Aligned<br><br>The value is only valid when byte1 is set to 0.                                                   |
| 3-10  | Encoder                     | 64s  | Current encoder position                                                                                                                                     |
| 11-18 | Time                        | 64s  | Current timestamp                                                                                                                                            |
| 19    | Current Job Filename Length | 16u  | Number of characters in the current job filename. (e.g., 11 for "current.job"). The length includes the .job extension. Valid when byte 1 = 0.               |
| 20-43 | Current Job Filename        |      | Name of currently loaded job file, including the ".job" extension. Each byte contains a single character. Valid when byte 1 = 0.                             |
| 84-87 | Runtime                     | 32s  | Runtime variable value at index 0                                                                                                                            |

| Byte  | Name               | Type | Description                       |
|-------|--------------------|------|-----------------------------------|
|       | Variable 0         |      |                                   |
| ...   | ...                |      |                                   |
| 96-99 | Runtime Variable 3 | 32s  | Runtime variable value at index 3 |

## Sample State Assembly

The sample state object contains measurements and their associated stamp information.

### Sample State Assembly

| Information       | Value                     |
|-------------------|---------------------------|
| Class             | 0x04                      |
| Instance          | 0x321                     |
| Attribute Number  | 3                         |
| Length            | 380 bytes                 |
| Supported Service | 0x0E (GetAttributeSingle) |

### Attribute 3

| Attribute | Name    | Type       | Value     | Description                                           | Access |
|-----------|---------|------------|-----------|-------------------------------------------------------|--------|
| 3         | Command | Byte Array | See below | Sample state information. See below for more details. | Get    |

### Sample State Information

| Byte    | Name             | Type | Description                                                   |
|---------|------------------|------|---------------------------------------------------------------|
| 0-1     | Inputs           |      | Digital input state.                                          |
| 2-9     | Z Index Position | 64s  | Encoder position at time of last index pulse.                 |
| 10-13   | Exposure         | 32u  | Laser exposure in $\mu$ s.                                    |
| 14-17   | Temperature      | 32u  | Sensor temperature in degrees Celsius * 100 (centidegrees).   |
| 18-25   | Position         | 64s  | Encoder position.                                             |
| 26-33   | Time             | 64u  | Time.                                                         |
| 34-41   | Frame Counter    | 64u  | Frame counter.                                                |
| 42      | Buffer Counter   | 8u   | Number of buffered messages currently in the queue.           |
| 43      | Buffer Overflow  |      | Buffer Overflow Indicator:<br>0 - No overflow<br>1 - Overflow |
| 44 - 79 | Reserved         |      | Reserved bytes.                                               |
| 80-83   | Measurement 0    | 32s  | Measurement value in $\mu$ m (0x80000000 if invalid).         |
| 84      | Decision 0       | 8u   | Measurement decision. A bit mask, where:                      |

| Byte    | Name           | Type | Description                                                                                                                                                    |
|---------|----------------|------|----------------------------------------------------------------------------------------------------------------------------------------------------------------|
|         |                |      | Bit 0:<br>1 - Pass<br>0 - Fail<br>Bits 1-7:<br>0 - Measurement value OK<br>1 - Invalid value<br>2 - Invalid anchor                                             |
| ...     | ...            |      |                                                                                                                                                                |
| 375-378 | Measurement 59 | 32s  | Measurement value in $\mu\text{m}$ (0x80000000 if invalid).                                                                                                    |
| 379     | Decision 59    | 8u   | Measurement decision. A bit mask, where:<br>Bit 0:<br>1 - Pass<br>0 - Fail<br>Bits 1-7:<br>0 - Measurement value OK<br>1 = Invalid value<br>2 = Invalid anchor |

Measurement results are reported in pairs of values and decisions. Measurement values are 32 bits wide and decisions are 8 bits wide.

The measurement ID defines the byte position of each pair within the state information. The position of the first word can be calculated as  $(80 + 5 * \text{ID})$ . For example, a measurement with ID set to 4 can be read from byte 100 (high word) to 103 (low word) and the decision at 104.

In Profile mode, the measurement results are updated after each profile is processed. In Surface mode, the measurement results are updated after each discrete part has been processed. If buffering is enabled in the Ethernet Output panel, reading the Extended Sample State Assembly Object automatically advances the buffer. See *Ethernet Output* on page 284 for information on the **Output** panel.

## Implicit Messaging Command Assembly

### *Implicit Messaging Command Assembly*

| Information      | Value    |
|------------------|----------|
| Class            | 0x04     |
| Instance         | 0x64     |
| Attribute Number | 3        |
| Length           | 32 bytes |

### *Implicit Messaging Command Assembly Information*

| Byte | Name                                                | Type | Description                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           |
|------|-----------------------------------------------------|------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 0    | Command                                             | 8u   | <p>A bit mask where setting the following bits will only perform the action with highest priority*:</p> <ul style="list-style-type: none"><li>8 – Set Runtime Variables</li><li>7 – Stop sensor</li><li>6 – Start sensor</li><li>5 – Perform Stationary Alignment</li><li>4 – Perform Moving Alignment</li><li>3 – Clear alignment</li></ul> <p>*The priority of commands is currently as follows:</p> <ul style="list-style-type: none"><li>1. Stop sensor</li><li>2. Start sensor</li><li>3. Perform Stationary Alignment</li><li>4. Perform Moving Alignment</li><li>5. Clear alignment</li><li>6. Set Runtime Variables</li></ul> |
| 1-31 | Reserved (except for configuring runtime variables) |      | For setting runtime variables, bytes 4 through 20 are used to define the values of each of the four runtime variables in Little Endian format.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        |

## Implicit Messaging Output Assembly

### *Implicit Messaging Output Assembly*

| Information      | Value     |
|------------------|-----------|
| Class            | 0x04      |
| Instance         | 0x322     |
| Attribute Number | 3         |
| Length           | 376 bytes |

### *Implicit Messaging Output Assembly Information*

| Byte | Name         | Type | Description                                                                                                                                               |
|------|--------------|------|-----------------------------------------------------------------------------------------------------------------------------------------------------------|
| 0    | Sensor State | 8u   | <p>Sensor state is a bit mask where:</p> <p>Bit 0:</p> <ul style="list-style-type: none"><li>1 – Running</li><li>0 – Stopped</li></ul> <p>Bits [1-7]:</p> |

| Byte  | Name                        | Type | Description                                                                                                                                                                  |
|-------|-----------------------------|------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
|       |                             |      | 0 – No state issue<br>1 – Conflict                                                                                                                                           |
| 1     | Alignment and Command state | 8u   | A bit mask where:<br>Bit 0:<br>1 – Explicit or Implicit Command in progress<br>0 – No Explicit or Implicit command is in progress<br>Bit 1<br>1 – Aligned<br>0 – Not aligned |
| 2-3   | Inputs                      | 16u  | Digital input state                                                                                                                                                          |
| 4-11  | Z Index Position            | 64u  | Encoder position at time of last index pulse                                                                                                                                 |
| 12-15 | Exposure                    | 32u  | Laser exposure in $\mu$ s                                                                                                                                                    |
| 16-19 | Temperature                 | 32u  | Sensor temperature in degrees celsius * 100 (centidegrees)                                                                                                                   |
| 20-27 | Encoder Position            | 64s  | Encoder position                                                                                                                                                             |
| 28-35 | Time                        | 64u  | Time                                                                                                                                                                         |
| 36-43 | Scan Count                  | 64u  | Represents the number of scans                                                                                                                                               |
| 44-55 | Reserved                    |      |                                                                                                                                                                              |
| 56    | Decision 0                  | 8u   | Measurement decision is a bit mask where:<br>Bit 0:<br>1 – Pass<br>0 – Fail<br>Bits [1-7]:<br>0 – Measurement value OK<br>1 – Invalid Value<br>2 – Invalid Anchor            |
| ...   | ...                         |      |                                                                                                                                                                              |
| 119   | Decision 63                 | 8u   | Measurement decision is a bit mask where:<br>Bit 0:<br>1 – Pass<br>0 – Fail<br>Bits [1-7]:<br>0 – Measurement value OK<br>1 – Invalid Value<br>2 – Invalid Anchor            |

| Byte    | Name           | Type | Description                                                     |
|---------|----------------|------|-----------------------------------------------------------------|
| 120-123 | Measurement 0  | 32s  | Measurement value in $\mu\text{m}$ .<br>(0x80000000 if invalid) |
| ...     | ...            |      |                                                                 |
| 372-375 | Measurement 63 | 32s  | Measurement value in $\mu\text{m}$ .<br>(0x80000000 if invalid) |

## ASCII Protocol

This section describes the ASCII protocol.

The ASCII protocol is available over either serial output or Ethernet output. Over serial output, communication is asynchronous (measurement results are automatically sent on the Data channel when the sensor is in the running state and results become available). Over Ethernet, communication can be asynchronous or can use polling. For more information on polling commands, see *Polling Operation Commands (Ethernet Only)* on the next page.

The protocol communicates using ASCII strings. The output result format from the sensor is user-configurable.

To use the ASCII protocol, it must be enabled and configured in the active job.



The Gocator 4.x firmware uses mm, mm<sup>2</sup>, mm<sup>3</sup>, and degrees as standard units. In all protocols, values are scaled by 1000, as values in the protocols are represented as integers. This results in effective units of mm/1000, mm<sup>2</sup>/1000, mm<sup>3</sup>/1000, and deg/1000 in the protocols.

For information on configuring the protocol with the Web interface (when using the protocol over Ethernet), see *Ethernet Output* on page 284.

For information on configuring the protocol with the Web interface (when using the protocol over Serial), see *Serial Output* on page 292.

## Connection Settings

### Ethernet Communication

With Ethernet ASCII output, you can set the connection port numbers of the three channels used for communication (Control, Data, and Health):

#### *Ethernet Ports for ASCII*

| Name    | Description                                   | Default Port |
|---------|-----------------------------------------------|--------------|
| Control | To send commands to control the sensor.       | 8190         |
| Data    | To retrieve measurement output.               | 8190         |
| Health  | To retrieve specific health indicator values. | 8190         |

Channels can share the same port or operate on individual ports. The following port numbers are reserved for Gocator internal use: 2016, 2017, 2018, and 2019. Each port can accept multiple connections, up to a total of 16 connections for all ports.

## Serial Communication

Over serial, Gocator ASCII communication uses the following connection settings:

### *Serial Connection Settings for ASCII*

| Parameter       | Value  |
|-----------------|--------|
| Start Bits      | 1      |
| Stop Bits       | 1      |
| Parity          | None   |
| Data Bits       | 8      |
| Baud Rate (b/s) | 115200 |
| Format          | ASCII  |
| Delimiter       | CR     |

Up to 16 users can connect to the sensor for ASCII interfacing at a time. Any additional connections will remove the oldest connected user.

## Polling Operation Commands (Ethernet Only)

On the Ethernet output, the Data channel can operate asynchronously or by polling.

Under asynchronous operation, measurement results are automatically sent on the Data channel when the sensor is in the running state and results become available. The result is sent on all connected data channels.

Under polling operation, a client can:

- Switch to a different job.
- Align, run, and trigger sensors.
- Receive sensor states, health indicators, stamps, and measurement results

Gocator sends Control, Data, and Health messages over separate channels. The Control channel is used for commands such as starting and stopping the sensor, loading jobs, and performing alignment (see *Control Commands* on the next page).

The Data channel is used to receive and poll for measurement results. When the sensor receives a [Result](#) command, it will send the latest measurement results on the same data channel that the request is received on. See *Data Commands* on page 481 for more information.

The Health channel is used to receive health indicators (see *Health Commands* on page 483).

## Command and Reply Format

Commands are sent from the client to the Gocator. Command strings are not case sensitive. The command format is:

<COMMAND><DELIMITER><PARAMETER><TERMINATION>

If a command has more than one parameter, each parameter is separated by the delimiter. Similarly, the reply has the following format:

<STATUS><DELIMITER><OPTIONAL RESULTS><DELIMITER>

The status can either be "OK" or "ERROR". The optional results can be relevant data for the command if successful, or a text based error message if the operation failed. If there is more than one data item, each item is separated by the delimiter.

The delimiter and termination characters are configured in the Special Character settings.

## Special Characters

The ASCII Protocol has three special characters.

### *Special Characters*

| Special Character | Explanation                                                                                        |
|-------------------|----------------------------------------------------------------------------------------------------|
| Delimiter         | Separates input arguments in commands and replies, or data items in results. Default value is ",". |
| Terminator        | Terminates both commands and result output. Default value is "%r%n".                               |
| Invalid           | Represents invalid measurement results. Default value is "INVALID"                                 |

The values of the special characters are defined in the Special Character settings. In addition to normal ASCII characters, the special characters can also contain the following format values.

### *Format values for Special Characters*

| Format Value | Explanation           |
|--------------|-----------------------|
| %t           | Tab                   |
| %n           | New line              |
| %r           | Carriage return       |
| %%           | Percentage (%) symbol |

## Control Commands

Optional parameters are shown in *italic*. The placeholder for data is surrounded by brackets (<>). In the examples, the delimiter is set to ','.

### **Start**

The Start command starts the sensor system (causes it to enter the Running state). This command is only valid when the system is in the Ready state. If a start target is specified, the sensor starts at the target time or encoder (depending on the trigger mode).



### Formats

| Message | Format                                                                                                                                                                                                                                                                                                                                                  |
|---------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Command | Start,start target<br><br>The start target (optional) is the time or encoder position at which the sensor will be started. The time and encoder target value should be set by adding a delay to the time or encoder position returned by the Stamp command. The delay should be set such that it covers the command response time of the Start command. |
| Reply   | OK or ERROR, <Error Message>                                                                                                                                                                                                                                                                                                                            |

### Examples:

```
Command: Start
Reply: OK
Command: Start,1000000
Reply: OK
Command: Start
Reply: ERROR, Could not start the sensor
```

## Stop

The stop command stops the sensor system (causes it to enter the Ready state). This command is valid when the system is in the Ready or Running state.

### Formats

| Message | Format                       |
|---------|------------------------------|
| Command | Stop                         |
| Reply   | OK or ERROR, <Error Message> |

### Examples:

```
Command: Stop
Reply: OK
```

## Trigger

The Trigger command triggers a single frame capture. This command is only valid if the sensor is configured in the Software trigger mode and the sensor is in the Running state. If a start target is specified, the sensor starts at the target time or encoder (depending on the unit setting in the Trigger panel; see *Triggers* on page 93).

### Formats

| Message | Format                                                                                                                                                                                                                                                                                                                                                    |
|---------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Command | Trigger,start target<br><br>The start target (optional) is the time or encoder position at which the sensor will be started. The time and encoder target value should be set by adding a delay to the time or encoder position returned by the Stamp command. The delay should be set such that it covers the command response time of the Start command. |
| Reply   | OK or ERROR, <Error Message>                                                                                                                                                                                                                                                                                                                              |

## Examples:

Command: Trigger

Reply: OK

Command: Trigger,1000000

Reply: OK

## LoadJob

The Load Job command switches the active sensor configuration.

### Formats

| Message | Format                                                                                                                                                                                                                          |
|---------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Command | LoadJob,job file name<br><br>If the job file name is not specified, the command returns the current job name. An error message is generated if no job is loaded. ".job" is appended if the filename does not have an extension. |
| Reply   | OK or ERROR, <Error Message>                                                                                                                                                                                                    |

## Examples:

Command: LoadJob,test.job

Reply: OK,test.job loaded successfully

Command: LoadJob

Reply: OK,test.job

Command: LoadJob,wrongname.job

Reply: ERROR, failed to load wrongname.job

## Stamp

The Stamp command retrieves the current time, encoder, and/or the last frame count.

### Formats

| Message | Format                                                                                                                                                                                                               |
|---------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Command | Stamp,time,encoder,frame<br><br>If no parameters are given, time, encoder, and frame will be returned. There could be more than one selection.                                                                       |
| Reply   | If no arguments are specified:<br><br>OK, time, <time value>, encoder, <encoder position>, frame, <frame count> ERROR, <Error Message><br><br>If arguments are specified, only the selected stamps will be returned. |

## Examples:

Command: Stamp

Reply: OK,Time,9226989840,Encoder,0,Frame,6

Command: Stamp,frame

Reply: OK,6

## Stationary Alignment

The Stationary Alignment command performs an alignment based on the settings in the sensor's live job file. A reply to the command is sent when the alignment has completed or failed. The command is timed out if there has been no progress after one minute.

### Formats

| Message | Format                                                        |
|---------|---------------------------------------------------------------|
| Command | StationaryAlignment                                           |
| Reply   | If no arguments are specified<br>OK or ERROR, <Error Message> |

### Examples:

Command: StationaryAlignment

Reply: OK

Command: StationaryAlignment

Reply: ERROR, ALIGNMENT FAILED

## Moving Alignment

The Moving Alignment command performs an alignment based on the settings in the sensor's live job file. A reply to the command is sent when the alignment has completed or failed. The command is timed out if there has been no progress after one minute.

### Formats

| Message | Format                                                        |
|---------|---------------------------------------------------------------|
| Command | MovingAlignment                                               |
| Reply   | If no arguments are specified<br>OK or ERROR, <Error Message> |

### Examples:

Command: MovingAlignment

Reply: OK

Command: MovingAlignment

Reply: ERROR, ALIGNMENT FAILED

## Clear Alignment

The Clear Alignment command clears the alignment record generated by the alignment process.

### Formats

| Message | Format                       |
|---------|------------------------------|
| Command | ClearAlignment               |
| Reply   | OK or ERROR, <Error Message> |

### Examples:

Command: ClearAlignment

Reply: OK

## Data Commands

Optional parameters are shown in *italic*. The placeholder for data is surrounded by brackets (<>). In the examples, the delimiter is set to ','.

### Result

The Result command retrieves measurement values and decisions.

#### Formats

| Message | Format                                                                                                                                                                                                                    |
|---------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Command | Result,measurement ID,measurement ID...                                                                                                                                                                                   |
| Reply   | If no arguments are specified, the custom format data string is used.<br>OK, <custom data string> ERROR, <Error Message><br>If arguments are specified,<br>OK, <data string in standard format><br>ERROR, <Error Message> |

Examples:

Standard data string for measurements ID 0 and 1:

```
Result,0,1
```

```
OK,M00,00,V151290,D0,M01,01,V18520,D0
```

Standard formatted measurement data with a non-existent measurement of ID 2:

```
Result,2
```

```
ERROR,Specified measurement ID not found. Please verify your input
```

Custom formatted data string (%time, %value[0], %decision[0]):

```
Result
```

```
OK,1420266101,151290,0
```

### Value

The Value command retrieves measurement values.

#### Formats

| Message | Format                                                                |
|---------|-----------------------------------------------------------------------|
| Command | Value,measurement ID,measurement ID...                                |
| Reply   | If no arguments are specified, the custom format data string is used. |

| Message | Format                                                                                              |
|---------|-----------------------------------------------------------------------------------------------------|
|         | OK, <custom data string> ERROR, <Error Message>                                                     |
|         | If arguments are specified,                                                                         |
|         | OK, <data string in standard format, except that the decisions are not sent> ERROR, <Error Message> |

Examples:

Standard data string for measurements ID 0 and 1:

```
Value,0,1
```

```
OK,M00,00,V151290,M01,01,V18520
```

Standard formatted measurement data with a non-existent measurement of ID 2:

```
Value,2
```

```
ERROR,Specified measurement ID not found. Please verify your input
```

Custom formatted data string (%time, %value[0]):

```
Value
```

```
OK, 1420266101, 151290
```

## Decision

The Decision command retrieves measurement decisions.

### Formats

| Message | Format                                                                                                                                                                                                                                                      |
|---------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Command | Decision,measurement ID,measurement ID...                                                                                                                                                                                                                   |
| Reply   | If no arguments are specified, the custom format data string is used.<br>OK, <custom data string> ERROR, <Error Message><br>If arguments are specified,<br>OK, <data string in standard format, except that the values are not sent> ERROR, <Error Message> |

Examples:

Standard data string for measurements ID 0 and 1:

```
Decision,0,1
```

```
OK,M00,00,D0,M01,01,D0
```

Standard formatted measurement data with a non-existent measurement of ID 2:

Decision,2

ERROR,Specified measurement ID not found. Please verify your input

Custom formatted data string (%time,%decision[0]):

Decision

OK,1420266101, 0

## Health Commands

Optional parameters are shown in *italic*. The placeholder for data is surrounded by brackets (<>). In the examples, the delimiter is set to ','.

### Health

The Health command retrieves health indicators. See *Health Results* on page 455 for details on health indicators.

#### Formats

| Message | Format                                                                                                                                                                                                                                                                                                      |
|---------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Command | Health,health indicator ID.Optional health indicator instance ...<br><br>More than one health indicator can be specified. Note that the health indicator instance is optionally attached to the indicator ID with a '.'. If the health indicator instance field is used the delimiter cannot be set to '.'. |
| Reply   | OK, <health indicator of first ID>, <health indicator of second ID><br><br>ERROR, <Error Message>                                                                                                                                                                                                           |

Examples:

health,2002,2017

OK,46,1674

Health

ERROR,Insufficient parameters.

## Standard Result Format

Gocator can send measurement results either in the standard format or in a custom format. In the standard format, you select in the web interface which measurement values and decisions to send. For each measurement the following message is transmitted:

|   |                |   |                |   |   |                |   |   |                |    |
|---|----------------|---|----------------|---|---|----------------|---|---|----------------|----|
| M | t <sub>n</sub> | , | i <sub>n</sub> | , | V | v <sub>n</sub> | , | D | d <sub>1</sub> | CR |
|---|----------------|---|----------------|---|---|----------------|---|---|----------------|----|

| Field            | Shorthand      | Length | Description                                   |
|------------------|----------------|--------|-----------------------------------------------|
| MeasurementStart | M              | 1      | Start of measurement frame.                   |
| Type             | t <sub>n</sub> | n      | Hexadecimal value that identifies the type of |

| Field         | Shorthand      | Length | Description                                                                                                                                                      |
|---------------|----------------|--------|------------------------------------------------------------------------------------------------------------------------------------------------------------------|
|               |                |        | measurement. The measurement type is the same as defined elsewhere (see <i>Data Results</i> on page 445).                                                        |
| Id            | i <sub>n</sub> | n      | Decimal value that represents the unique identifier of the measurement.                                                                                          |
| ValueStart    | V              | 1      | Start of measurement value.                                                                                                                                      |
| Value         | v <sub>n</sub> | n      | Measurement value, in decimal. The unit of the value is measurement-specific.                                                                                    |
| DecisionStart | D              | 1      | Start of measurement decision.                                                                                                                                   |
| Decision      | d <sub>1</sub> | 1      | Measurement decision,<br>a bit mask where:<br>Bit 0:<br>1 – Pass<br>0 – Fail<br>Bits 1-7:<br>0 – Measurement value OK<br>1 – Invalid value<br>2 – Invalid anchor |

## Custom Result Format

In the custom format, you enter a format string with place holders to create a custom message. The default format string is "%time, %value[0], %decision[0]".

### Result Placeholders

| Format Value              | Explanation                                                                                                                                                                            |
|---------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| %time                     | Timestamp                                                                                                                                                                              |
| %encoder                  | Encoder position                                                                                                                                                                       |
| %frame                    | Frame number                                                                                                                                                                           |
| %value[Measurement ID]    | Measurement value of the specified measurement ID. The ID must correspond to an existing measurement.<br><br>The value output will be displayed as an integer in micrometers.          |
| %decision[Measurement ID] | Measurement decision, where the selected measurement ID must correspond to an existing measurement.<br><br>Measurement decision is a bit mask where:<br>Bit 0:<br>1 – Pass<br>0 – Fail |

| Format Value | Explanation              |
|--------------|--------------------------|
|              | Bits 1-7:                |
|              | 0 – Measurement value OK |
|              | 1 – Invalid value        |
|              | 2 - Invalid anchor       |



# Selcom Protocol

This section describes the Selcom serial protocol settings and message formats supported by Gocator sensors.

To use the Selcom protocol, it must be enabled and configured in the active job.

For information on configuring the protocol using the Web interface, see *Serial Output* on page 292.



Units for data scales use the standard units (mm, mm<sup>2</sup>, mm<sup>3</sup>, and degrees).

## Serial Communication

Data communication is synchronous using two unidirectional (output only) RS-485 serial channels: data (Serial\_Out0) and clock (Serial\_Out1). See *Serial Output* on page 563 for cable pinout information.

Measurement results are sent on the serial output (data) in asynchronous mode. Measurement values and decisions can be transmitted to an RS-485 receiver, but job handling and control operations must be performed through the Gocator's web interface or through communications on the Ethernet output.

## Connection Settings

The Selcom protocol uses the following connection settings:

### *Serial Connection Settings*

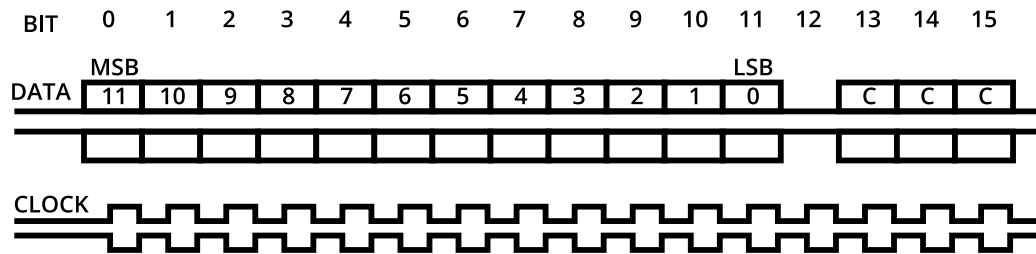
| Parameter       | Value                  |
|-----------------|------------------------|
| Data Bits       | 16                     |
| Baud Rate (b/s) | 96000, 512000, 1024000 |
| Format          | Binary                 |

## Message Format

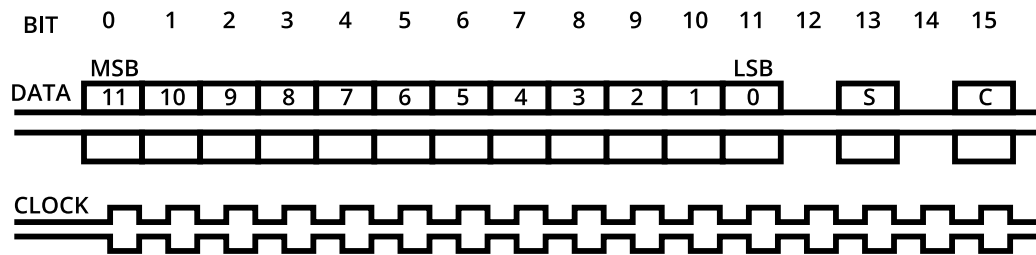
The data channel is valid on the rising edge of the clock and data is output with the most significant bit first, followed by control bits for a total of 16 bits of information per frame. The time between the start of the camera exposure and the delivery of the corresponding range data is fixed to a deterministic value.

The sensor can output data using one of four formats, illustrated below, where:

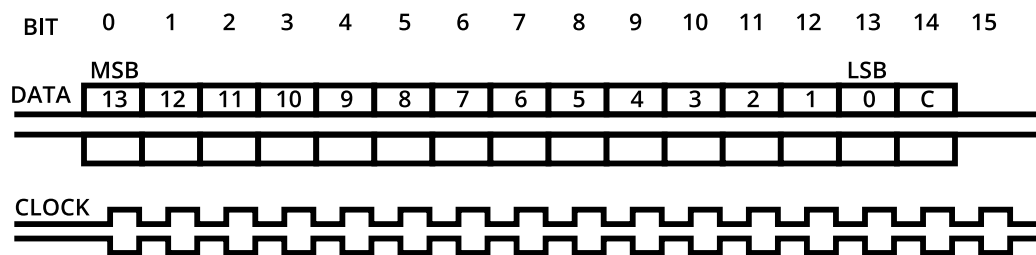
- MSB = most significant bit
- LSB = least significant bit
- C = data valid bit (high = invalid)
- S = whether data is acquired in search mode or track mode (high = search mode)



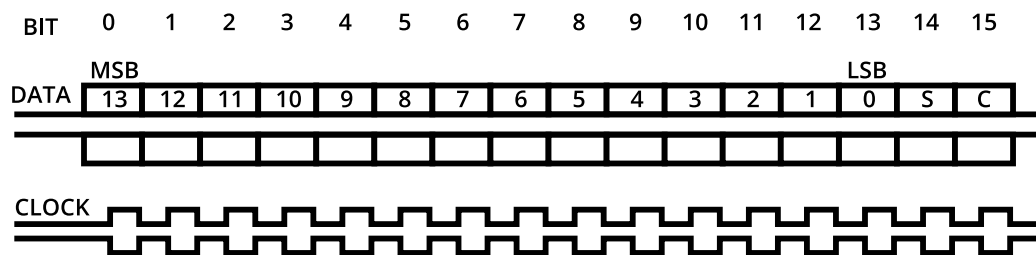
*12-bit data format (SLS mode; "SLS" in Gocator web interface)*



*12-bit data format with Search/Track bit*



*14-bit data format*



*14-bit data format with Search/Track bit*

# Development Kits

Gocator includes two development kits:

- [Software Development Kit \(SDK\)](#)
- [Gocator Development Kit \(GDK\)](#)

## SDK

The Gocator Software Development Kit (SDK) includes open-source software libraries and documentation that can be used to programmatically access and control Gocator sensors. To get the latest version of the SDK, go to <http://lmi3d.com/support>, choose your product from the Product Downloads section, and download it from the Download Center.

You can download the Gocator SDK from within the Web interface.

Software Development Kit (SDK):

Download

*To download the SDK:*

1. Go to the **Manage** page and click on the **Support** category
2. Next to **Software Development Kit (SDK)**, click **Download**
3. Choose the location for the SDK on the client computer.

Applications compiled with previous versions of the SDK are compatible with Gocator firmware if the major version numbers of the protocols match. For example, an application compiled with version 4.0 of the SDK (which uses protocol version 4.0) will be compatible with a Gocator running firmware version 4.1 (which uses protocol version 4.1). However, any new features in firmware version 4.1 would not be available.

If the major version number of the protocol is different, for example, an application compiled using SDK version 3.x being used with a Gocator running firmware 4.x, you must rewrite the application with the SDK version corresponding to the sensor firmware in use.

The Gocator API, included in the SDK, is a C language library that provides support for the commands and data formats used with Gocator sensors. The API is written in standard C to allow the code to be compiled for any operating system. A pre-built DLL is provided to support 32-bit and 64-bit Windows operating systems. Projects and makefiles are included to support other editions of Windows and Linux.

For Windows users, code examples explaining how to wrap the calls in C# and VB.NET are provided in the tools package, which can be downloaded at go to <http://lmi3d.com/support>, choose your product from the Product Downloads section, and download it from the Download Center.

For more information about programming with the Gocator SDK, refer to the class reference and sample programs included in the Gocator SDK.

## Setup and Locations

### Class Reference

The full SDK class reference is found by accessing 14400-4.x.x.xx\_SOFTWARE\_GO\_SDK\GO\_SDK\doc\GoSdk\Gocator\_2x00\GoSdk.html.

### Examples

Examples showing how to perform various operations are provided, each one targeting a specific area. All of the examples can be found in *GoSdkSamples.sln*.

To run the SDK samples, make sure *GoSdk.dll* and *kApi.dll* (or *GoSdkd.dll* and *kApid.dll* in debug configuration) are copied to the executable directory. All sample code, including C examples, is now located in the *Tools* package, which can be downloaded by going to <http://lmi3d.com/support>, choose your product from the Product Downloads section, and download it from the Download Center.

### Sample Project Environment Variable

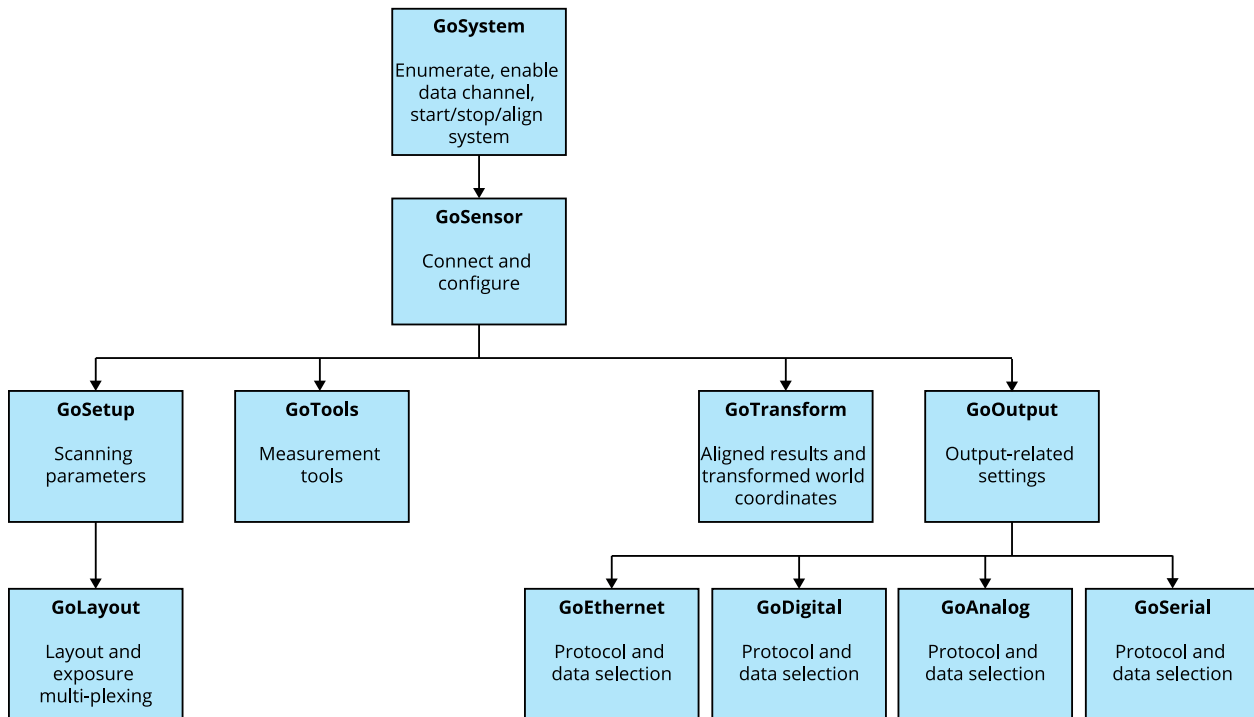
All sample projects use the environment variable *GO\_SDK\_4*. The environment variable should point to the *GO\_SDK* directory, for example, *C:\14400-4.0.9.156\_SOFTWARE\_GO\_SDK\GO\_SDK*.

### Header Files

Header files are referenced with GoSdk as the source directory, for example: `#include <GoSdk/GoSdk.h>`. The SDK header files also reference files from the *kApi* directory. The include path must be set up for both the GoSdk and the kApi directories. For example, the sample projects set the include path to `$(GO_SDK_4)\Gocator\GoSdk` and `$(GO_SDK_4)\Platform\kApi`.

## Class Hierarchy

This section describes the class hierarchy of the Gocator 4.x SDK.



## GoSystem

The *GoSystem* class is the top-level class in Gocator 4.x. Multiple sensors can be enabled and connected in one *GoSystem*. Only one *GoSystem* object is required for multi-sensor control.

Refer to the *How To Use The Open Source SDK To Fully Control A Gocator Multi-sensor System* how-to guide in [http://lmi3d.com/sites/default/files/APPNOTE\\_Gocator\\_4.x\\_Multi\\_Sensor\\_Guide.zip](http://lmi3d.com/sites/default/files/APPNOTE_Gocator_4.x_Multi_Sensor_Guide.zip) for details on how to control and operate a multi-sensor system using the SDK.



All objects that are explicitly created by the user or passed via callbacks should be destroyed by using the *GoDestroy* function.

## GoSensor

*GoSensor* represents a physical sensor. If the physical sensor is the Main sensor in a dual-sensor setup, it can be used to configure settings that are common to both sensors.

## GoSetup

The *GoSetup* class represents a device's configuration. The class provides functions to get or set all of the settings available in the Gocator web interface.

*GoSetup* is included inside *GoSensor*. It encapsulates scanning parameters, such as exposure, resolution, spacing interval, etc. For parameters that are independently controlled for Main and Buddy sensors, functions accept a role parameter.

## GoLayout

The *GoLayout* class represents layout-related sensor configuration.

## GoTools

The *GoTools* class is the base class of the measurement tools. The class provides functions for getting and setting names, retrieving measurement counts, etc.

## GoTransform

The *GoTransform* class represents a sensor transformation and provides functions to get and set transformation information, as well as encoder-related information.

## GoOutput

The *GoOutput* class represents output configuration and provides functions to get the specific types of output (Analog, Digital, Ethernet, and Serial). Classes corresponding to the specific types of output (*GoAnalog*, *GoDigital*, *GoEthernet*, and *GoSerial*) are available to configure these outputs.

## Data Types

The following sections describe the types used by the SDK and the *kApi* library.

### Value Types

*GoSDK* is built on a set of basic data structures, utilities, and functions, which are contained in the *kApi* library.

The following basic value types are used by the *kApi* library.

#### *Value Data Types*

| Type       | Description                           |
|------------|---------------------------------------|
| k8u        | 8-bit unsigned integer                |
| k16u       | 16-bit unsigned integer               |
| k16s       | 16-bit signed integer                 |
| k32u       | 32-bit unsigned integer               |
| k32s       | 32-bit signed integer                 |
| k64s       | 64-bit signed integer                 |
| k64u       | 64-bit unsigned integer               |
| k64f       | 64-bit floating number                |
| kBool      | Boolean, value can be kTRUE or kFALSE |
| kStatus    | Status, value can be kOK or kERROR    |
| kIpAddress | IP address                            |

### Output Types

The following output types are available in the SDK.

#### *Output Data Types*

| Data Type  | Description                                          |
|------------|------------------------------------------------------|
| GoAlignMsg | Represents a message containing an alignment result. |

| Data Type             | Description                                                                                                    |
|-----------------------|----------------------------------------------------------------------------------------------------------------|
| GoBoundingBoxMatchMsg | Represents a message containing bounding box based part matching results.                                      |
| GoDataMsg             | Represents a base message sourced from the data channel. See <i>GoDataSet Type</i> below for more information. |
| GoEdgeMatchMsg        | Represents a message containing edge based part matching results.                                              |
| GoEllipseMatchMsg     | Represents a message containing ellipse based part matching results.                                           |
| GoExposureCalMsg      | Represents a message containing exposure calibration results.                                                  |
| GoMeasurementMsg      | Represents a message containing a set of GoMeasurementData objects.                                            |
| GoProfileIntensityMsg | Represents a data message containing a set of profile intensity arrays.                                        |
| GoProfileMsg          | Represents a data message containing a set of profile arrays.                                                  |
| GoRangeIntensityMsg   | Represents a data message containing a set of range intensity data.                                            |
| GoRangeMsg            | Represents a data message containing a set of range data.                                                      |
| GoResampledProfileMsg | Represents a data message containing a set of resampled profile arrays.                                        |
| GoSectionMsg          | Represents a data message containing a set of section arrays.                                                  |
| GoSectionIntensityMsg | Represents a data message containing a set of profile intensity arrays.                                        |
| GoStampMsg            | Represents a message containing a set of acquisition stamps.                                                   |
| GoSurfaceIntensityMsg | Represents a data message containing a surface intensity array.                                                |
| GoSurfaceMsg          | Represents a data message containing a surface array.                                                          |
| GoVideoMsg            | Represents a data message containing a video image.                                                            |

Refer to the *GoSdkSamples* sample code for examples of acquiring data using these data types.

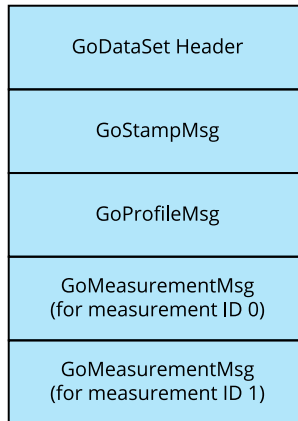


See *Setup and Locations* on page 489 for more information on the code samples.

## GoDataSet Type

Data are passed to the data handler in a *GoDataSet* object. The *GoDataSet* object is a container that can contain any type of data, including scan data (profiles, sections, or surfaces), measurements, and results from various operations. Data inside the *GoDataSet* object are represented as messages.

The following illustrates the content of a *GoDataSet* object of a profile mode setup with two measurements. The content when using a surface mode setup is identical, except that a *GoSurfaceMsg* is sent instead of a *GoProfileMsg*.



After receiving the *GoDataSet* object, you should call *GoDestroy* to dispose the *GoDataSet* object. You do not need to dispose objects within the *GoDataSet* object individually.



All objects that are explicitly created by the user or passed via callbacks should be destroyed by using the *GoDestroy* function.

## Measurement Values and Decisions

Measurement values and decisions are 32-bit signed values (k32s). See *Value Types* on page 491 for more information on value types.

The following table lists the decisions that can be returned.

### Measurement Decisions

| Decision | Description                                                                                                                                             |
|----------|---------------------------------------------------------------------------------------------------------------------------------------------------------|
| 1        | The measurement value is between the maximum and minimum decision values. This is a pass decision.                                                      |
| 0        | The measurement value is outside the maximum and minimum. This is a fail decision.                                                                      |
| -1       | The measurement is invalid (for example, the target is not within range). Provides the reason for the failure.                                          |
| -2       | The tool containing the measurement is anchored and has received invalid measurement data from one of its anchors. Provides the reason for the failure. |

Refer to the *SetupMeasurement* example for details on how to add and configure tools and measurements. Refer to the *ReceiveMeasurement* example for details on how to receive measurement decisions and values.

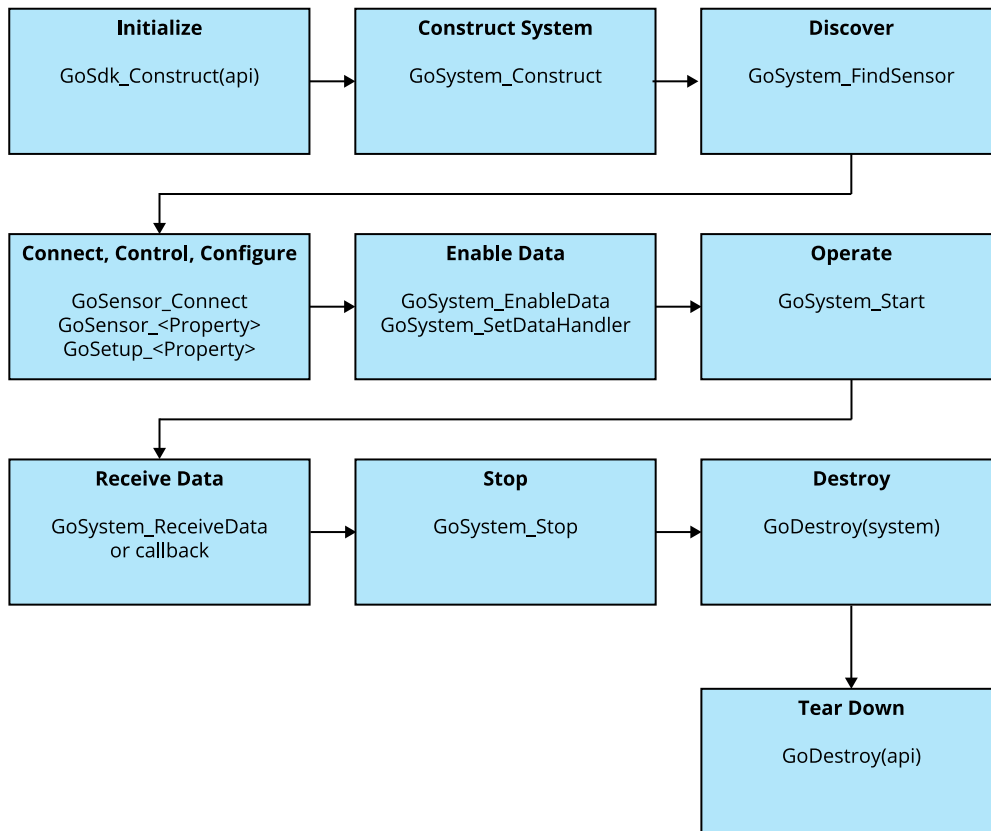


You should check a decision against  $\leq 0$  for failure or invalid measurement.

## Operation Workflow

Applications created using the SDK typically use the following programming sequence:





See *Setup and Locations* on page 489 for more information on the code samples referenced below.



Sensors must be connected before the system can enable the data channel.



All data functions are named *Go<Object>\_<Function>*, for example, *GoSensor\_Connect*. For property access functions, the convention is *Go<Object>\_<Property Name>* for reading the property and *Go<Object>\_Set<Property Name>* for writing it, for example, *GoMeasurement\_DecisionMax* and *GoMeasurement\_SetDecisionMax*, respectively.

## Initialize GoSdk API Object

Before the SDK can be used, the *GoSdk* API object must be initialized by calling *GoSdk\_Construct(api)*:

```

kAssembly api = kNULL;
if ((status = GoSdk_Construct(&api)) != kOK)
{
    printf("Error: GoSdk_Construct:%d\n", status);
    return;
}
  
```

When the program finishes, call *GoDestroy(api)* to destroy the API object.

## Discover Sensors

Sensors are discovered when *GoSystem* is created, using *GoSystem\_Construct*. You can use *GoSystem\_SensorCount* and *GoSystem\_SensorAt* to iterate all the sensors that are on the network.

*GoSystem\_SensorCount* returns the number of sensors physically in the network.

Alternatively, use *GoSystem\_FindSensorById* or *GoSystem\_FindSensorByIpAddress* to get the sensor by ID or by IP address.

Refer to the *Discover* example for details on iterating through all sensors. Refer to other examples for details on how to get a sensor handle directly from IP address.

## Connect Sensors

Sensors are connected by calling *GoSensor\_Connect*. You must first get the sensor object by using *GoSystem\_SensorAt*, *GoSystem\_FindSensorById*, or *GoSystem\_FindSensorByIpAddress*.

## Configure Sensors

Some configuration is performed using the *GoSensor* object, such as managing jobs, uploading and downloading files, scheduling outputs, setting alignment reference, etc. Most configuration is however performed through the *GoSetup* object, for example, setting scan mode, exposure, exposure mode, active area, speed, alignment, filtering, subsampling, etc. Surface generation is configured through the *GoSurfaceGeneration* object and part detection settings are configured through the *GoPartDetection* object.

See *Class Hierarchy* on page 489 for information on the different objects used for configuring a sensor. Sensors must be connected before they can be configured.

Refer to the *Configure* example for details on how to change settings and to switch, save, or load jobs. Refer to the *BackupRestore* example for details on how to back up and restore settings.

## Enable Data Channels

Use *GoSystem\_EnableData* to enable the data channels of all connected sensors. Similarly, use *GoSystem\_EnableHealth* to enable the health channels of all connected sensors.

## Perform Operations

Operations are started by calling *GoSystem\_Start*, *GoSystem\_StartAlignment*, and *GoSystem\_StartExposureAutoSet*.

Refer to the *StationaryAlignment* and *MovingAlignment* examples for details on how to perform alignment operations. Refer to the *ReceiveRange*, *ReceiveProfile*, and *ReceiveWholePart* examples for details on how to acquire data.

### Example: Configuring and starting a sensor with the Gocator API

```
#include <GoSdk/GoSdk.h>
```

```
void main()  
{
```

```

kIpAddress ipAddress;
GoSystem system = kNULL;
GoSensor sensor = kNULL;
GoSetup setup = kNULL;

//Construct the GoSdk library.
GoSdk_Construct(&api);
//Construct a Gocator system object.
GoSystem_Construct(&system, kNULL);
//Parse IP address into address data structure
kIpAddress_Parse(&ipAddress, SENSOR_IP);
//Obtain GoSensor object by sensor IP address
GoSystem_FindSensorByIpAddress(system, &ipAddress, &sensor)
//Connect sensor object and enable control channel
GoSensor_Connect(sensor);
//Enable data channel
GoSensor_EnableData(system, kTRUE)
//[Optional] Setup callback function to receive data asynchronously
//GoSystem_SetDataHandler(system, onData, &contextPointer)
//Retrieve setup handle
setup = GoSensor_Setup(sensor);
//Reconfigure system to use time-based triggering.
GoSetup_SetTriggerSource(setup, GO_TRIGGER_TIME);
//Send the system a "Start" command.
GoSystem_Start(system);

//Data will now be streaming into the application
//Data can be received and processed asynchronously if a callback function has been
//set (recommended)
//Data can also be received and processed synchronously with the blocking call
//GoSystem_ReceiveData(system, &dataset, RECEIVE_TIMEOUT)
//Send the system a "Stop" command.
GoSystem_Stop(system);

//Free the system object.
GoDestroy(system);

//Free the GoSdk library
GoDestroy(api);
}

```

## Limiting Flash Memory Write Operations

Several operations and Gocator SDK functions write to the Gocator's flash memory. The lifetime of the flash memory is limited by the number of write cycles. Therefore it is important to avoid frequent write operation to the Gocator's flash memory when you design your system with the Gocator SDK.



Power loss during flash memory write operation will also cause Gocators to enter rescue mode.



This topic applies to all Gocator sensors.

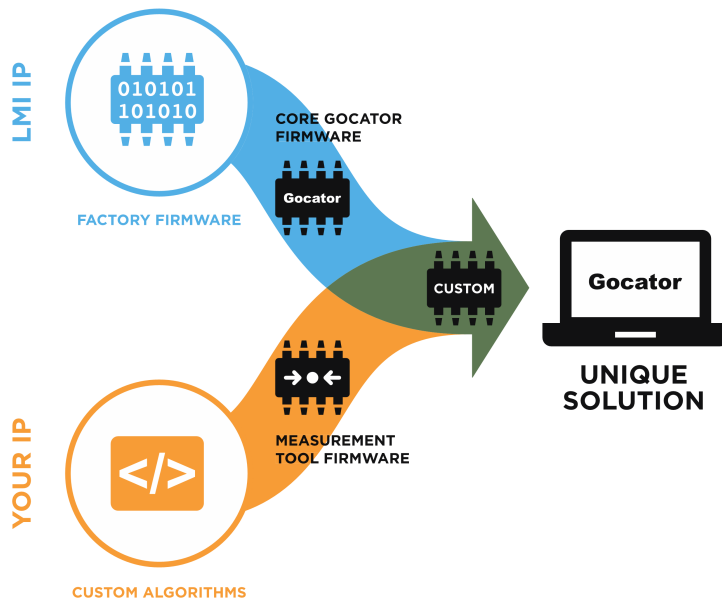
### *Gocator SDK Write-Operation Functions*

| Name                     | Description                                                                                                                                                                                                                             |
|--------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| GoSensor_Restore         | Restores a backup of sensor files.                                                                                                                                                                                                      |
| GoSensor_RestoreDefaults | Restores factory default settings.                                                                                                                                                                                                      |
| GoSensor_CopyFile        | Copies a file within the connected sensor.<br><br>The flash write operation does not occur if GoSensor_CopyFile function is used to load an existing job file. This is accomplished by specifying "_live" as the destination file name. |
| GoSensor_DeleteFile      | Deletes a file in the connected sensor.                                                                                                                                                                                                 |
| GoSensor_SetDefaultJob   | Sets a default job file to be loaded on boot.                                                                                                                                                                                           |
| GoSensor_UploadFile      | Uploads a file to the connected sensor.                                                                                                                                                                                                 |
| GoSensor_Upgrade         | Upgrades sensor firmware.                                                                                                                                                                                                               |
| GoSystem_StartAlignment  | When alignment is performed with alignment reference set to fixed, flash memory is written immediately after alignment. GoSensor_SetAlignmentReference() is used to configure alignment reference.                                      |
| GoSensor_SetAddress      | Configures a sensor's network address settings.                                                                                                                                                                                         |
| GoSensor_ChangePassword  | Changes the password associated with the specified user account.                                                                                                                                                                        |

System created using the SDK should be designed in a way that parameters are set up to be appropriate for various application scenarios. Parameter changes not listed above will not invoke flash memory write operations when the changes are not saved to a file using the GoSensor\_CopyFile function. Fixed alignment should be used as a means to attach previously conducted alignment results to a job file, eliminating the need to perform a new alignment.

## GDK

The Gocator Development Kit (GDK) is a framework for developing and testing custom Gocator measurement tools containing your own algorithms, and then deploying them to Gocator sensors.



Custom tools created with the GDK act much like native Gocator measurement tools, running at native speeds and taking advantage of features such as anchoring. The GDK supports all data types (profile and surface), and tools created with the GDK use the same data visualization as native tools.

For more information on the GDK, see the technical user manual (15201-4.x.x.xxx\_MANUAL\_Technical\_Gocator-Measurement-Tool.pdf). To get the manual, go to <http://lmi3d.com/support>, choose your product from the Product Downloads section, and download it from the Download Center. You can download the GDK package (14524-4.5.4.102\_SOFTWARE\_GDK.zip) and the prerequisite tools package (14525\_1.0.0.0\_SOFTWARE\_GDK\_Prerequisites.zip) from the same location.

## Benefits

When you use the GDK to create custom measurement tools, you have complete control over how and where your custom measurement tools are used, which protects your intellectual property.

You can also easily troubleshoot and modify your tools on-site, letting you respond quickly to your customers' urgent issues.

## Supported Sensors

The GDK is available for free for the following Gocator sensors:

- Gocator 1300 series
- Gocator 2300 series
- Gocator 2400 series
- Gocator 3100 series

## Typical Workflow

The following is the typical workflow for creating and deploying custom measurement tools:

- Develop and build measurement tools using the GDK project files and libraries in Microsoft Visual Studio, targeting Win32.
- Debug the measurement tools using the emulator on a PC.
- Build the measurement tools into a custom firmware binary.
- Upload the custom firmware to a sensor.

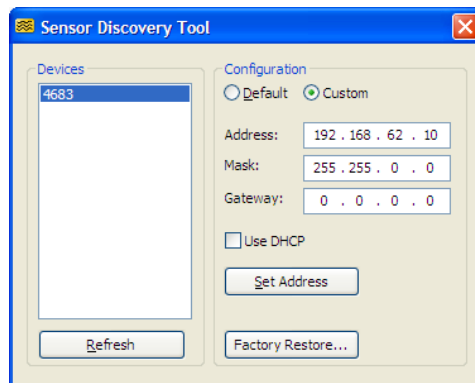
# Tools and Native Drivers

The following sections describe the tools and native drivers you can use with a Gocator.

## Sensor Recovery Tool

If a sensor's network address or administrator password is forgotten, the sensor can be discovered on the network and/or restored to factory defaults by using a special software tool called the Sensor Discovery tool. This software tool can be obtained from the downloads area of the LMI Technologies website: <http://www.lmi3D.com>.

After downloading the tool package [14405-x.x.x.x\_SOFTWARE\_GO\_Tools.zip], unzip the file and run the Sensor Discovery Tool [bin>win32>kDiscovery.exe].



Any sensors that are discovered on the network will be displayed in the Devices list.

*To change the network address of a sensor:*

1. To change the network address of a sensor.
2. Select the **Custom** option.
3. Enter the new network address information.
4. Press the Set Address button.

*To restore a sensor to factory defaults:*

1. Select the sensor serial number in the **Devices** list.
2. Press the **Factory Restore...** button.  
Confirm when prompted.



The Sensor Discovery tool uses UDP broadcast messages to reach sensors on different subnets. This enables the Sensor Discovery tool to locate and re-configure sensors even when the sensor IP address or subnet configuration is unknown.



# GenTL Driver

GenTL is an industry standard method of controlling and acquiring data from an imaging device. The GenTL driver included with Gocator allows GenTL-compliant third-party software applications such as Halcon and Common Vision Blox to acquire and process 3D point clouds and intensity generated from the Gocator's Video, Profile (with **Uniform Spacing** disabled) and Surface modes in real-time.



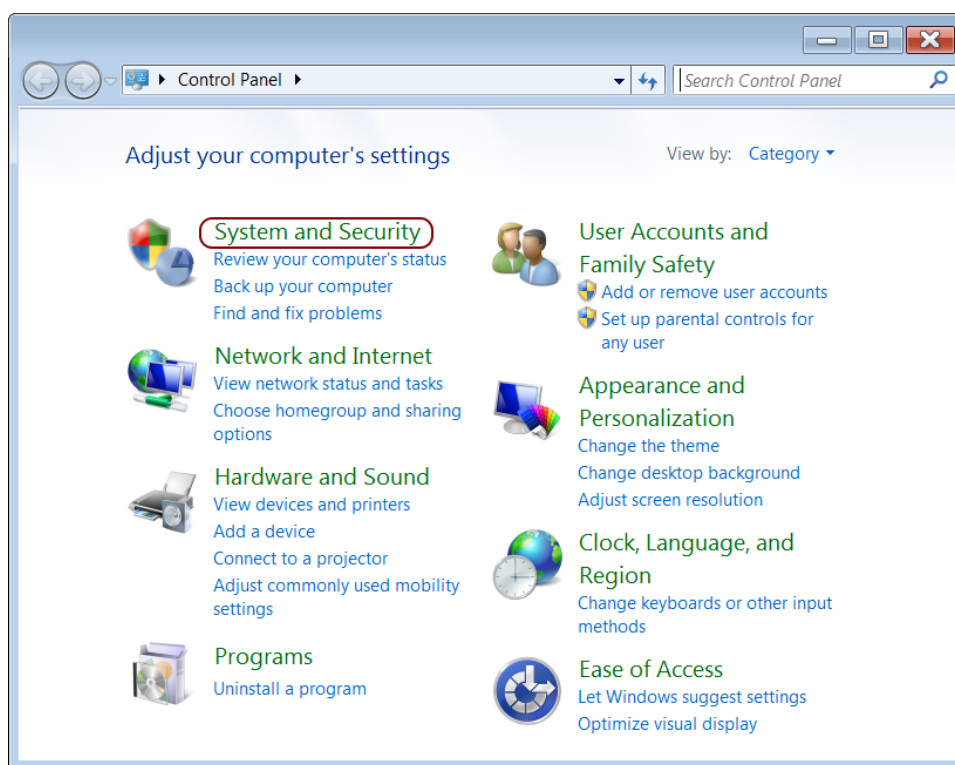
To use these third-party software applications, you *must* configure a system variable so the software can access the GenTL driver. For instructions, see *To configure system variables to use the driver in Windows 7*, below.

To get the toolset package containing the driver ( 14405-x.x.x\_SOFTWARE\_GO\_Tools.zip), go to <http://lmi3d.com/support>, choose your product from the Product Downloads section, and download it from the Download Center.

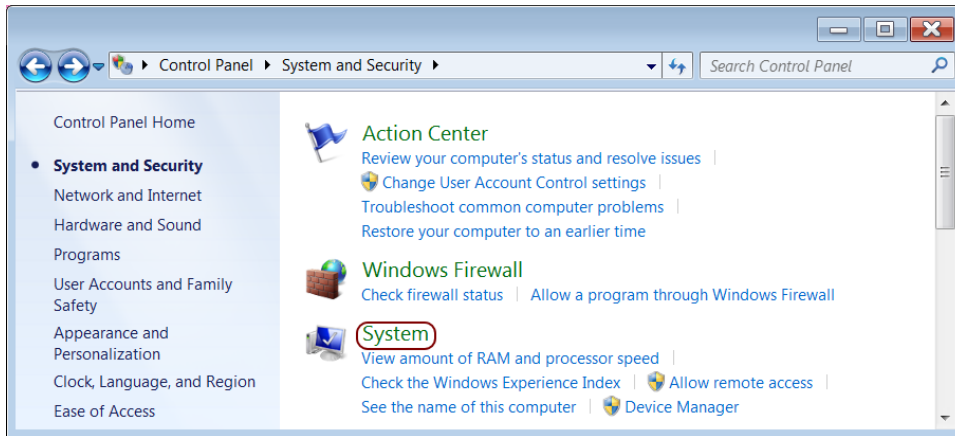
After downloading the package and unzipping the file to a location you will remember, you will find the driver in the GenTL\x86 or GenTL\x64 folder (you can move the GenTL folder to a more convenient location).

*To configure system variables to use the driver in Windows 7:*

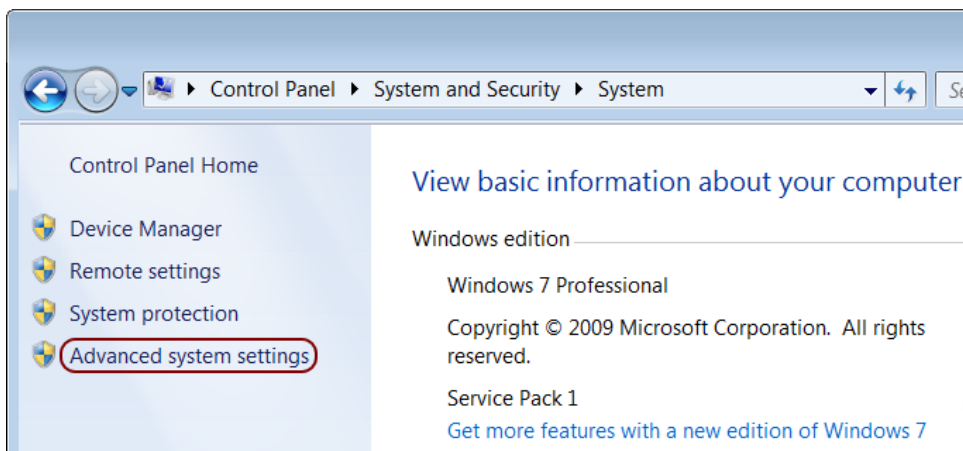
1. From the Start menu, open the **Control** panel and then click **System and Security**.



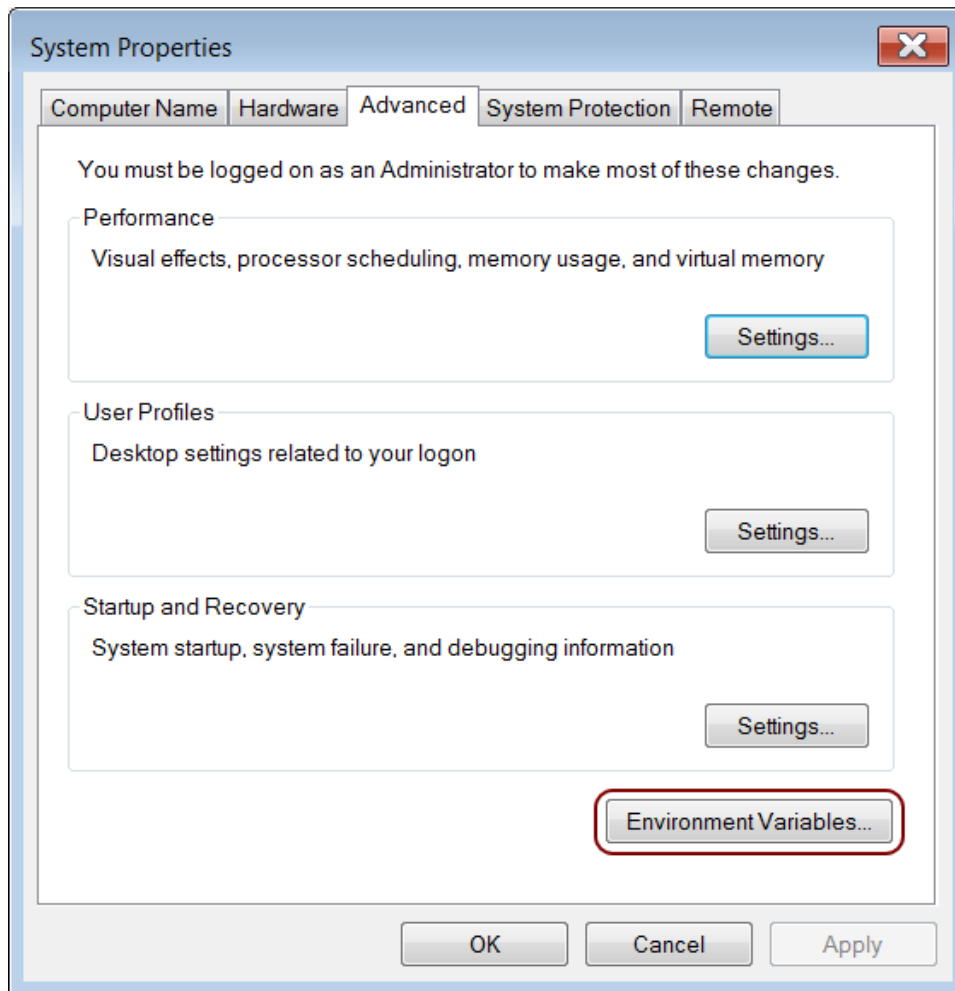
2. Click **System**.



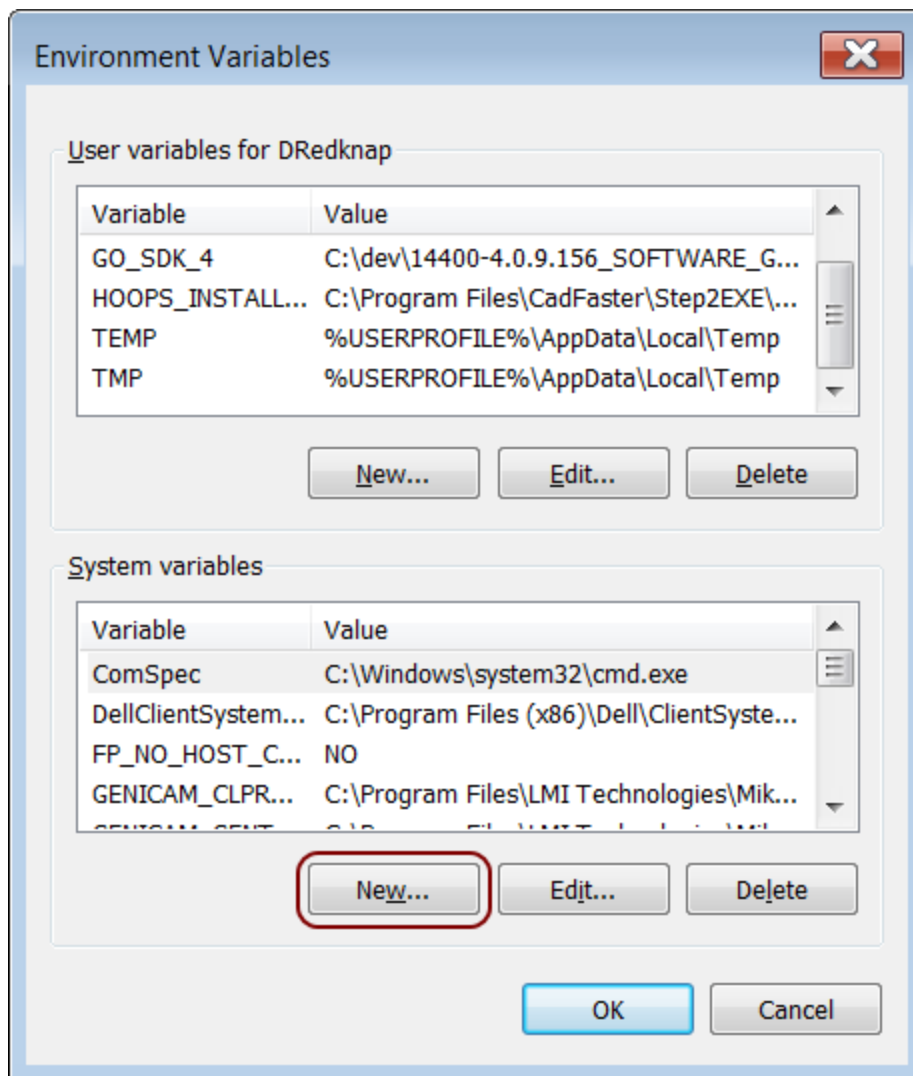
3. Click **Advanced System Settings**.



4. In the **System Properties** dialog, on the **Advanced** tab, click **Environment Variables...**

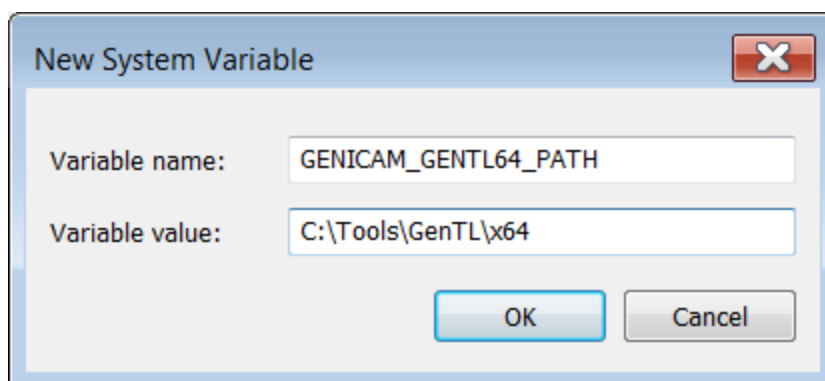


5. In the **Environment Variables** dialog, under the **System variables** list, click **New**.



6. In the **New System Variable** dialog, enter the following information, depending on your system:

|               | Variable name        | Variable value                        |
|---------------|----------------------|---------------------------------------|
| 32-bit system | GENICAM_GENTL32_PATH | The full path to the GenTLx86 folder. |
| 64-bit system | GENICAM_GENTL64_PATH | The full path to the GenTLx64 folder. |



7. Click OK in the dialogs until they are all closed.

To work with the Gocator GenTL driver, the Gocator must operate in Surface or Video mode with its the appropriate output enabled in the **Ethernet** panel in the **Output** page. Check **Acquire Intensity** in the **Scan Mode** panel on the **Scan** page and enable intensity output in the **Ethernet** panel if intensity data is required.

The GenTL driver packs the part output, intensity, and stamps (e.g., time stamp, encoder index, etc.) into either a 16-bit RGB image or a 16-bit grey scale image. You can select the format in the Go2GenTL.xml setting file.

The width and height of the 16-bit RGB or grey scale image is calculated from the maximum number of columns and rows needed to accommodate the sensor's field of view and the maximum part length.

## 16-bit RGB Image

When the 16-bit RGB format is used, the height map, intensity, and stamps are stored in the red, green, and blue channel respectively.

| Channel | Details                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   |
|---------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Red     | <p>Height map information. The width and height of the image represent the dimensions in the X and Y axis. Together with the pixel value, each red pixel presents a 3D point in the real-world coordinates.</p> <p>The following formula can be used to calculate the real-world coordinates (X, Y, Z) from pixel coordinates (Px, Py, Pz):</p> $X = X \text{ offset} + Px * X \text{ resolution}$ $Y = Y \text{ offset} + Py * Y \text{ resolution}$ $Z = Z \text{ offset} + Pz * Z \text{ resolution}$ <p>Refer to the blue channel on how to retrieve the offset and resolution values. If Pz is 0 if the data is invalid. The Z offset is fixed to <math>-32768 * Z \text{ resolution}</math>. Z is zero if Pz is 32768.</p>                                                                                                                                          |
| Green   | <p>Intensity information. Same as the red channel, the width and height of the image represent the dimension in the X and the Y axis. Together with the pixel value, each blue pixel represents an intensity value in the real-world coordinates.</p> <p>The following formula can be used to calculate the real-world coordinates (X, Y, Z) from pixel coordinates (Px, Py, Pz):</p> $X = X \text{ offset} + Px * X \text{ resolution}$ $Y = Y \text{ offset} + Py * Y \text{ resolution}$ $Z = 16\text{-bit intensity value}$ <p>The intensity value is 0 if the intensity image is not available. Gocator outputs 8-bit intensity values. The values stored in the 16-bit RGB image is multiplied by 256. To obtain the original values, divide the intensity values by 256.</p> <p>Refer to the blue channel on how to retrieve the offset and resolution values.</p> |
| Blue    | <p>Stamp information. Stamps are 64-bit auxiliary information related to the height map and intensity content. The next table explains how the stamps are packed into the blue</p>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        |

| Channel | Details                                                                          |
|---------|----------------------------------------------------------------------------------|
|         | pixel channel                                                                    |
|         | See <i>Data Results</i> on page 445 for an explanation of the stamp information. |

The following table shows how the stamp information is packed into the blue channel. A stamp is a 64-bit value packed into four consecutive 16-bit blue pixels, with the first byte position storing the most significant byte.

*Stamp Information from GenTL driver*

| Stamp Index | Blue Pixel Position | Details                                                                             |
|-------------|---------------------|-------------------------------------------------------------------------------------|
| 0           | 0..3                | Version                                                                             |
| 1           | 4..7                | Frame Count                                                                         |
| 2           | 8..11               | Timestamp (µs)                                                                      |
| 3           | 12..15              | Encoder value (ticks)                                                               |
| 4           | 16..19              | Encoder index (ticks)<br>This is the encoder value when the last index is triggered |
| 5           | 20..23              | Digital input states                                                                |
| 6           | 24..27              | X offset (nm)                                                                       |
| 7           | 28..31              | X resolution(nm)                                                                    |
| 8           | 32..35              | Y offset (nm)                                                                       |
| 9           | 36..39              | Y resolution (nm)                                                                   |
| 10          | 40..43              | Z offset (nm)                                                                       |
| 11          | 44..47              | Z resolution (nm)                                                                   |
| 12          | 48..51              | Height map Width (in pixels)                                                        |
| 13          | 52..55              | Height map length (in pixels)                                                       |
| 14          | 56..59              | Specify if the intensity is enabled                                                 |

## 16-bit Grey Scale Image

When the 16-bit grey scale format is used, the height map, intensity, and stamps are stored sequentially in the grey scale image.

The last row of the image contains the stamp information.

| Rows                       | Details                                                                                                                                                                                                                                                                                                                                                                                        |
|----------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 0 .. (max part height - 1) | Height map information. The width and height of the image represent the dimensions in the X and Y axis. Together with the pixel value, each pixel presents a 3D point in the real-world coordinates.<br><br>The following formula can be used to calculate the real-world coordinates (X, Y, Z) from pixel coordinates (Px, Py, Pz):<br><br>$X = X \text{ offset} + Px * X \text{ resolution}$ |

| Rows                                                                           | Details                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  |
|--------------------------------------------------------------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
|                                                                                | $Y = Y \text{ offset} + P_y * Y \text{ resolution}$ $Z = Z \text{ offset} + P_z * Z \text{ resolution}$ <p>Refer to the blue channel on how to retrieve the offset and resolution values. If <math>P_z</math> is 0 if the data is invalid. The Z offset is fixed to <math>-32768 * Z \text{ Resolution}</math>. Z is zero if <math>P_z</math> is 32768.</p>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              |
| (max part height) .. $2 * (\text{max part height})$<br>If intensity is enabled | <p>Intensity information. The width and height of the image represent the dimension in the X and the Y axis. Together with the pixel value, each blue pixel represents an intensity value in the real-world coordinates.</p> <p>The following formula can be used to calculate the real-world coordinates (X, Y, Z) from pixel coordinates (Px, Py, Pz): The following formula assumes Py is relative to the first row of the intensity information, not the first row of the whole 16-bit grey scale image.</p> $X = X \text{ offset} + P_x * X \text{ resolution}$ $Y = Y \text{ offset} + P_y * Y \text{ resolution}$ $Z = 16\text{-bit intensity value}$ <p>This intensity value is 0 if the intensity image is not available. Gocator outputs 8-bit intensity values. The values stored in the 16-bit Grey scale image is multiplied by 256. To obtain the original values, divide the intensity values by 256.</p> <p>Refer to the stamps on how to retrieve the offset and resolution values.</p> |
| The last row of the 16-bit grey scale image                                    | <p>Stamp information. Stamps are 64-bit auxiliary information related to the height map and intensity content. The next table explains how the stamps are packed into the blue pixel channel</p> <p>See <i>Data Results</i> on page 445 for an explanation of the stamp information.</p>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 |

The following table shows how the stamp information is packed into the last row. A stamp is a 64-bit value packed into four consecutive 16-bit pixels, with the first byte position storing the most significant byte.

#### *Stamp Information from GenTL driver*

| Stamp Index | Column Position | Details                                                                             |
|-------------|-----------------|-------------------------------------------------------------------------------------|
| 0           | 0..3            | Version                                                                             |
| 1           | 4..7            | Frame Count                                                                         |
| 2           | 8..11           | Timestamp ( $\mu$ s)                                                                |
| 3           | 12..15          | Encoder value (ticks)                                                               |
| 4           | 16..19          | Encoder index (ticks)<br>This is the encoder value when the last index is triggered |
| 5           | 20..23          | Digital input states                                                                |
| 6           | 24..27          | X offset (nm)                                                                       |
| 7           | 28..31          | X resolution(nm)                                                                    |
| 8           | 32..35          | Y offset (nm)                                                                       |

| Stamp Index | Column Position | Details                                |
|-------------|-----------------|----------------------------------------|
| 9           | 36..39          | Y resolution (nm)                      |
| 10          | 40..43          | Z offset (nm)                          |
| 11          | 44..47          | Z resolution (nm)                      |
| 12          | 48..51          | Height map Width (in pixels)           |
| 13          | 52..55          | Height map length (in pixels)          |
| 14          | 56..59          | Specify if intensity is enabled or not |

## Registers

GenTL registers are multiples of 32 bits. The registers are used to control the operation of the GenTL driver, send commands to the sensors, or to report the current sensor information.

### Register Map Overview

| Register Address | Name               | Read/Write | Length (bytes) | Description                                                                                                                                                                                                                                                        |
|------------------|--------------------|------------|----------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 260              | WidthReg           | RO         | 4              | Specify the width of the returned images. The part height map is truncated if it is wider than the specified width.                                                                                                                                                |
| 264              | HeightReg          | RO         | 4              | Specify the height of the returned images (i.e., length of the part). The part height map is truncated if it is longer than the specified length.                                                                                                                  |
| 292              | ResampleMode       | RO         | 4              | <p>Enable the resampling logic in the GenTL driver</p> <p>0 – Disable resampling</p> <p>1 – Enable resampling</p> <p>When resampling is enabled, the GenTL driver will resample the height map so that the pixel spacing is the same in the X and Y axis.</p>      |
| 296              | EncoderValue0      | RO         | 4              | <p>Report the current encoder value (least significant 32-bit).</p> <p>The current encoder value is latched from the sensor when this register is read.</p>                                                                                                        |
| 300              | EncoderValue1      | RO         | 4              | <p>Report the current encoder value (most significant 32-bit).</p> <p>The encoder value is latched when EncoderValue0 register is read. User should read EncoderValue0 before reading EncoderValue1.</p>                                                           |
| 304              | Configuration File | RW         | 16             | Read the name of sensor live configuration file or switch (write) the sensor configuration file. The configuration name is NULL terminated and includes the extension ".job". Writing to this register causes the sensor to switch to the specified configuration. |



| Register Address | Name                       | Read/Write | Length (bytes) | Description                                  |
|------------------|----------------------------|------------|----------------|----------------------------------------------|
| 320              | Transformation X offset    | RO         | 4              | Return the sensor transformation X offset    |
| 324              | Transformation Z offset    | RO         | 4              | Return the sensor transformation Z offset    |
| 328              | Transformation Angle       | RO         | 4              | Return the sensor transformation angle       |
| 332              | Transformation Orientation | RO         | 4              | Return the sensor transformation orientation |
| 336              | Clearance distance         | RO         | 4              | Return the sensor clearance distance         |

## XML Settings File

The settings file, Go2GenTL.xml, resides in the same directory as the Gocator GenTL driver. Users can set the resample mode and output format by changing the setting in this file.

| Element      | Type | Description                                                                                                                                                                                                                                          |
|--------------|------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| ResampleMode | 32u  | Settings to disable or enable resampling mode:<br>0 – Disable<br>1 – Enable<br><br>When resampling mode is enabled, the GenTL driver will resample the height map so that the pixel spacing is the same in the X and Y axis. The default value is 1. |
| DataFormat   | 32u  | Settings to choose 16-bit RGB or 16-bit grey scale image output:<br>0 – 16-bit RGB Image<br>1 – 16-bit grey scale Image<br>The default value is 0.                                                                                                   |

## Interfacing with Halcon

Halcon is a comprehensive software package for machine vision applications with an integrated development environment. Gocator can use the included GenTL driver to stream 3D point clouds and intensity data into Halcon in real-time.



The Gocator 4.x GenTL driver does not currently support scanning in profile mode.

For information on setting up the GenTL driver, see *GenTL Driver* on page 502.

This section describes how to configure Halcon to acquire data from the Gocator 4.x firmware. You should be familiar with Gocator's Surface mode. Before continuing, make sure Halcon is installed.

## Requirements

|          |                              |
|----------|------------------------------|
| Sensor   | Gocator laser profile sensor |
| Firmware | Firmware 4.0.9.136 or later  |
| Halcon   | Version 10.0 or later        |

## Setting Up Halcon

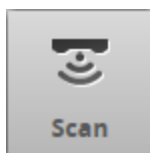
Before using Halcon with Gocator, you must set up Halcon.

*To set up Halcon:*

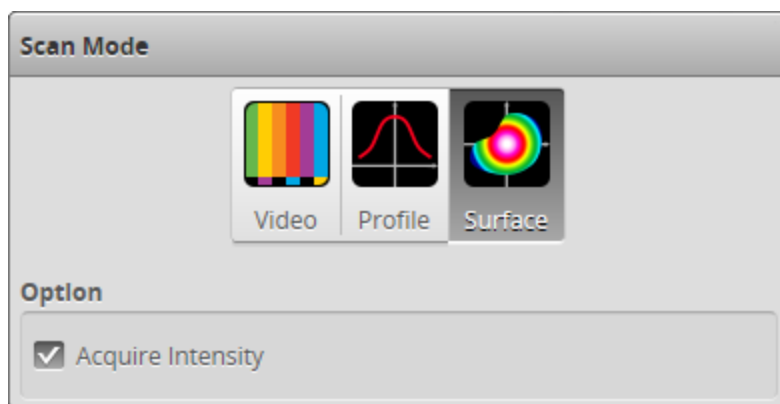
1. Connect a Gocator sensor to the PC running Halcon.

You will need a Master hub to connect the sensor to the PC. For more information, see *Installation* on page 28 and *Network Setup* on page 37.

2. Click the **Scan** page icon.



3. On the **Scan** page, click the **Surface** icon to switch to Surface mode.



4. (Optional) If you need intensity data, check the **Acquire Intensity** option.

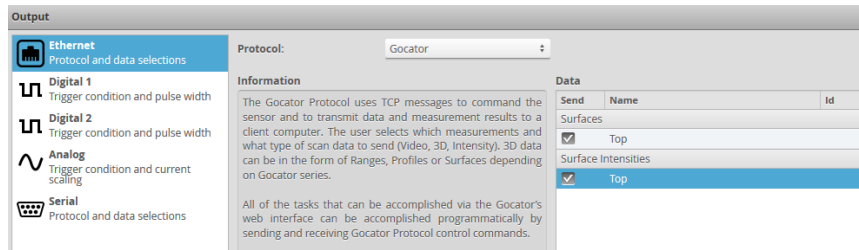
5. Configure the sensor to produce the desired surface data.

For more information on configuring Gocator sensors, see *Scan Setup and Alignment* on page 91 and *Models* on page 140.

6. Click the **Output** page icon.

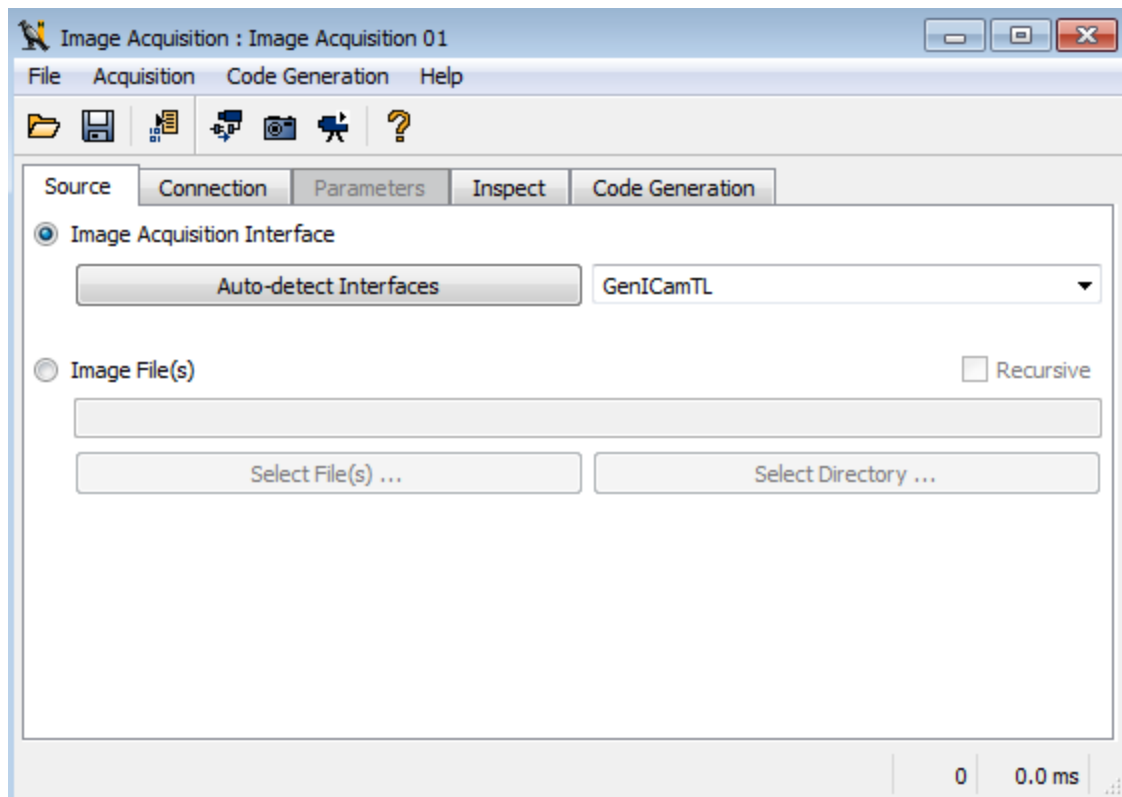


7. On the **Output** page, enable the required surface under **Data** and choose Gocator in **Protocol**.



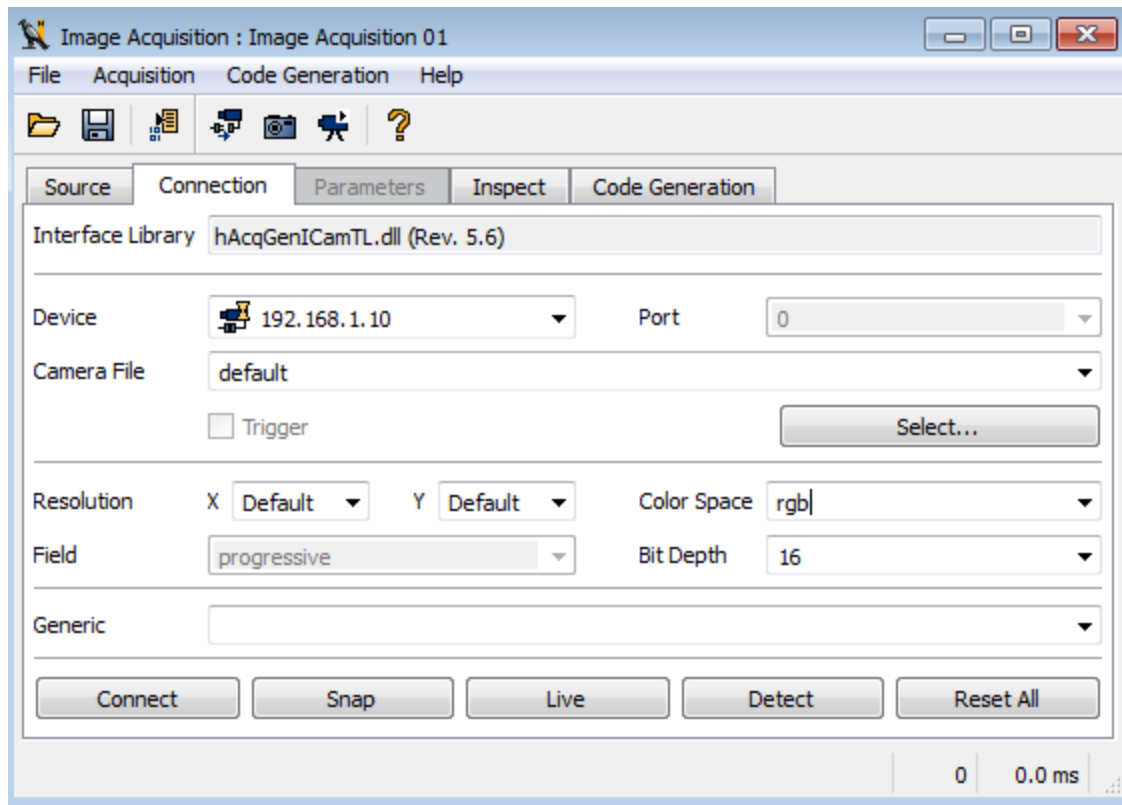
For more information on configuring Ethernet output, see *Ethernet Output* on page 284.

8. Make sure the Gocator is running.
9. On the PC, launch Halcon.
10. In Halcon, in the **Assistants** menu, click **Open New Image Acquisition**.
11. In the dialog that opens, in the **Source** tab, check the **Image Acquisition Interface** option and choose GenICamTL in the drop-down.



The driver uses the Gocator protocol discovery messages to search for available Gocator sensors. Discovery messages can be blocked by a PC's firewall. You should therefore turn off the firewall and try again if the Gocator sensor can't be detected.

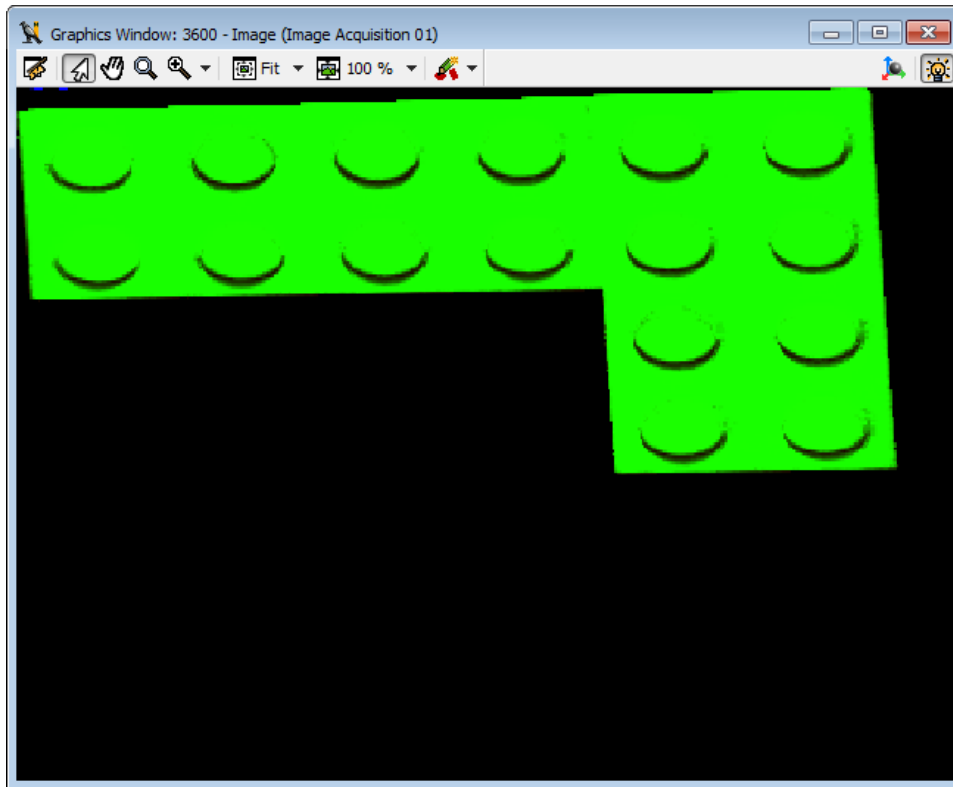
12. Switch to the **Connection** tab.
- If Halcon detects a Gocator sensor, the sensor's IP will be listed next to **Device**.



13. In the **Connection** tab, set **Color Space** to RGB and **Bit Depth** to 16.
14. In the Gocator web interface, click the Snapshot button to trigger the output of a surface.



The output displays in the Halcon **Graphics Window**.



Halcon is now configured for use with Gocator.

## Halcon Procedures

The Halcon example code contains internal procedures that you can use to decompose the RGB image and to control registers that the GenTL driver opens.

You can import the procedures into your own code by selecting **File > Insert Program > Insert Procedures** and then choosing the example code `Continuous_Acq.hdev` under the `Examples/Halcon` directory.



The `Go2GenTL.xml` file for Gocator 4.x has more fields than the Gocator 3.x version. Make sure you are using the correct version.

The following section describes each of these procedures.

### Halcon Procedures

| Procedures             | Description                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    |
|------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Go2GenTL_<br>ParseData | <p>The GenTL driver packs the height map, intensity and stamp information into a 16-bit RGB image. The function is used to extract data from the RGB image.</p> <p>For details on how the information is packed in the data, see the sections under <i>GenTL Driver</i> on page 502.</p> <p>The function accepts the image acquired from <code>grab_image_async</code>, and returns the height map, intensity and stamps.</p> <p><i>Parameters (Input)</i></p> <p><b>Image:</b> RGB Image acquired by using <code>grab_image_async</code>.</p> |

| Procedures              | Description                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             |
|-------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
|                         | <p><i>Parameters (Output)</i></p> <p><b>HeightMap:</b> The height map image.</p> <p><b>Intensity:</b> The intensity image.</p> <p><b>FrameCount:</b> The number of frames.</p> <p><b>Timestamp:</b> The timestamp.</p> <p><b>Encoder:</b> The encoder position.</p> <p><b>EncoderIndex:</b> The last index of the encoder.</p> <p><b>Inputs:</b> The digital input states.</p> <p><b>xOffset:</b> The X offset in millimeters.</p> <p><b>xResolution:</b> The X resolution in millimeters.</p> <p><b>yOffset:</b> The Y offset in millimeters.</p> <p><b>yResolution:</b> The Y resolution in millimeters.</p> <p><b>zOffset:</b> The Z offset in millimeters.</p> <p><b>zResolution:</b> The Z resolution in millimeters.</p> <p><b>Width:</b> The width (number of columns) of the image that contains the part. The part width can be less than the image width requested by the user.</p> <p><b>Height:</b> The height or length (number of rows) of the image that contains the part. The part length can be less than the image height requested by the user.</p> <p><b>HasIntensity:</b> Specifies if the intensity image is available. The intensity image is available if <b>Acquire Intensity</b> is enabled in the Gocator web interface.</p> <p>Each output is returned as decimal value.</p> <p><i>Example</i></p> <pre>Go2GenTL_ParseData(Image, HeightMap, Intensity, frameCount, timestamp, encoderPosition, encoderIndex, inputs, xOffset, xResolution, yOffset, yResolution, zOffset, zResolution, width, height, hasIntensity)</pre> |
| Go2GenTL_ResampleMode   | <p>Returns the resample mode.</p> <p><i>Parameters (Input)</i></p> <p><b>AcqHandle:</b> Acquisition handle created by <code>open_framegrabber</code>.</p> <p><i>Parameters (Output)</i></p> <p><b>ResampleMode:</b></p> <p>No - Resample is disabled.</p> <p>Yes - Resample is enabled.</p> <p>When resampling is enabled, the GenTL driver resamples the height map so that the pixel spacing is the same on the X and Y axis.</p> <p><i>Example</i></p> <pre>Go2GenTL_ResampleMode (AcqHandle, ResampleMode)</pre> <div style="border: 1px solid black; padding: 10px; margin-top: 10px;"> <p> To set the resample mode, you must directly modify Go2GenTL.xml, which is in the same directory as the Gocator GenTL driver (Go2GenTL.cti).</p> </div>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              |
| Go2GenTL_ConfigFileName | <p>Returns the current live sensor job file name.</p> <p><i>Parameters (Input)</i></p> <p><b>AcqHandle:</b> Acquisition handle created by <code>open_framegrabber</code>.</p>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           |

| Procedures                 | Description                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          |
|----------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
|                            | <p><i>Parameters (Output)</i></p> <p><b>ConfigFile:</b> The name of the job file. The file name includes the extension .job.</p> <p><i>Example</i></p> <pre>Go2GenTL_ConfigFileName (AcqHandle, ConfigFile)</pre>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    |
| Go2GenTL_SetConfigFileName | <p>Sets the sensor live configuration.</p> <p><i>Parameters (Input)</i></p> <p><b>AcqHandle:</b> Acquisition handle created by open_framegrabber.</p> <p><b>ConfigFile:</b> The name of the job file. The file name should include the extension .job.</p> <p><i>Example</i></p> <pre>Go2GenTL_SetConfigFileName (AcqHandle, 'test2.cfg')</pre>                                                                                                                                                                                                                                                                                                                                                      |
| Go2GenTL_Encoder           | <p>Returns the current encoder value. When this function is called, the GenTL driver retrieves the latest encoder value from the sensor. The value is returned as a two-element tuple. The first element is the least significant 32-bit value, and the second element is the most significant 32-bit value.</p> <p><i>Parameters (Input)</i></p> <p><b>AcqHandle:</b> Acquisition handle created by open_framegrabber.</p> <p><i>Parameters (Output)</i></p> <p><b>EncoderValue:</b> The current encoder value.</p> <p><i>Example</i></p> <pre>Go2GenTL_Encoder (AcqHandle, EncoderValue)</pre>                                                                                                     |
| Go2GenTL_ImageSize         | <p>Returns the size of the image returned by the GenTL driver.</p> <p><i>Parameters (Input)</i></p> <p><b>AcqHandle:</b> Acquisition handle created by open_framegrabber.</p> <p><i>Parameters (Output)</i></p> <p><b>Width:</b> The width of the image.</p> <p><b>Height:</b> The height of the image.</p> <p><i>Example</i></p> <pre>Go2GenTL_ImageSize (AcqHandle, Width, Height)</pre>                                                                                                                                                                                                                                                                                                           |
| Go2GenTL_CoordinateXYZ     | <p>Returns the real-world coordinates (X, Y, Z) of the part given the row and column position in the height map.</p> <p>The values of the offset and resolution input parameters can be retrieved using Go2GenTL_ParseData.</p> <p><i>Parameters (Input)</i></p> <p><b>HeightMap:</b> The height map image.</p> <p><b>Row:</b> The row in the height map.</p> <p><b>Column:</b> The column in the height map.</p> <p><b>xOffset:</b> The X offset in millimeters.</p> <p><b>xResolution:</b> The X resolution in millimeters.</p> <p><b>yOffset:</b> The Y offset in millimeters.</p> <p><b>yResoluion:</b> The Y resolution in millimeters.</p> <p><b>zOffset:</b> The Z offset in millimeters.</p> |

| Procedures             | Description                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    |
|------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
|                        | <p><b>zResolution:</b> The Z resolution in millimeters.</p> <p><i>Parameters (Output)</i></p> <p><b>coordinateXYZ:</b> The real-world coordinates.</p>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         |
| Go2GenTL_Exposure      | <p>Returns the current exposure.</p> <p><i>Parameters (Input)</i></p> <p><b>AcqHandle:</b> Acquisition handle created by open_framegrabber.</p> <p><i>Parameters (Output)</i></p> <p><b>Exposure:</b> The current exposure value (in <math>\mu</math>s). The value is returned as an integer. Decimals are truncated.</p> <p><i>Example</i></p> <pre>Go2GenTL_Exposure(AcqHandle, exposure)</pre>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              |
| Go2GenTL_SetExposure   | <p>Sets the current exposure.</p> <p><i>Parameters (Input)</i></p> <p><b>AcqHandle:</b> Acquisition handle created by open_framegrabber.</p> <p><b>Exposure:</b> The current exposure value (in <math>\mu</math>s), as an integer.</p> <p><i>Example</i></p> <pre>Go2GenTL_SetExposure(AcqHandle, exposure)</pre>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              |
| set_framegrabber_param | <p>Generic Halcon function to set parameters on the scanner. Can be used to set scanner specific settings. For a complete list of settings that can be changed, see the SDK interface files. In the generic form:</p> <pre>set_framegrabber_param( AcqHandle, 'Name', 'Value')</pre> <p><i>Parameters (Input)</i></p> <p><b>AcqHandle:</b> Acquisition handle created by open_framegrabber.</p> <p><b>Name:</b> The name of the parameter to set on the scanner.</p> <p><b>Value:</b> The parameter value to set on the scanner.</p> <p><i>Examples</i></p> <p>To set the format of the image buffer to 16-bit packed:</p> <pre>set_framegrabber_param( AcqHandle, 'PixelFormat', 'RGB16Packed')</pre> <p>To set the Scan mode to HDR (1 = no HDR, 2 = HDR, 3 = Super HDR):</p> <pre>set_framegrabber_param( AcqHandle, 'Dynamic', '2')</pre> <p>To set the brightness to '3':</p> <pre>set_framegrabber_param( AcqHandle, 'Exposure', '3')</pre> <p>To schedule a system to start in 1000000 ticks or microseconds (depends on current domain unit):</p> <pre>set_framegrabber_param( AcqHandle, 'XMLSettings', 'GenTL/System') set_framegrabber_param( AcqHandle, 'XMLSettings', 'ScheduledStart=1') set_framegrabber_param( AcqHandle, 'XMLSettings', '000000') set_framegrabber_param( AcqHandle, 'XMLSettings', '')</pre> |



| Procedures | Description |
|------------|-------------|
|------------|-------------|

To schedule a *sensor* to start after a delay (ticks or microseconds), pass `GentL/Sensor` in the first call to `set_framegrabber_param`, followed by the remaining calls to the function as described in the previous example:

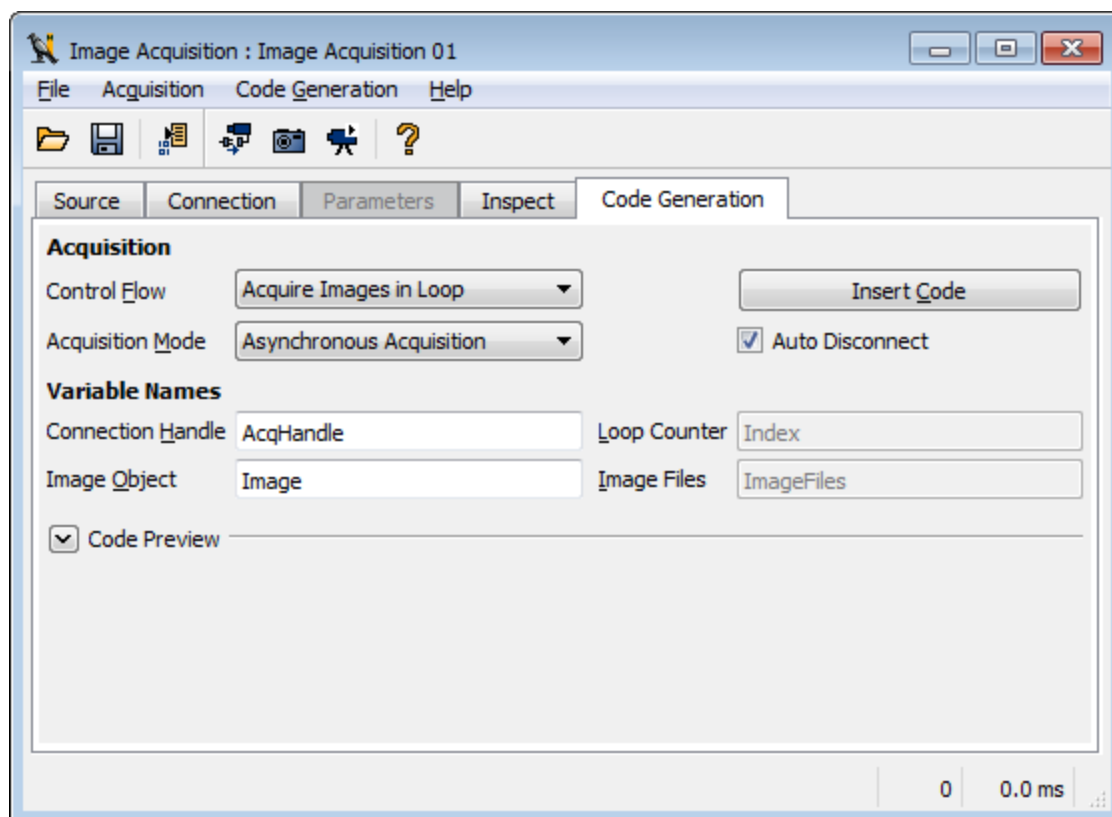
```
set_framegrabber_param( AcqHandle, 'XMLSettings', 'GentL/Sensor')
```

## Generating Halcon Acquisition Code

Halcon lets you insert acquisition code into your code in the IDE.

To generate acquisition code:

1. In Halcon, in the **Assistants** menu, click **Open New Image Acquisition**.
2. In the dialog that opens, in the **Code Generation** tab, set **Acquisition Mode** to **Asynchronous Acquisition**.



3. Under **Acquisition**, click **Insert Code** to generate the code that will open the acquisition device.



To handle cases when the `grab_image` function times out while waiting for data, add a try-catch statement around the `grab_image` function code.

After the example code is generated, you should add a `catch` instruction to bypass the acquisition timeout event, and use the [Go2GentL\\_ParseData](#) function to extract information from the returned image.

An example, `Continuous_Acq.hdev`, is included in the `Examples/Halcon` directory and is shown below:

```

* This example illustrates how to do the following:
* 1. Acquire data from the Gocator (16-bit RGB or gray image)
* 2. Decompose the returned image into three separate image for height map, intensity and
stamps.
* 3. Extract some stamp values from the stamp image.
* Connect to the Gocator device. This code is auto generated by the Image Acquisition
dialog box. User can manually override the directory path by editing the line below.
* Set image type to 'rgb' if the format is 16-bit RGB. 'gray' if the format is 16-bit
mono
open_framegrabber ('GenICamTL', 0, 0, 0, 0, 0, 0, 'progressive', 16, 'rgb', -1, 'false',
'default', '192.168.1.10', 0, -1, AcqHandle)
grab_image_start (AcqHandle, -1)
while (true)
    try
        grab_image_async (Image, AcqHandle, -1)
    catch(Exception)
        continue
    endtry

Go2GenTL_ParseData (Image, HeightMap, Intensity, frameCount, timestamp, encoderPosition,
encoderIndex, inputs, xOffset, xResolution, yOffset, yResolution, zOffset, zResolution,
width, height, hasIntensity)

* Image Processing Routines Start ****

* Add your own routines here!

* Image Processing Routines End ****
endwhile
close_framegrabber (AcqHandle)

```

## CSV Converter Tool

After you have exported recorded data to CSV, you can use the Gocator CSV Converter Tool to convert the exported profile or part data into the following formats:

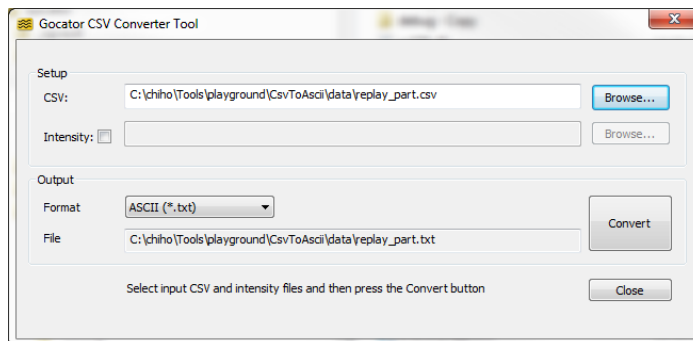
- ASCII (XYZI)
- 16-bit BMP
- 16-bit PNG
- GenTL
- OBJ
- STL
- HexSight HIG

- ODSCAD's OMC format
- SUR

To get the tool package (14405-x.x.x.x\_SOFTWARE\_GO\_Tools.zip), go to <http://lmi3d.com/support>, choose your product from the Product Downloads section, and download it from the Download Center.

For more information on exporting recorded data, see *Downloading, Uploading, and Exporting Replay Data* on page 64.

After downloading the tool package, unzip the file and run the Gocator CSV Converter tool [bin>win32>kCsvConverter.exe].



The software tool supports data exported from Profile or Surface mode.



The GenTL format is a 48-bit RGB or grey scale PNG. Height map, intensity and stamp information are stored as defined in the GenTL Driver section (*GenTL Driver* on page 502). You can load the exported data into image processing software to provide simulation data for developing applications using the GenTL driver.

*To convert exported CSV into different formats:*

1. Select the CSV file to convert.
2. If intensity information is required, check the **Intensity** box and select the intensity bitmap. Intensity information is only used when converting to ASCII or GenTL format. If intensity is not selected, the ASCII format will only contain the point coordinates (XYZ).
3. If a dual-sensor system was used, use the **Image** spin box to select the source sensor. Use **0** for the Main sensor, **1** for the Buddy sensor.
4. Select the output format.  
The converted file will reside in the same directory as the CSV file. It will also have the same name but with a different file extension. The converted file name is displayed in the **Output File** field.
5. Press the **Convert** button.

# Troubleshooting

Review the guidance in this chapter if you are experiencing difficulty with a Gocator sensor system. If the problem that you are experiencing is not described in this section, see *Return Policy* on page 583.

## Mechanical/Environmental

The sensor is warm.

- It is normal for a sensor to be warm when powered on. A Gocator sensor is typically 15° C warmer than the ambient temperature.

## Connection

When attempting to connect to the sensor with a web browser, the sensor is not found (page does not load).

- Verify that the sensor is powered on and connected to the client computer network. The Power Indicator LED should illuminate when the sensor is powered.
- Check that the client computer's network settings are properly configured.
- Ensure that the latest version of Flash is loaded on the client computer.
- Use the LMI Discovery tool to verify that the sensor has the correct network settings. See *Sensor Recovery Tool* on page 500 for more information.

When attempting to log in, the password is not accepted.

- See *Sensor Recovery Tool* on page 500 for steps to reset the password.

## Laser Profiling

When the Start button or the Snapshot button is pressed, the sensor does not emit laser light.

- Ensure that the sticker covering the laser emitter window (normally affixed to new sensors) has been removed.
- The laser safety input signal may not be correctly applied. See *Specifications* on page 523 for more information.
- The exposure setting may be too low. See *Exposure* on page 103 for more information on configuring exposure time.
- Use the Snapshot button instead of the Start button to capture a laser profile. If the laser flashes when you use the **Snapshot** button, but not when you use the **Start** button, then the problem could be related to triggering. See *Triggers* on page 93 for information on configuring the trigger source.

The sensor emits laser light, but the Range Indicator LED does not illuminate and/or points are not displayed in the Data Viewer.

- Verify that the measurement target is within the sensor's field of view and measurement range. See *Specifications* on page 523 to review the measurement specifications for your sensor model.

- Check that the exposure time is set to a reasonable level. See *Exposure* on page 103 for more information on configuring exposure time.

## **Performance**

The sensor CPU level is near 100%.

- Consider reducing the speed. If you are using a time or encoder trigger source, see *Triggers* on page 93 for information on reducing the speed. If you are using an external input or software trigger, consider reducing the rate at which you apply triggers.
- Consider reducing the laser profile resolution.  
See *Spacing* on page 107 for more information on configuring resolution.
- Review the measurements that you have programmed and eliminate any unnecessary measurements.

# Specifications

The following sections describe the specifications of Gocator sensors and connectors, as well as Master hubs.

## Sensors

The following sections provide the specifications of Gocator sensors.

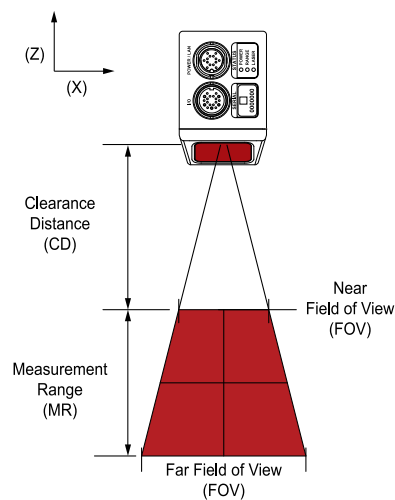
### Gocator 2100 & 2300 Series

The Gocator 2100 and 230 series consists of the following models:

| MODEL                                              | 2320               | 2x30             | 2x40             | 2342             | 2x50             | 2x70             | 2375         | 2x80          |
|----------------------------------------------------|--------------------|------------------|------------------|------------------|------------------|------------------|--------------|---------------|
| Data Points / Profile                              | 1280               | 640 / 1280       | 640 / 1280       | 1280             | 640 / 1280       | 640 / 1280       | 1280         | 640 / 1280    |
| Linearity Z<br>(+/- % of MR)                       | 0.01               | 0.01             | 0.01             | 0.01             | 0.01             | 0.04             | 0.05         | 0.04          |
| Resolution Z<br>(mm)                               | 0.0018 -<br>0.0030 | 0.006 -<br>0.014 | 0.013 -<br>0.037 | 0.015 -<br>0.040 | 0.019 -<br>0.060 | 0.055 -<br>0.200 | 0.154 - 0.56 | 0.092- 0.488  |
| Resolution X<br>(mm)<br>(Profile Data<br>Interval) |                    |                  |                  |                  |                  |                  |              |               |
| 2100 series                                        | n/a                | 0.088 -<br>0.150 | 0.19 - 0.34      | n/a              | 0.3 - 0.6        | 0.55 - 1.10      | n/a          | 0.75 - 2.20   |
| 2300 series                                        | 0.014 - 0.021      | 0.044 -<br>0.075 | 0.095 -<br>0.170 | 0.095 -<br>0.170 | 0.150 -<br>0.300 | 0.275 -<br>0.550 | 0.27 - 0.80  | 0.375 - 1.100 |
| Repeatability Z<br>(µm)                            | 0.4                | 0.8              | 1.2              | 1.2              | 2                | 8                | n/a          | 12            |
| Clearance<br>Distance (CD)<br>(mm)                 | 40                 | 90               | 190              | 190              | 300              | 400              | 650          | 350           |
| Measurement<br>Range (MR)<br>(mm)                  | 25                 | 80               | 210              | 210              | 400              | 500              | 1350         | 800           |
| Field of View<br>(FOV) (mm)                        | 18 - 26            | 47 - 85          | 96 - 194         | 64 - 140         | 158 - 365        | 308 - 687        | 345 - 1028   | 390 - 1260    |
| Recommended<br>Laser Class                         | 2M                 | 2M               | 3R               | 3R               | 3R               | 3B               | 3B-N         | 3B            |

| MODEL                 | 2320         | 2x30                                  | 2x40                        | 2342      | 2x50                        | 2x70      | 2375                              | 2x80                                     |
|-----------------------|--------------|---------------------------------------|-----------------------------|-----------|-----------------------------|-----------|-----------------------------------|------------------------------------------|
| Other Laser Classes   | 3R           | 3R / 3B<br>(2300 series only)         | 2M<br>3B (2300 series only) | 3B        | 2M<br>3B (2300 series only) | 3R        |                                   |                                          |
| Input Voltage (Power) |              | +24 to +48 VDC (13 W); Ripple +/- 10% |                             |           |                             |           | +48 VDC (20 W);<br>Ripple +/- 10% | +24 to +48 VDC (13 W);<br>Ripple +/- 10% |
| Dimensions (mm)       | 35x120x149.5 | 49x75x142                             | 49x75x197                   | 49x75x197 | 49x75x272                   | 49x75x272 | 49x75x272                         | 49x75x272                                |
| Weight (kg)           | 0.8          | 0.74                                  | 0.94                        | 0.94      | 1.3                         | 1.3       | 1.3                               | 1.3                                      |

The following diagram illustrates some of the terms used in the table above.



Optical models, laser classes, and packages can be customized. Contact LMI for more details.

Gocator 2300 series sensors provide 1280 data points per profile. Gocator 2100 series sensors provide 640 data points per profile.

Specifications stated are based on standard laser classes. Linearity Z, Resolution Z, and Repeatability Z may vary for other laser classes.

All specification measurements are performed on LMI's standard calibration target (a diffuse, painted white surface).

Linearity Z is the worst case difference in average height measured, compared to the actual position over the measurement range.

Resolution Z is the maximum variability of height measurements across multiple frames, with 95% confidence.

Resolution X is the distance between data points along the laser line.

Repeatability Z is measured with a flat target at the middle of the measurement range. It is the 95% confidence variation of the average height over 4096 frames. Height values are averaged over the full FOV.

See *Resolution and Accuracy* on page 46 for more information.

| ALL 2x00 SERIES MODELS |                                                                            |
|------------------------|----------------------------------------------------------------------------|
| Scan Rate              | Approx. 170Hz to 5000 Hz                                                   |
| Interface              | Gigabit Ethernet                                                           |
| Inputs                 | Differential Encoder, Laser Safety Enable, Trigger                         |
| Outputs                | 2x Digital output, RS-485 Serial (115 kBaud), 1x Analog Output (4 - 20 mA) |
| Housing                | Gasketed aluminum enclosure, IP67                                          |
| Operating Temp.        | 0 to 50° C                                                                 |
| Storage Temp.          | -30 to 70° C                                                               |

Mechanical dimensions, CD/FOV/MR, and the envelope for each sensor model are illustrated on the following pages.

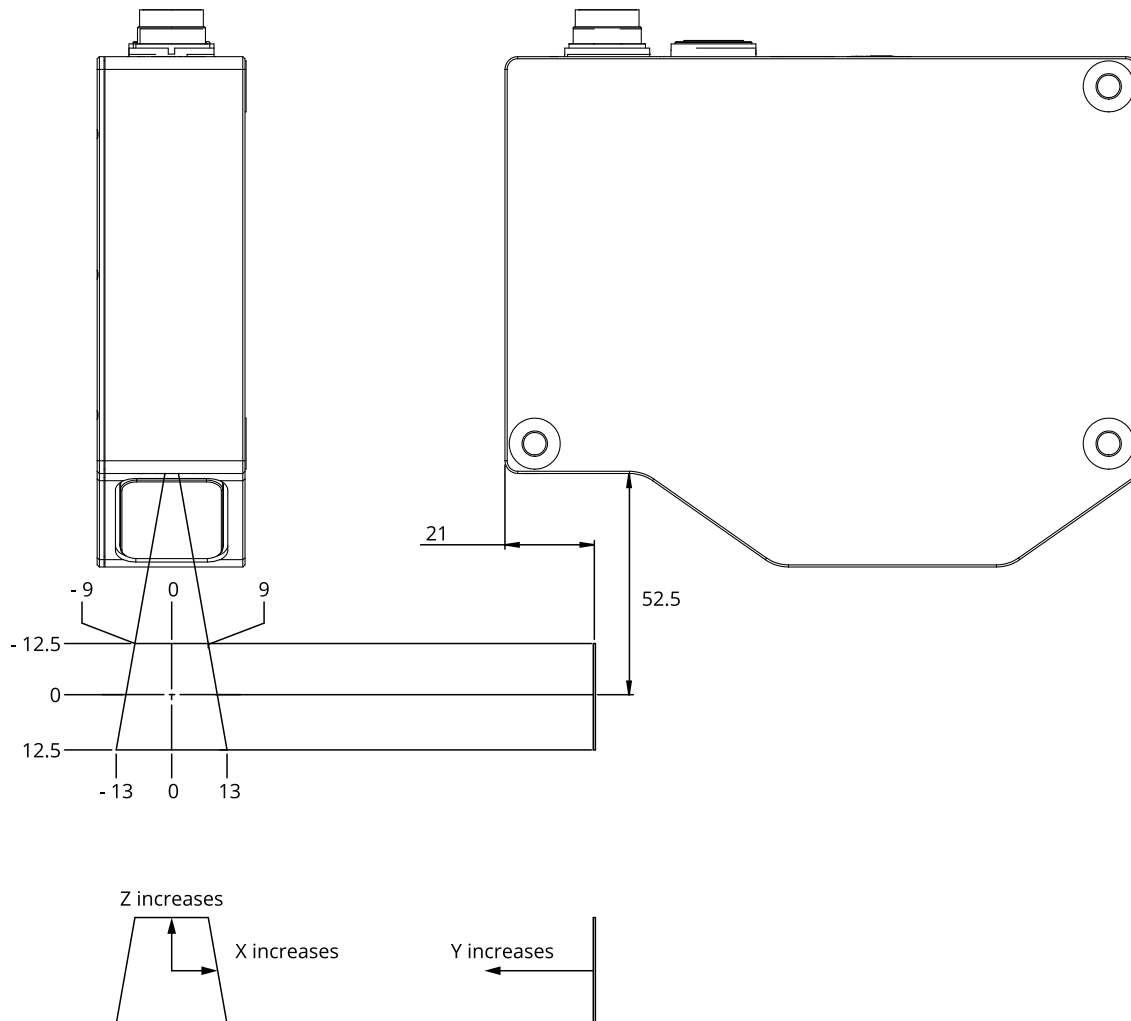


In the following drawings, the physical height dimensions of measurement ranges are reversed compared to the logical height values returned by sensors. For an illustration of the orientation of coordinate systems in relation to physical sensors, see the sections below for each sensor model.

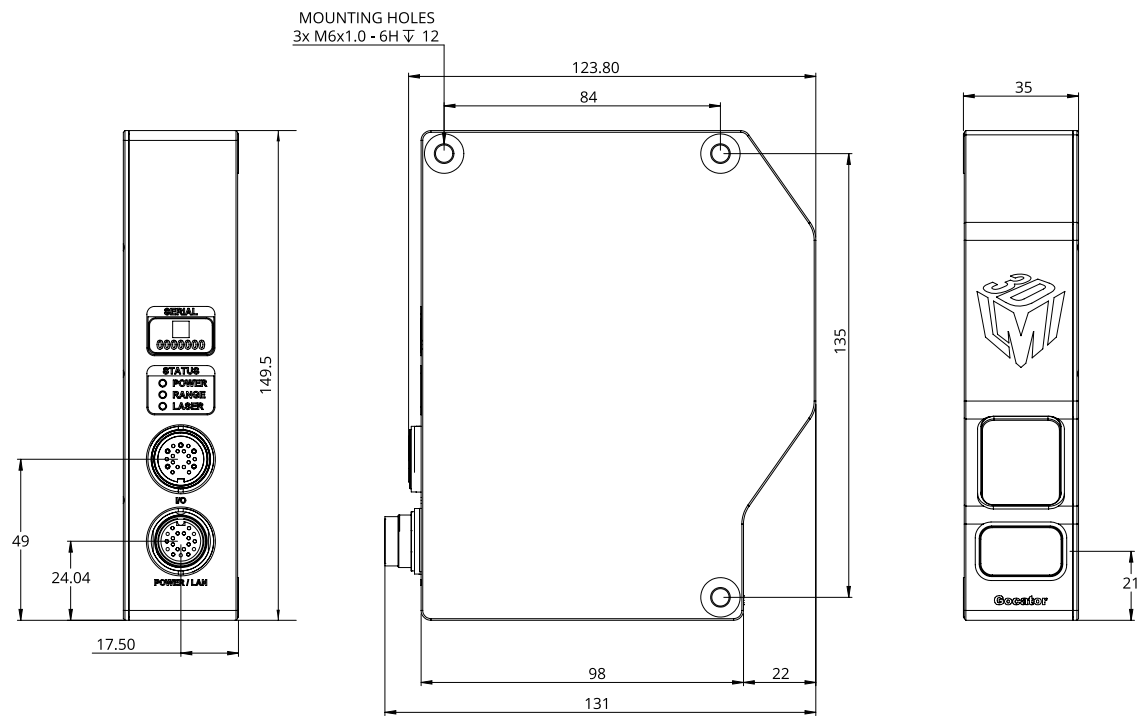


## Gocator 2320

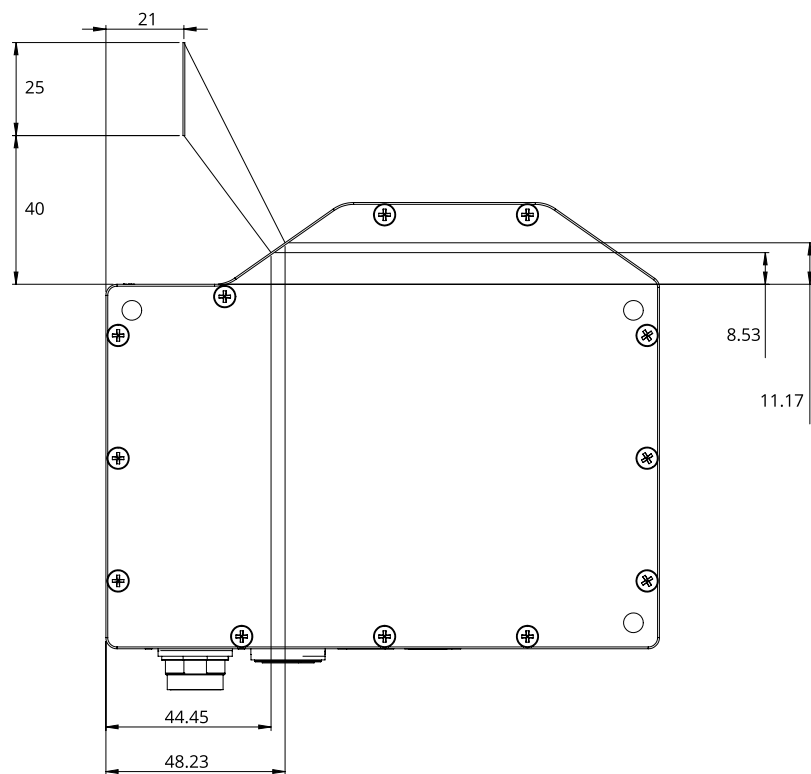
### Field of View / Measurement Range / Coordinate System Orientation



Dimensions

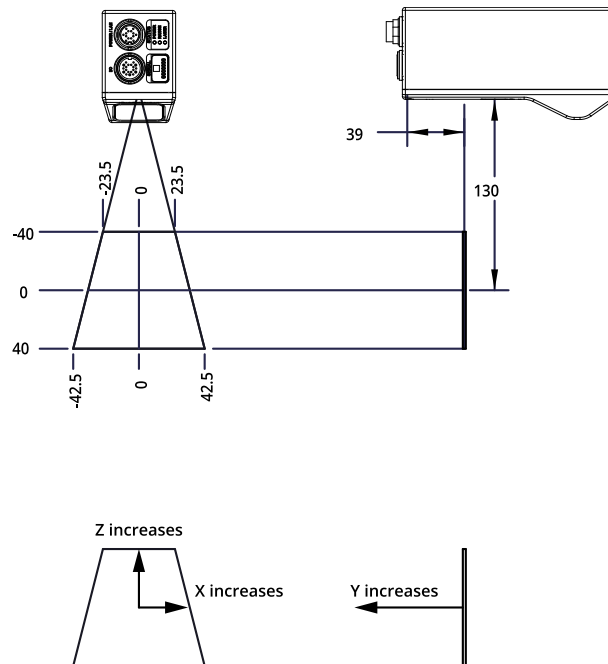


Envelope

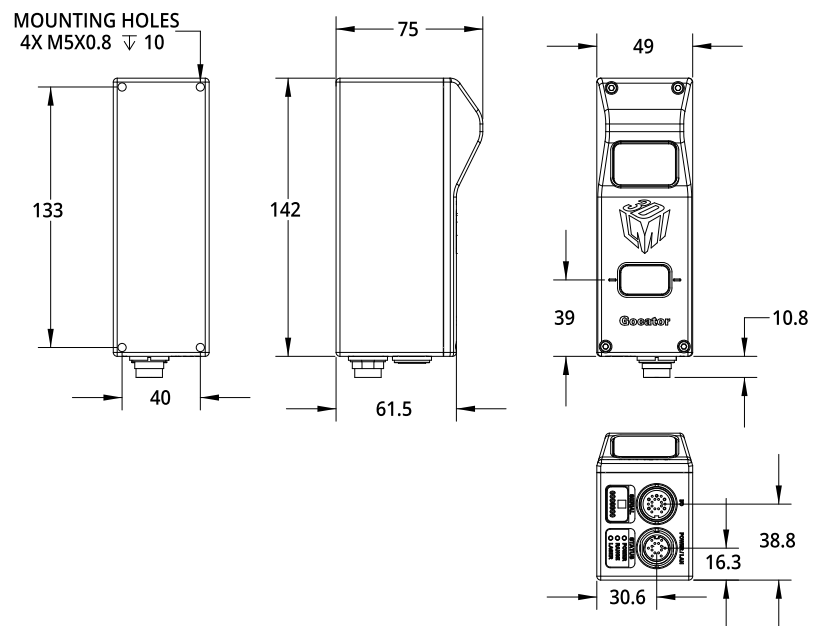


## Gocator 2130 and 2330

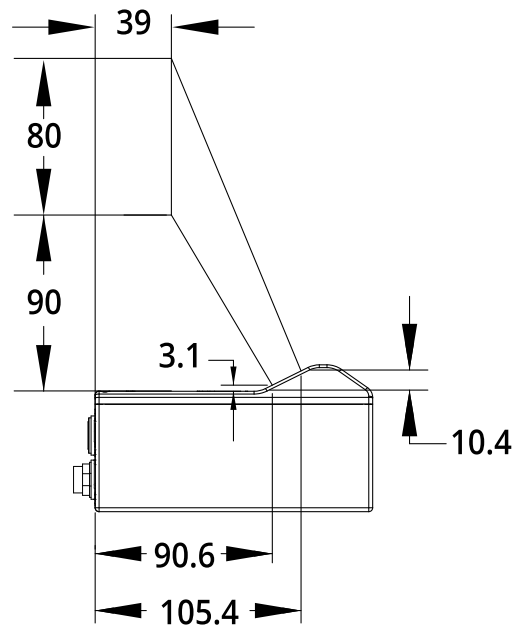
### Field of View / Measurement Range / Coordinate System Orientation



### Dimensions

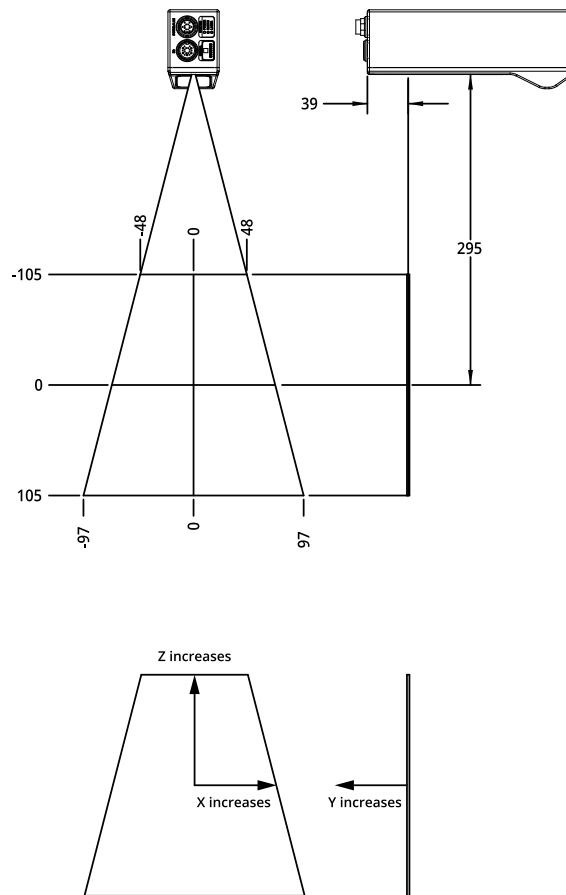


## Envelope

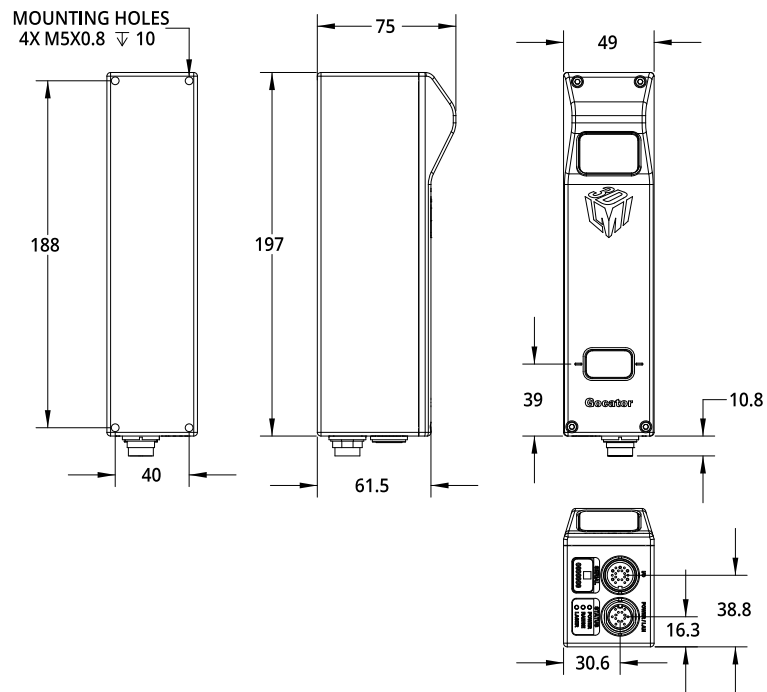


## Gocator 2140 and 2340

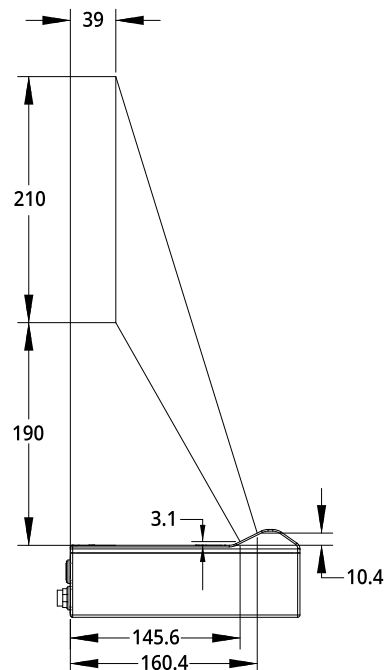
### Field of View / Measurement Range / Coordinate System Orientation



## Dimensions

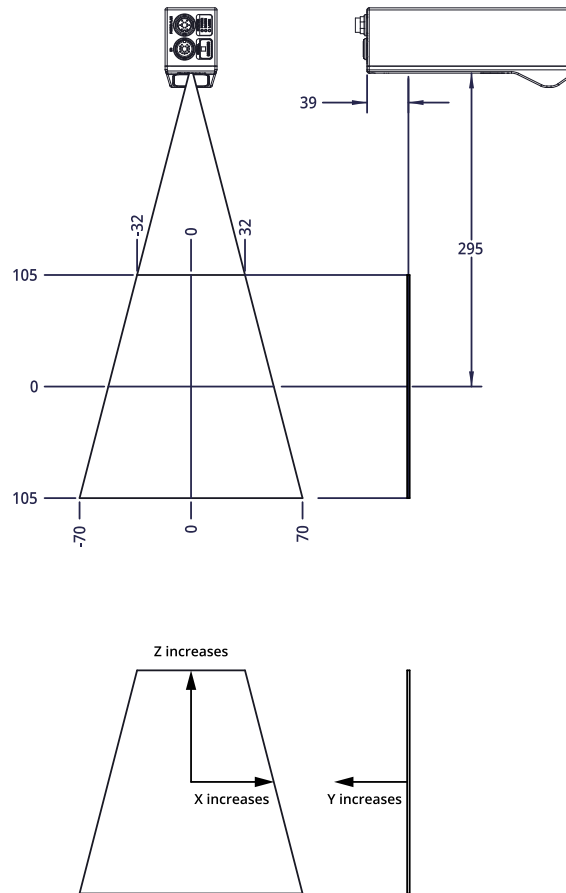


## Envelope

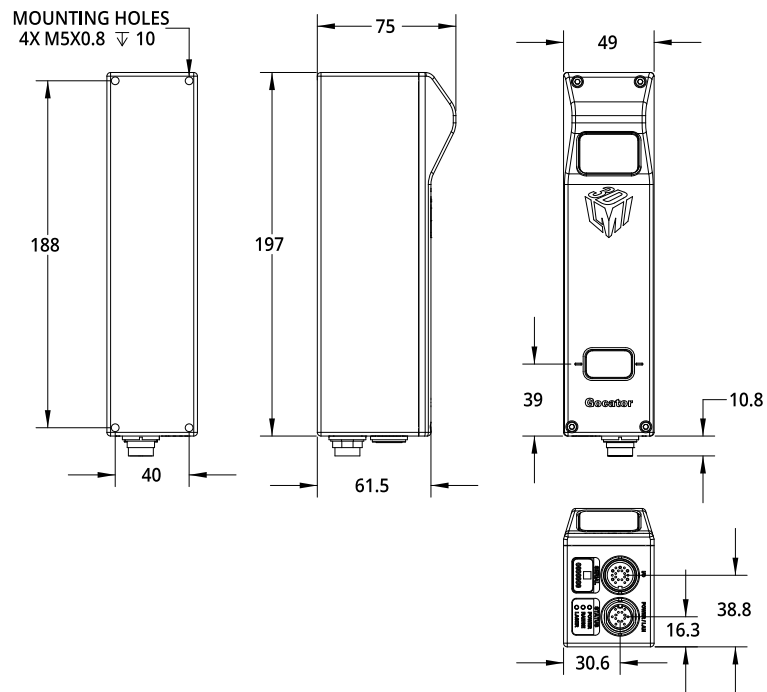


## Gocator 2342

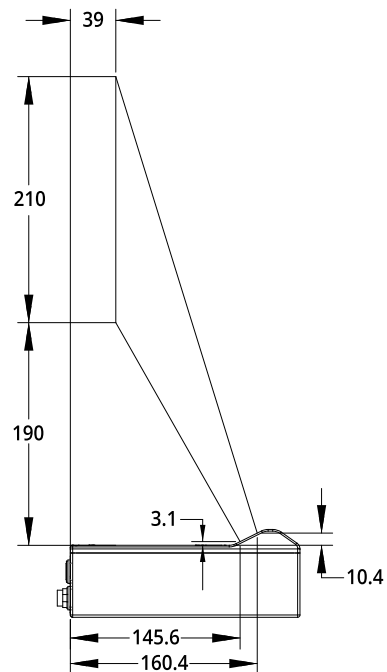
### Field of View / Measurement Range / Coordinate System Orientation



## Dimensions



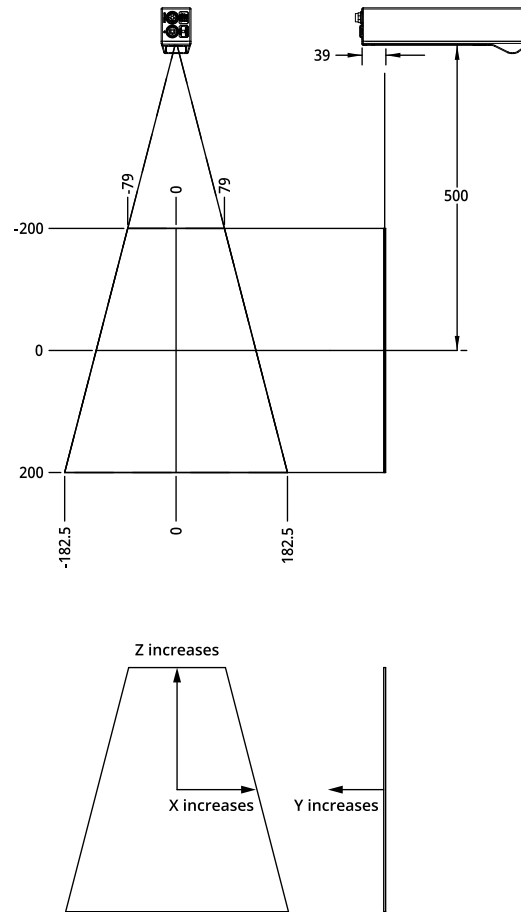
## Envelope



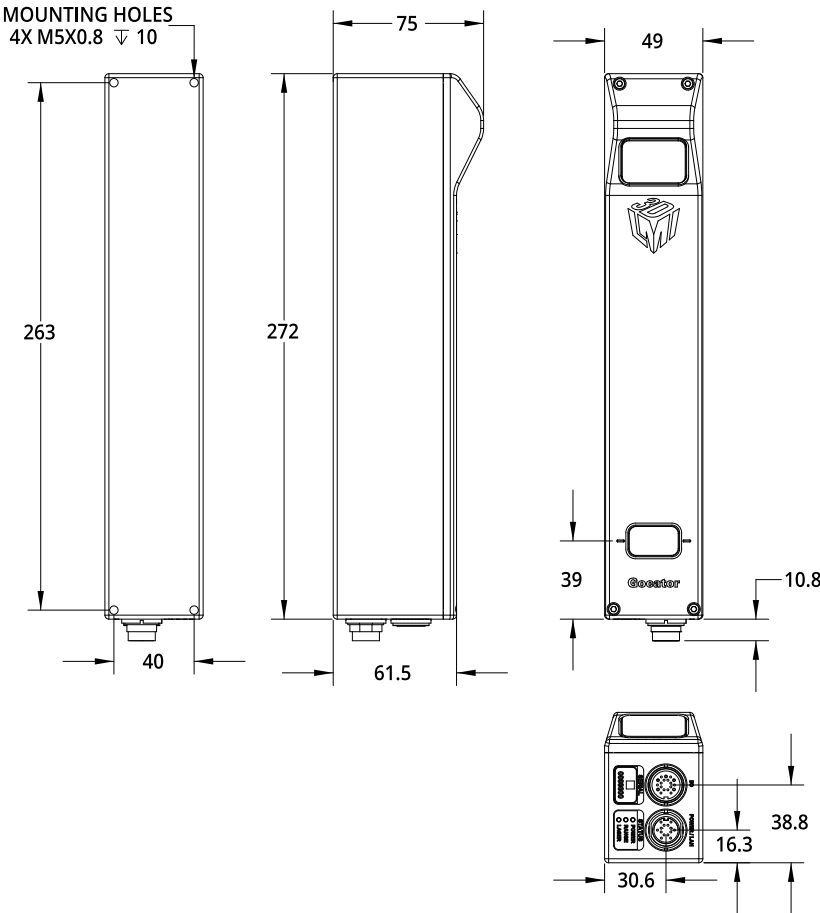


## Gocator 2150 and 2350

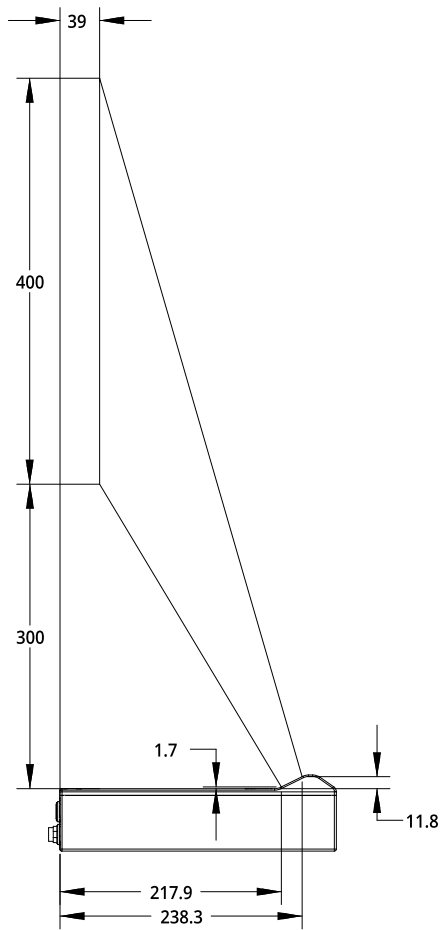
### Field of View / Measurement Range / Coordinate System Orientation



Dimensions

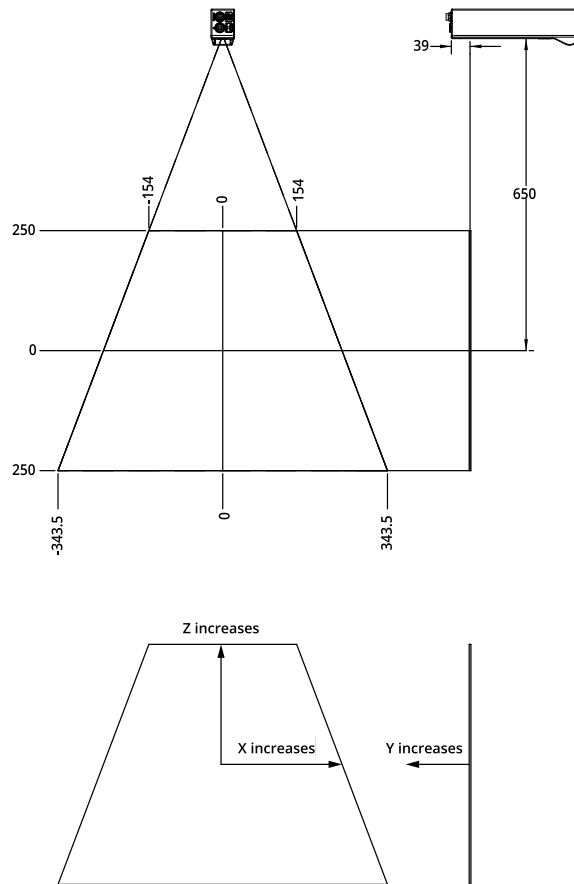


Envelope

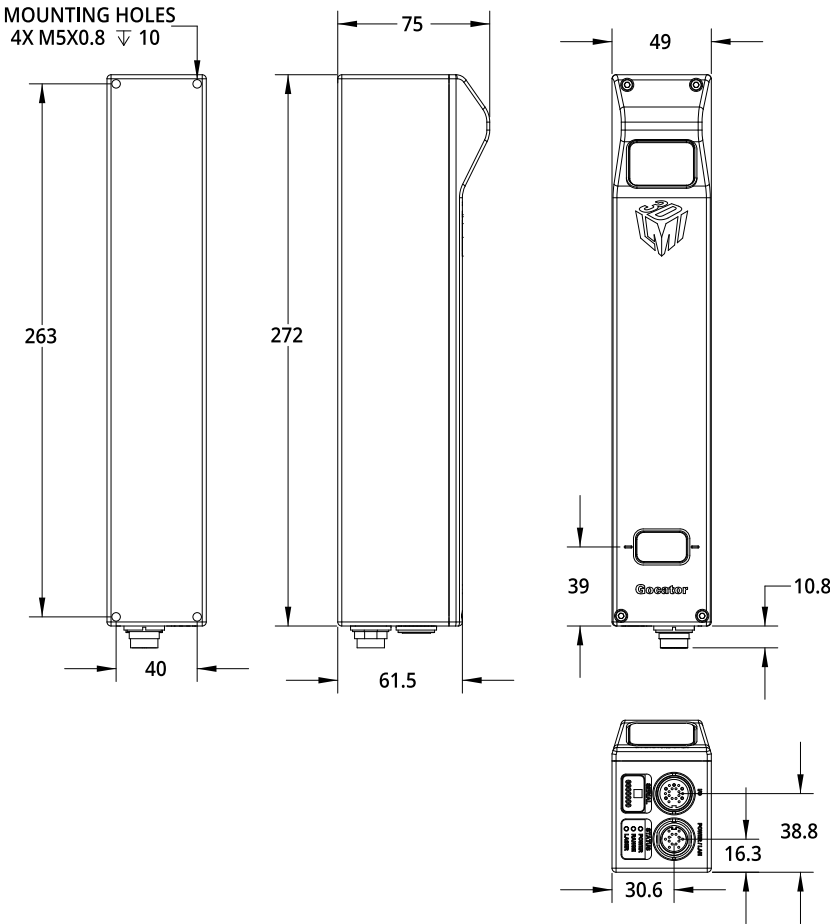


## Gocator 2170 and 2370

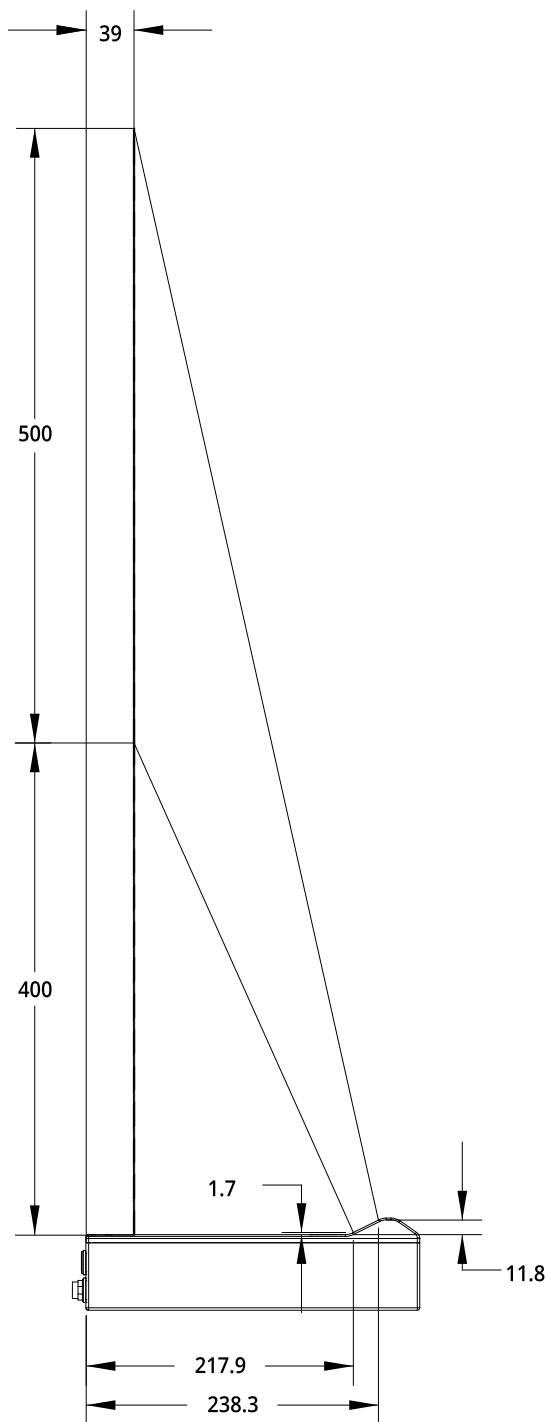
### Field of View / Measurement Range / Coordinate System Orientation



Dimensions

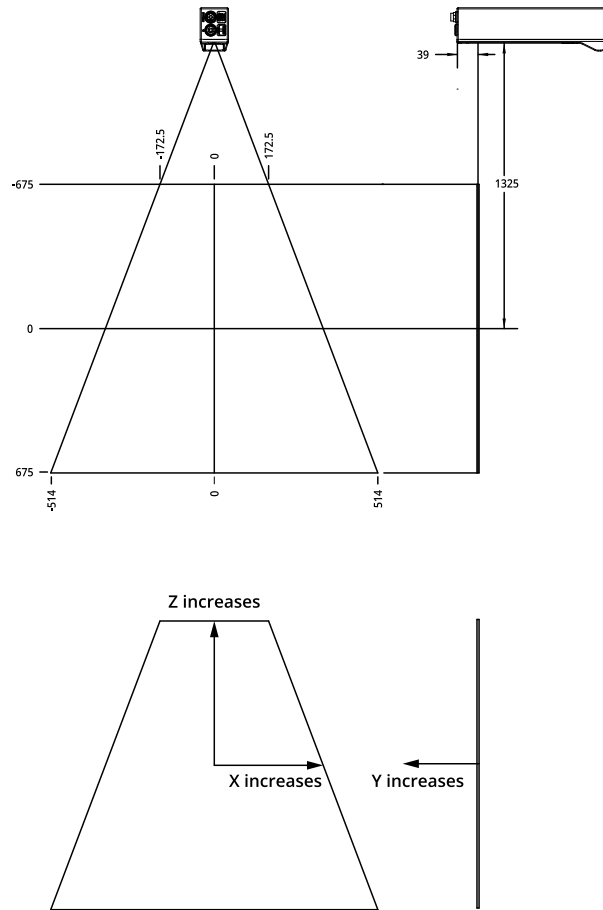


Envelope

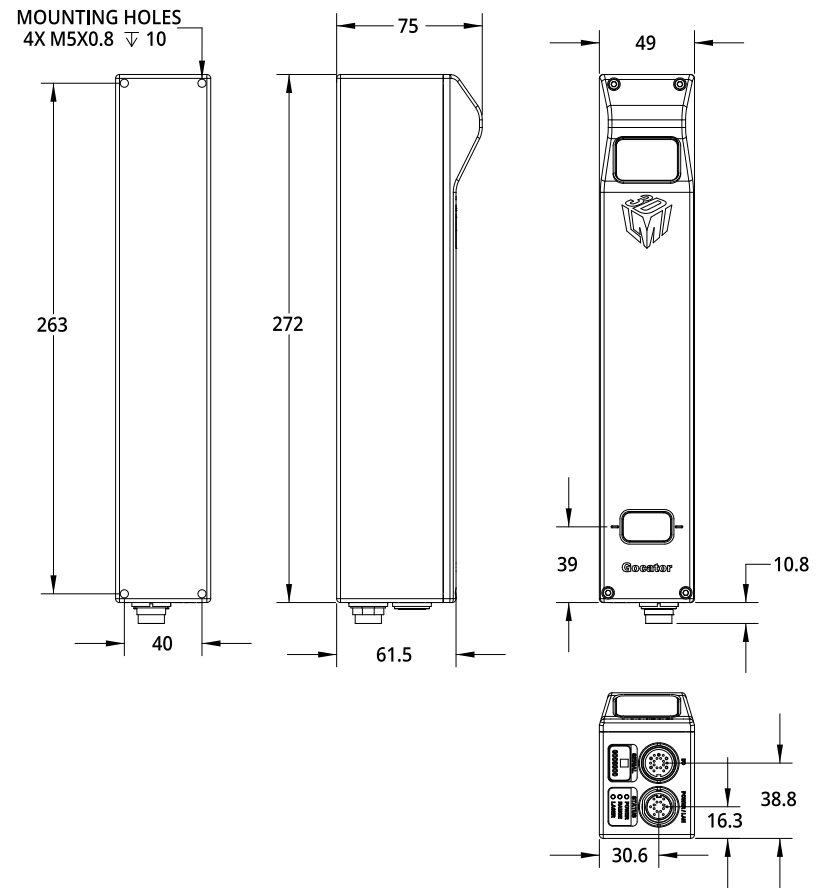


## Gocator 2375

### Field of View / Measurement Range / Coordinate System Orientation

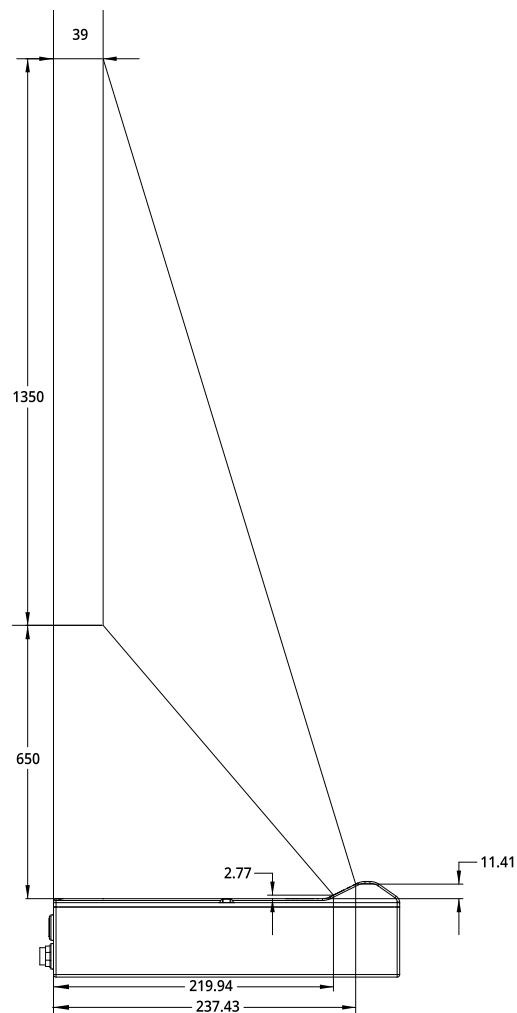


Dimensions



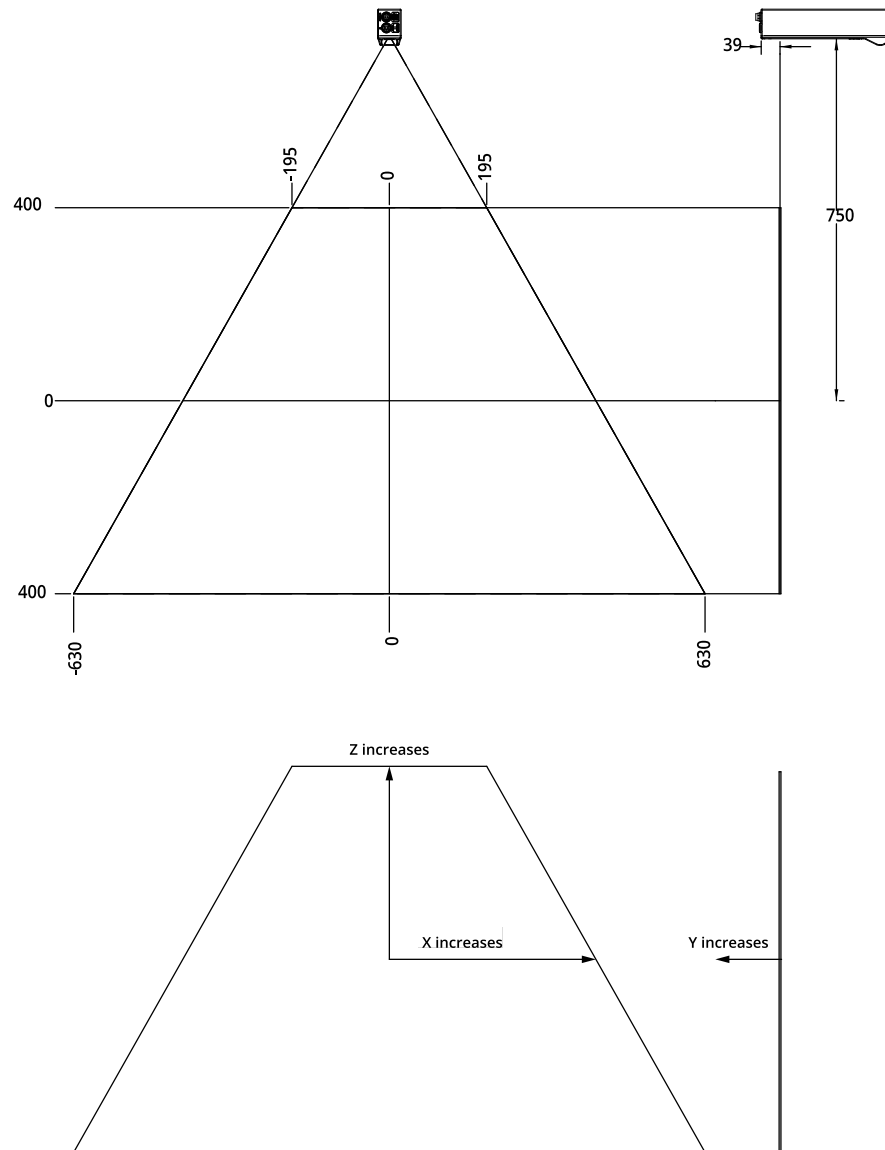


Envelope

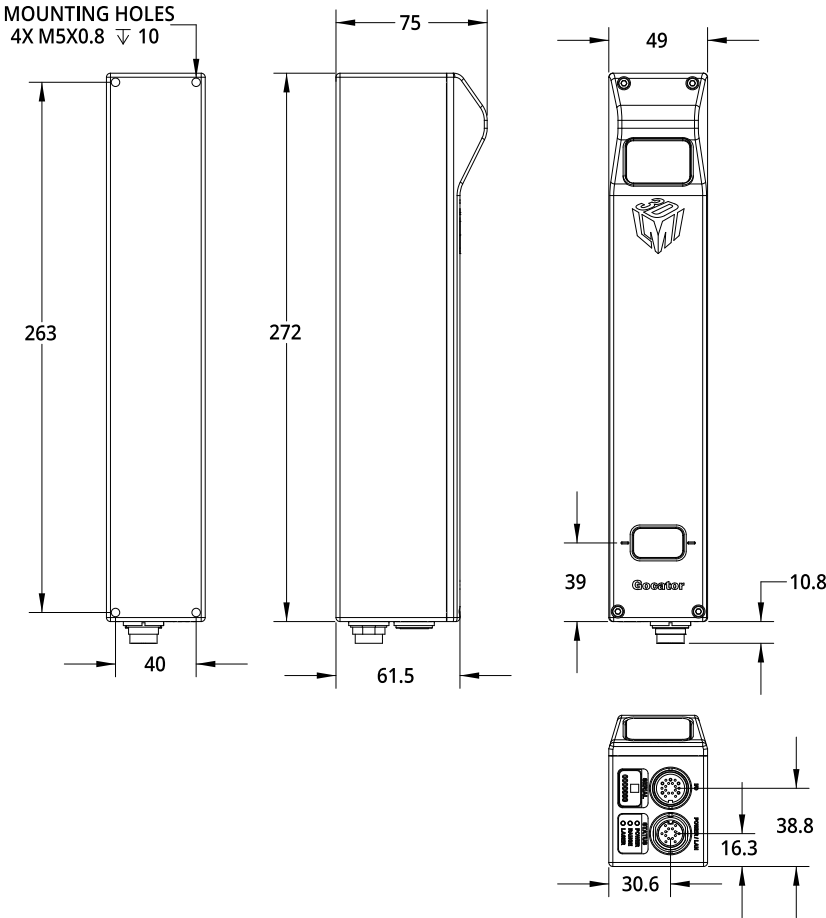


## Gocator 2180 and 2380

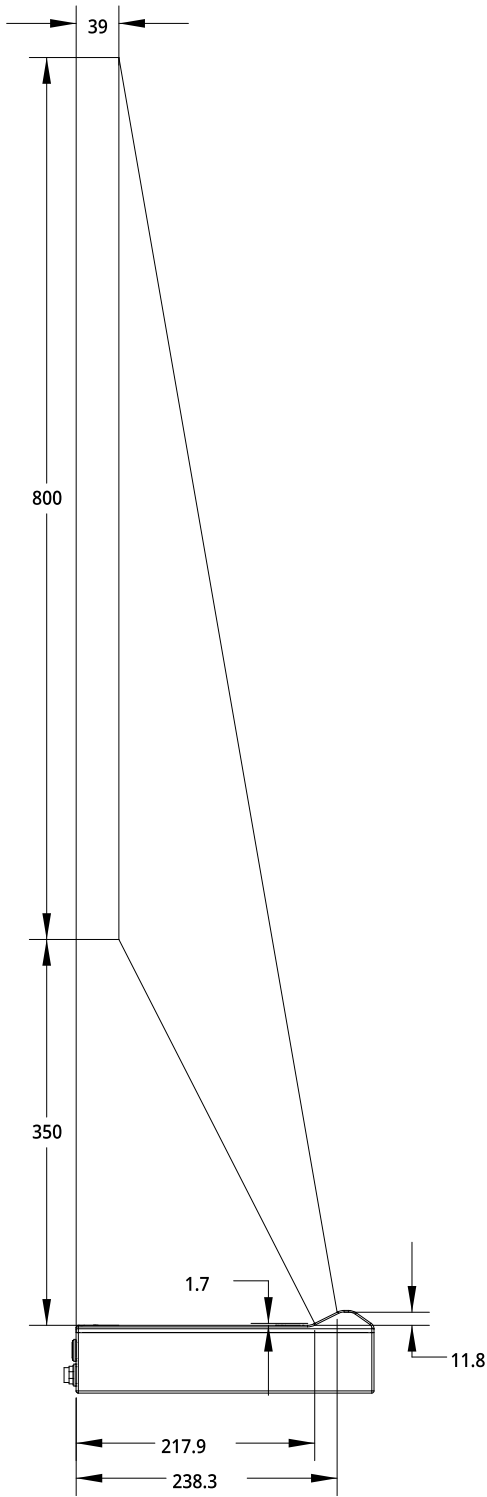
### Field of View / Measurement Range / Coordinate System Orientation



Dimensions



Envelope

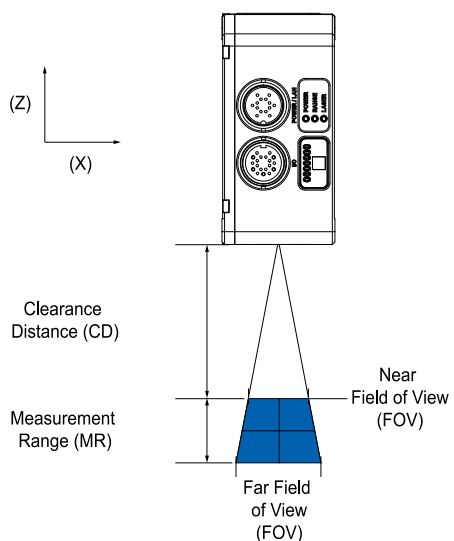


## Gocator 2400 Series

The Gocator 2400 series consists of the following models:

| MODEL                                                     | 2410              | 2420              |
|-----------------------------------------------------------|-------------------|-------------------|
| Data Points / Profile                                     | 1710              | 1940              |
| Linearity Z<br>(+/- % of MR)                              | 0.015             | 0.006             |
| Resolution Z ( $\mu\text{m}$ )                            | 1.1               | 1.8 - 3.0         |
| Resolution X ( $\mu\text{m}$ )<br>(Profile Data Interval) | 5.8 - 6.2         | 14.0 - 16.5       |
| Repeatability Z ( $\mu\text{m}$ )                         | 0.2               | 0.4               |
| Clearance<br>Distance (CD) (mm)                           | 19                | 60                |
| Measurement<br>Range (MR) (mm)                            | 6                 | 25                |
| Field of View (FOV) (mm)                                  | 10 - 10           | 27 - 32           |
| Recommended Laser Class                                   | 2M (blue, 405 nm) | 2M (blue, 405 nm) |
| Other Laser Classes                                       | 3R (blue, 405 nm) | 3R (blue, 405 nm) |
| Dimensions (mm)                                           | 44x90x145         | 44x90x145         |
| Weight (kg)                                               | 0.88              | 0.88              |

The following diagram illustrates some of the terms used in the table above.



Optical models, laser classes, and packages can be customized. Contact LMI for more details.

Specifications stated are based on standard laser classes. Linearity Z, Resolution Z, and Repeatability Z may vary for other laser classes.

All specification measurements are performed on LMI's standard calibration target (a diffuse, painted white surface).

Linearity Z is the worst case difference in average height measured, compared to the actual position over the measurement range.

Resolution Z is the maximum variability of height measurements across multiple frames, with 95% confidence.

Resolution X is the distance between data points along the laser line.

Repeatability Z is measured with a flat target at the middle of the measurement range. It is the 95% confidence variation of the average height over 4096 frames. Height values are averaged over the full FOV.

See *Resolution and Accuracy* on page 46 for more information.

---

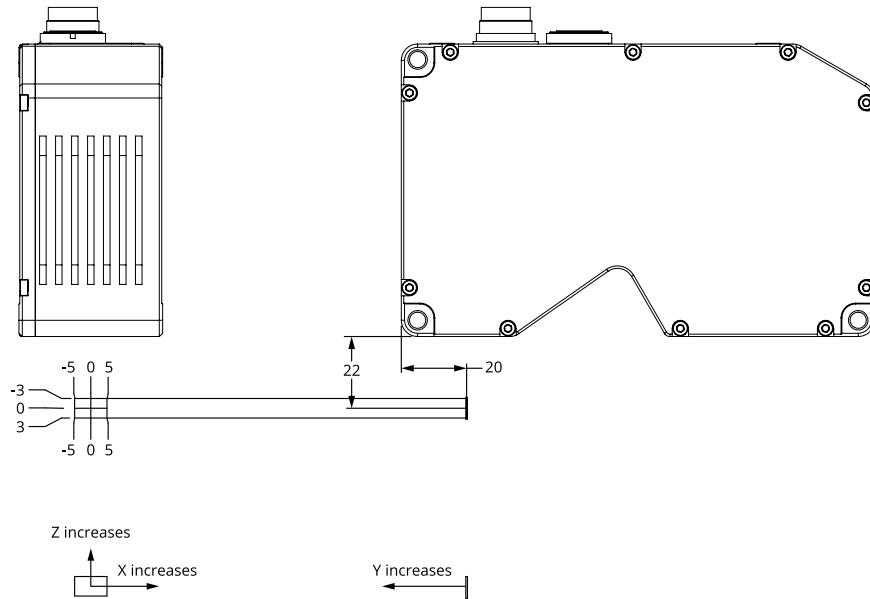
**ALL 2400 SERIES MODELS**

|                       |                                                                                   |
|-----------------------|-----------------------------------------------------------------------------------|
| Scan Rate             | 200 Hz (expanded full window), 400 Hz (G23xx equivalent full window), up to 5 kHz |
| Interface             | Gigabit Ethernet                                                                  |
| Inputs                | Differential Encoder, Laser Safety Enable, Trigger                                |
| Outputs               | 2x Digital output, RS-485 Serial (115 kBaud), 1x Analog Output (4 - 20 mA)        |
| Housing               | Gasketed aluminum enclosure, IP67                                                 |
| Input Voltage (Power) | +24 to +48 VDC (9 W); Ripple +/- 10%                                              |
| Operating Temp.       | 0 to 50° C                                                                        |
| Storage Temp.         | -30 to 70° C                                                                      |

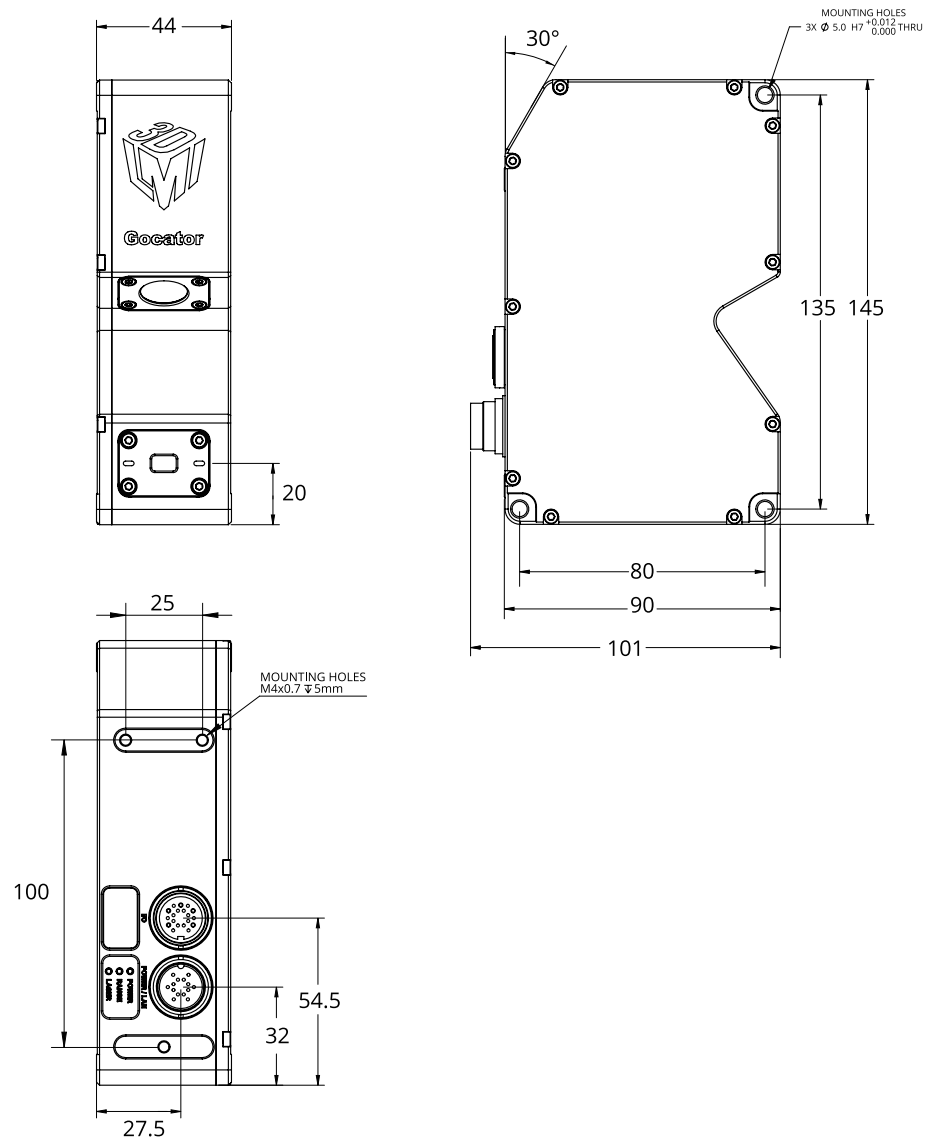
Mechanical dimensions, CD/FOV/MR, and the envelope for each sensor model are illustrated on the following pages.

## Gocator 2410

### Field of View / Measurement Range / Coordinate System Orientation

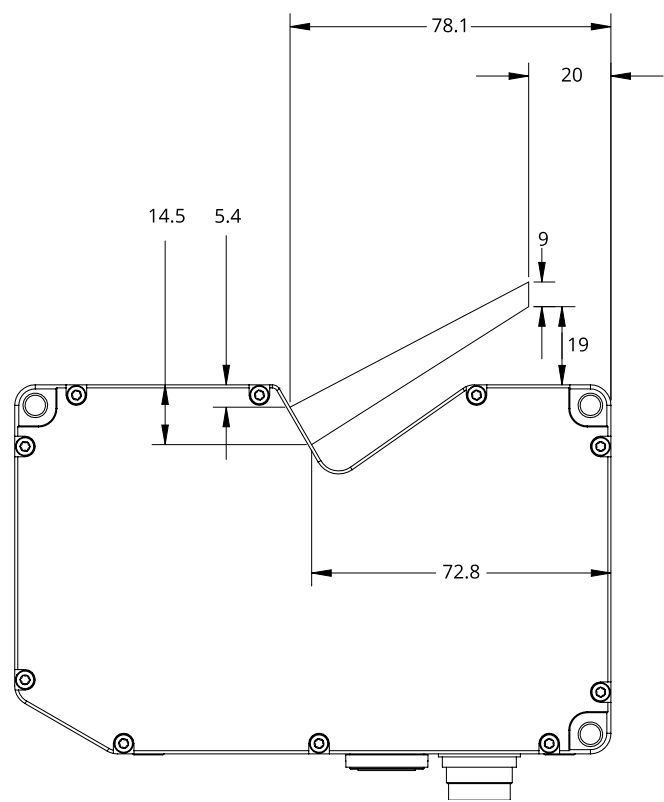


Dimensions



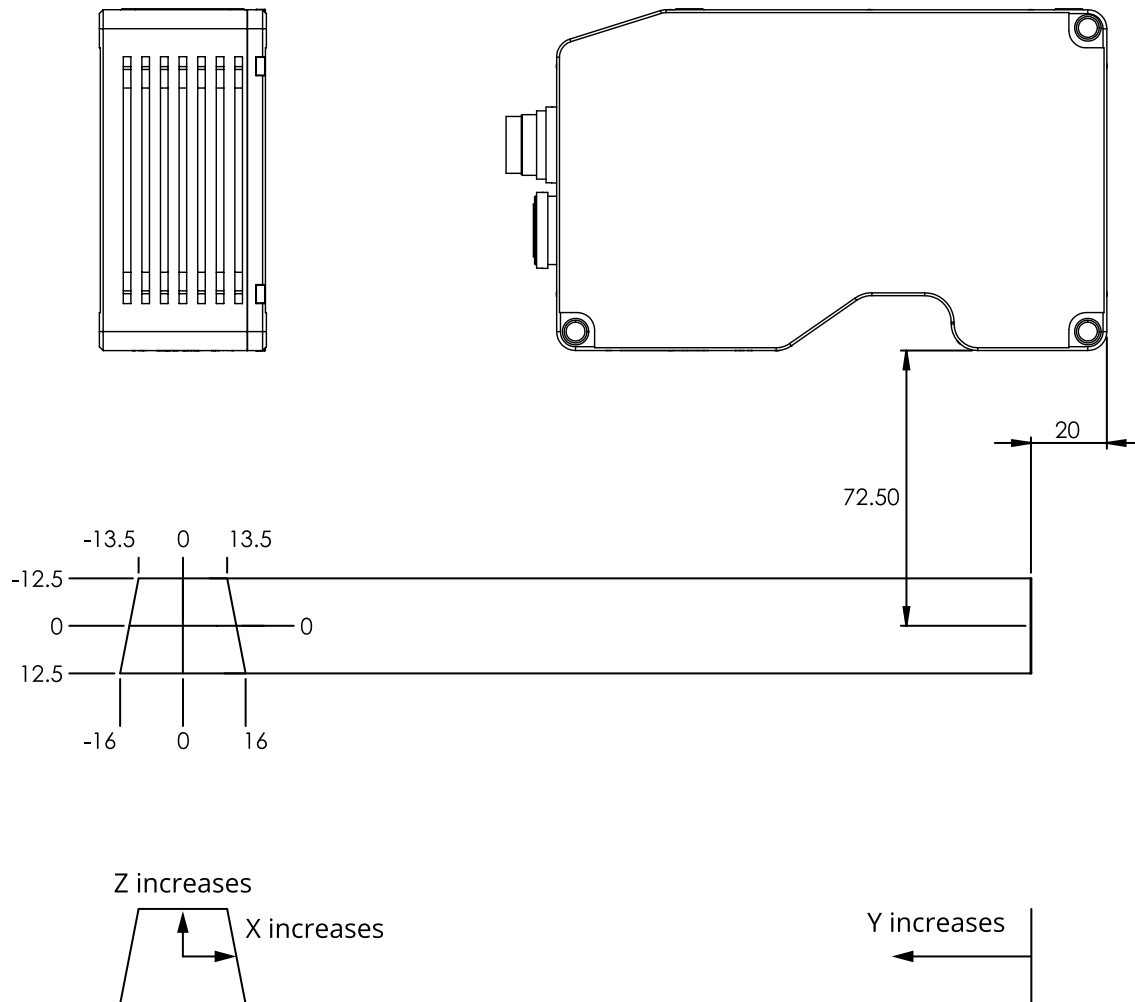


Envelope

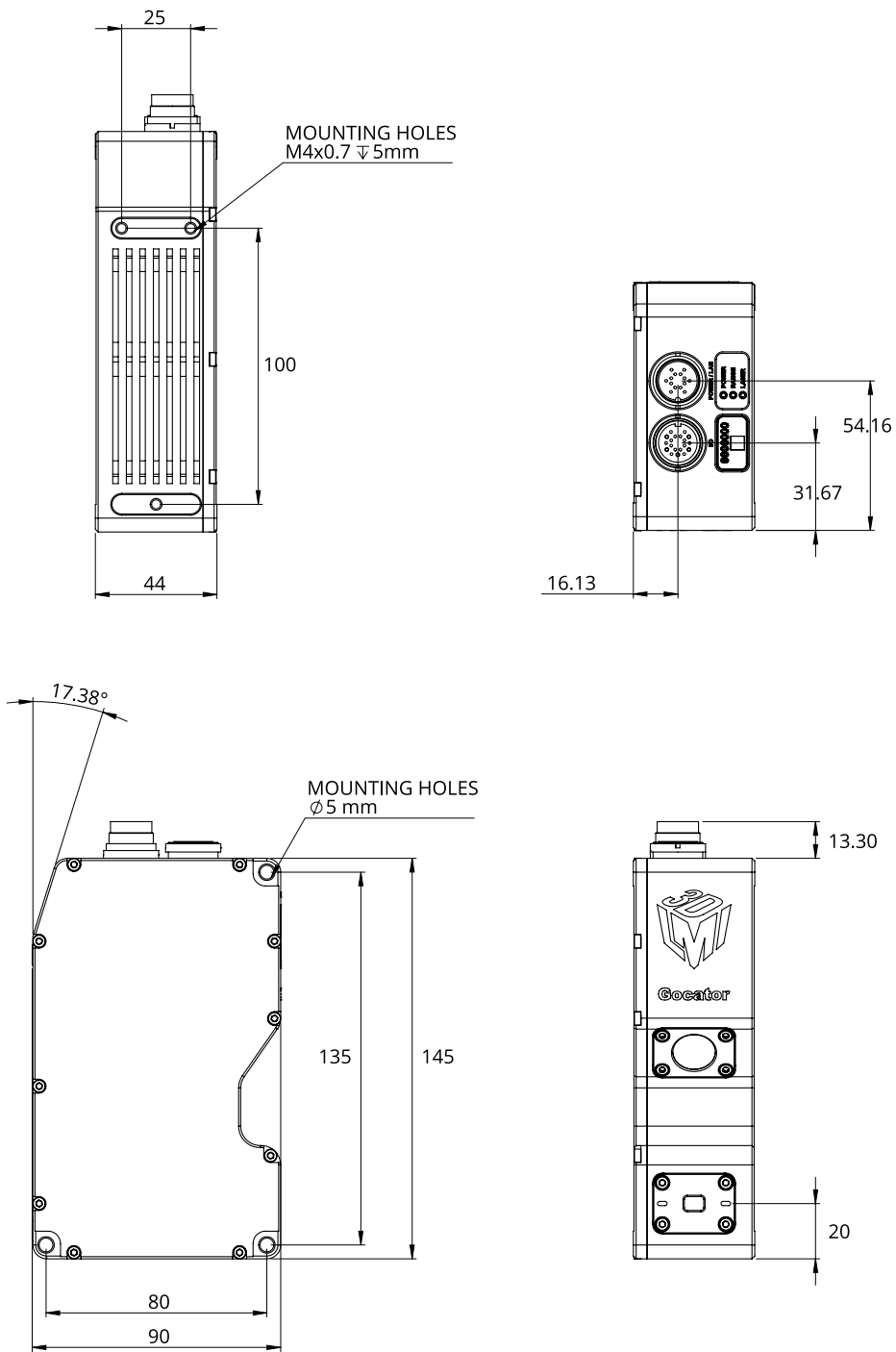


## Gocator 2420

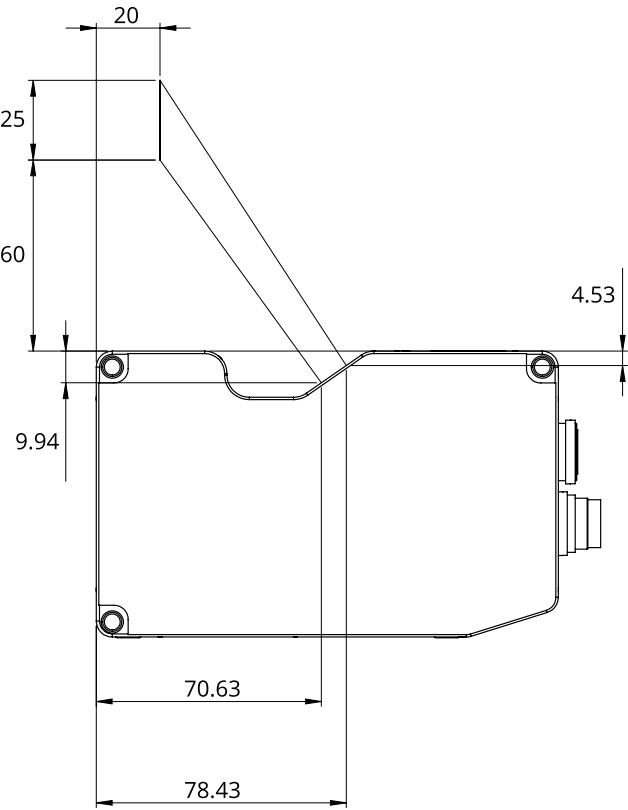
### Field of View / Measurement Range / Coordinate System Orientation



Dimensions



Envelope



## Gocator 2880 Sensor

The Gocator 2880 is defined below.

| MODEL                           | 2880                                                                       |
|---------------------------------|----------------------------------------------------------------------------|
| Data Points / Profile           | 1280                                                                       |
| Linearity Z<br>(+/- % of MR)    | 0.04                                                                       |
| Resolution Z (mm)               | 0.092 - 0.488                                                              |
| Resolution X (mm)               | 0.375 - 1.1                                                                |
| Clearance<br>Distance (CD) (mm) | 350                                                                        |
| Measurement<br>Range (MR) (mm)  | 800                                                                        |
| Field of View (FOV) (mm)        | 390 - 1260                                                                 |
| Recommended Laser<br>Class      | 3B                                                                         |
| Dimensions (mm)                 | 49x75x498                                                                  |
| Weight (kg)                     | 1.3                                                                        |
| Scan Rate                       | Approx. 170Hz to 5000 Hz                                                   |
| Interface                       | Gigabit Ethernet                                                           |
| Inputs                          | Differential Encoder, Laser Safety Enable, Trigger                         |
| Outputs                         | 2x Digital output, RS-485 Serial (115 kBaud), 1x Analog Output (4 - 20 mA) |
| Input Voltage (Power)           | +24 to +48 VDC (13 Watts); RIPPLE +/- 10%                                  |
| Housing                         | Gasketed aluminum enclosure, IP67                                          |
| Operating Temp.                 | 0 to 50 °C                                                                 |
| Storage Temp.                   | -30 to 70 °C                                                               |

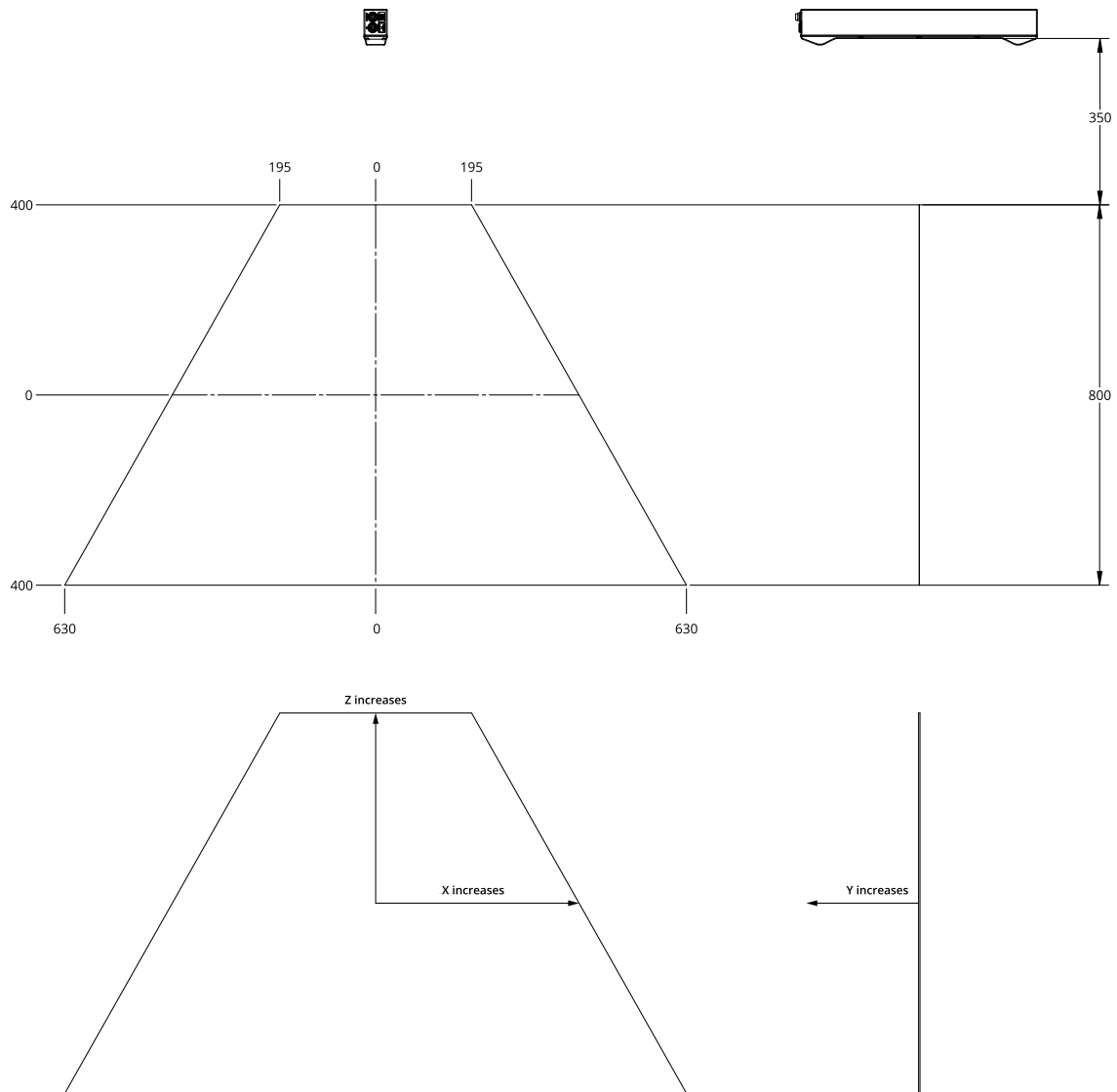
Optical models, laser classes, and packages can be customized. Contact LMI for more details.

Specifications stated are based on standard laser classes. Resolution Z and Linearity Z may vary for other laser classes.

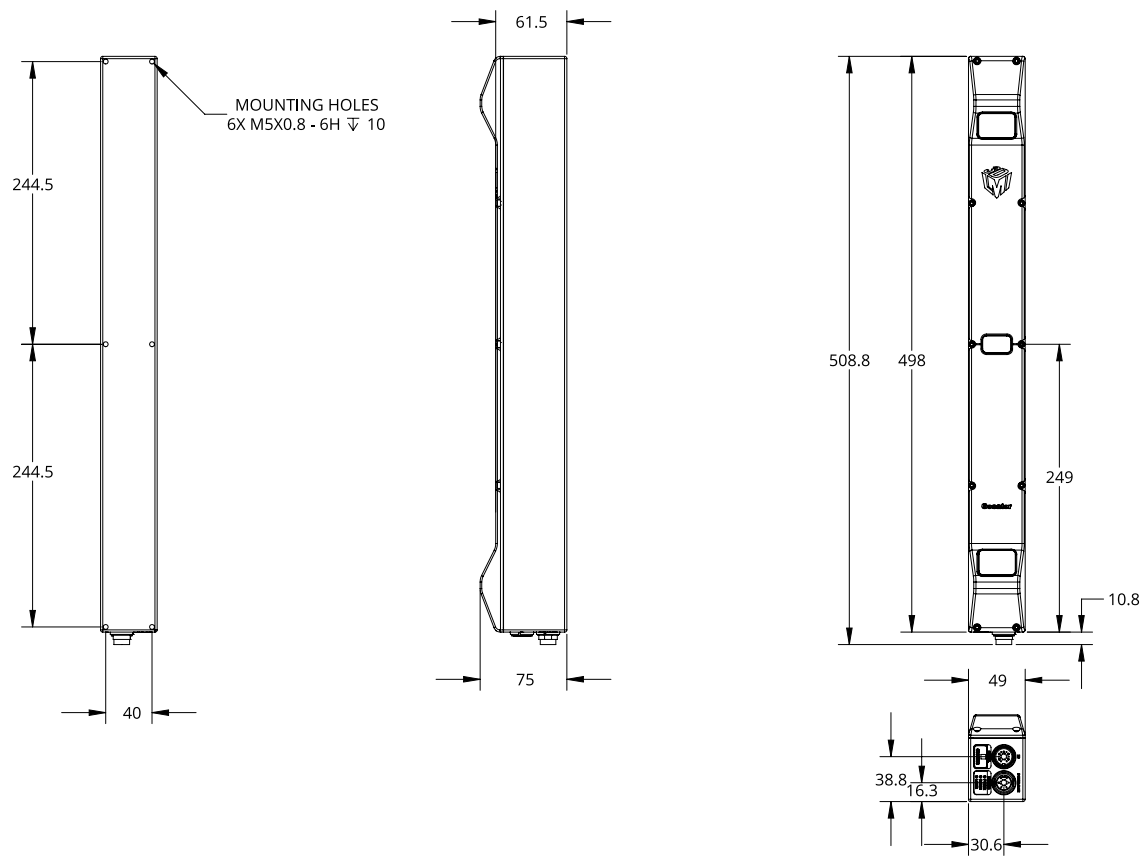
Mechanical dimensions, CD/FOV/MR, and the envelope for each sensor model are illustrated on the following pages.

## Gocator 2880

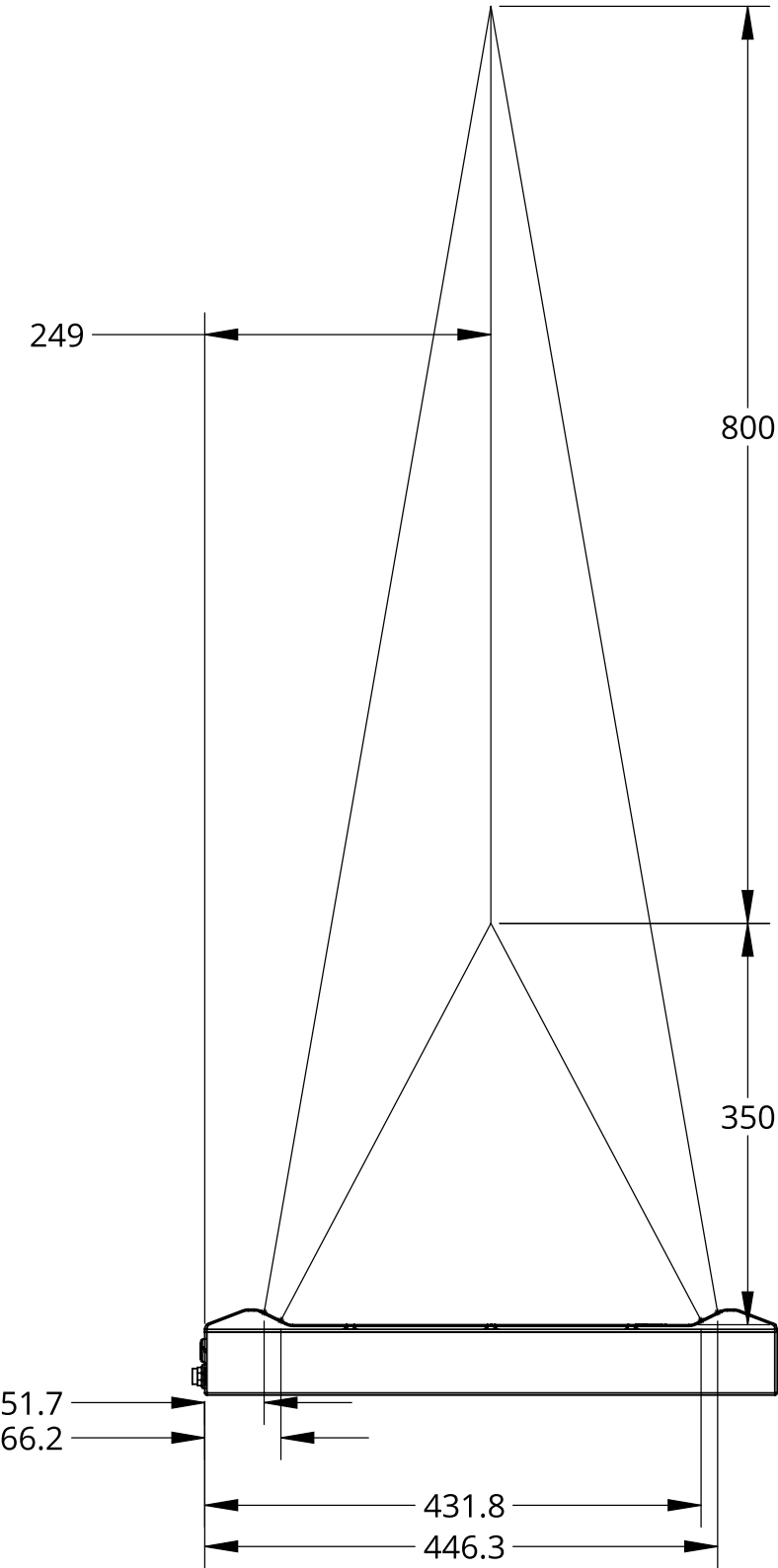
### Field of View / Measurement Range / Coordinate System Orientation



Dimensions



Envelope





# Sensor Connectors

The following sections provide the specifications of the connectors on Gocator sensors.

## Gocator Power/LAN Connector

The Gocator Power/LAN connector is a 14 pin, M16 style connector that provides power input, laser safety input and Ethernet.

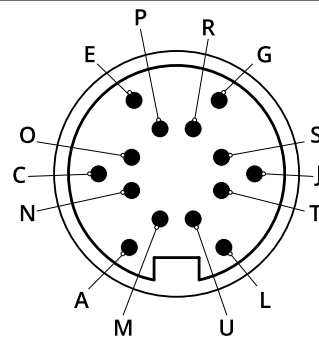


This connector is rated IP67 only when a cable is connected or when a protective cap is used.

This section defines the electrical specifications for Gocator Power/LAN Connector pins, organized by function.

### Gocator Power/LAN Connector Pins

| Function      | Pin | Lead Color on Cordset    |
|---------------|-----|--------------------------|
| GND_24-48V    | L   | White/<br>Orange & Black |
| GND_24-48V    | L   | Orange/ Black            |
| DC_24-48V     | A   | White/<br>Green & Black  |
| DC_24-48V     | A   | Green/ Black             |
| Safety-       | G   | White/ Blue &<br>Black   |
| Safety+       | J   | Blue/<br>Black           |
| Sync+         | E   | White/<br>Brown & Black  |
| Sync-         | C   | Brown/ Black             |
| Ethernet MX1+ | M   | White/ Orange            |
| Ethernet MX1- | N   | Orange                   |
| Ethernet MX2+ | O   | White/ Green             |
| Ethernet MX2- | P   | Green                    |
| Ethernet MX3- | S   | White/ Blue              |
| Ethernet MX3+ | R   | Blue                     |
| Ethernet MX4+ | T   | White/ Brown             |
| Ethernet MX4- | U   | Brown                    |



View: Looking into the connector **on** the sensor

Two wires are connected to the ground and power pins.

## Grounding Shield

The grounding shield should be mounted to the earth ground.

## Power

Apply positive voltage to DC\_24-48V. See *Gocator 2100 & 2300 Series* on page 523 or *Gocator 2400 Series* on page 546

### *Power requirements*

| Function     | Pins | Min  | Max  |
|--------------|------|------|------|
| DC_24-48V    | A    | 24 V | 48 V |
| GND_24-48VDC | L    | 0 V  | 0 V  |

## Laser Safety Input

The Safety\_in+ signal should be connected to a voltage source in the range listed below. The Safety\_in- signal should be connected to the ground/common of the source supplying the Safety\_in+.

### *Laser safety requirements*

| Function   | Pins | Min  | Max  |
|------------|------|------|------|
| Safety_in+ | J    | 24 V | 48 V |
| Safety_in- | G    | 0 V  | 0 V  |



Confirm the wiring of Safety\_in- before starting the sensor. Wiring DC\_24-48V into Safety\_in- may damage the sensor.

## Gocator I/O Connector

The Gocator I/O connector is a 19 pin, M16 style connector that provides encoder, digital input, digital outputs, serial output, and analog output signals.

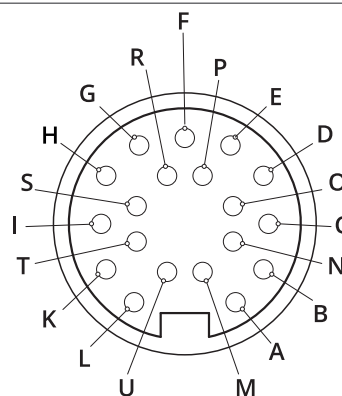


This connector is rated IP67 only when a cable is connected or when a protective cap is used.

This section defines the electrical specifications for Gocator I/O connector pins, organized by function.

### Gocator I/O Connector Pins

| Function                  | Pin | Lead Color on Cordset   |
|---------------------------|-----|-------------------------|
| Trigger_in+               | D   | Grey                    |
| Trigger_in-               | H   | Pink                    |
| Out_1+ (Digital Output 0) | N   | Red                     |
| Out_1- (Digital Output 0) | O   | Blue                    |
| Out_2+ (Digital Output 1) | S   | Tan                     |
| Out_2- (Digital Output 1) | T   | Orange                  |
| Encoder_A+                | M   | White / Brown & Black   |
| Encoder_A-                | U   | Brown / Black           |
| Encoder_B+                | I   | Black                   |
| Encoder_B-                | K   | Violet                  |
| Encoder_Z+                | A   | White / Green & Black   |
| Encoder_Z-                | L   | Green / Black           |
| Serial_out+               | B   | White                   |
| Serial_out-               | C   | Brown                   |
| Reserved                  | E   | Blue / Black            |
| Reserved                  | G   | White / Blue & Black    |
| Analog_out+               | P   | Green                   |
| Analog_out-               | F   | Yellow & Maroon / White |
| Reserved                  | R   | Maroon                  |



View: Looking into the connector **on** the sensor

## Grounding Shield

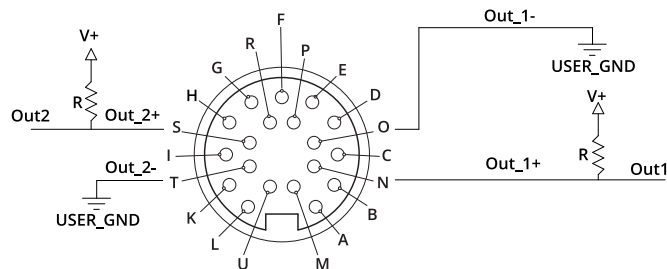
The grounding shield should be mounted to the earth ground.

## Digital Outputs

Each Gocator sensor has two optically isolated outputs. Both outputs are open collector and open emitter, which allows a variety of power sources to be connected and a variety of signal configurations.

Out\_1 (Collector – Pin N and Emitter – Pin O) and Out\_2 (Collector – Pin S and Emitter – Pin T) are independent and therefore V+ and GND are not required to be the same.

| Function | Pins | Max Collector Current | Max Collector-Emitter Voltage | Min Pulse Width |
|----------|------|-----------------------|-------------------------------|-----------------|
| Out_1    | N, O | 40 mA                 | 70 V                          | 20 $\mu$ s      |
| Out_2    | S, T | 40 mA                 | 70 V                          | 20 $\mu$ s      |

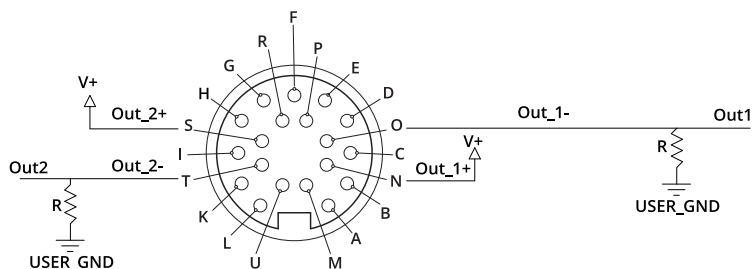


The resistors shown above are calculated by  $R = (V+) / 2.5 \text{ mA}$ .

The size of the resistors is determined by power =  $(V+)^2 / R$ .

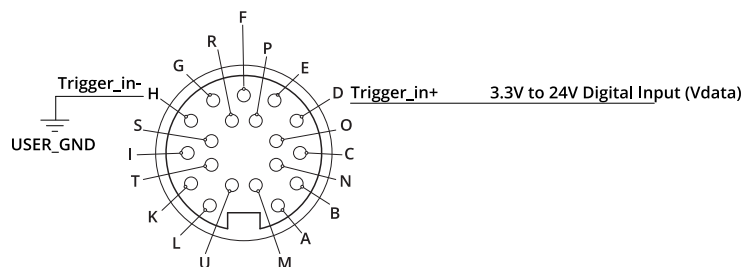
### Inverting Outputs

To invert an output, connect a resistor between ground and Out\_1- or Out\_2- and connect Out\_1+ or Out\_2+ to the supply voltage. Take the output at Out\_1- or Out\_2-. For resistor selection, see above.



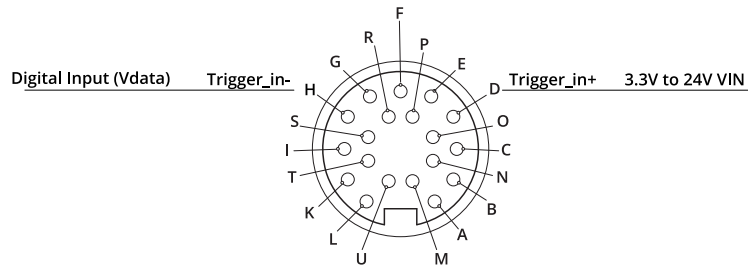
### Digital Input

Every Gocator sensor has a single optically isolated input. To use this input without an external resistor, supply 3.3 - 24 V to the positive pin and GND to the negative.



*Active High*

If the supplied voltage is greater than 24 V, connect an external resistor in series to the positive. The resistor value should be  $R = [(V_{in}-1.2V)/10mA]-680$ .



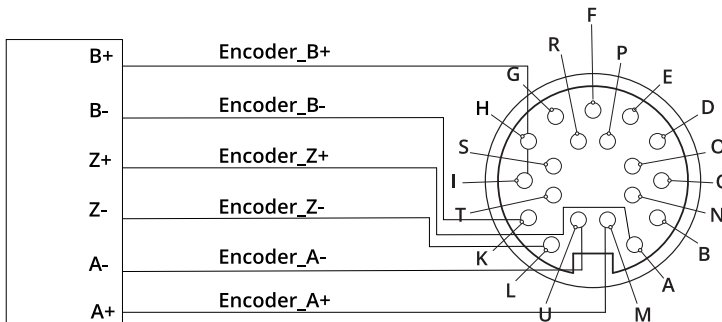
Active Low

To assert the signal, the digital input voltage should be set to draw a current of 3 mA to 40 mA from the positive pin. The current that passes through the positive pin is  $I = (V_{in} - 1.2 - V_{data}) / 680$ . To reduce noise sensitivity, we recommend leaving a 20% margin for current variation (i.e., uses a digital input voltage that draws 4mA to 25mA).

| Function   | Pins | Min Voltage | Max Voltage | Min Current | Max Current | Min Pulse Width |
|------------|------|-------------|-------------|-------------|-------------|-----------------|
| Trigger_in | D, H | 3.3 V       | 24 V        | 3 mA        | 40 mA       | 20 $\mu$ s      |

## Encoder Input

Encoder input is provided by an external encoder and consists of three RS-485 signals. These signals are connected to Encoder\_A, Encoder\_B, and Encoder\_Z.



| Function  | Pins | Common Mode Voltage |      | Differential Threshold Voltage |         |        | Max Data Rate |
|-----------|------|---------------------|------|--------------------------------|---------|--------|---------------|
|           |      | Min                 | Max  | Min                            | Typ     | Max    |               |
| Encoder_A | M, U | -7 V                | 12 V | -200 mV                        | -125 mV | -50 mV | 1 MHz         |
| Encoder_B | I, K | -7 V                | 12 V | -200 mV                        | -125 mV | -50 mV | 1 MHz         |
| Encoder_Z | A, L | -7 V                | 12 V | -200 mV                        | -125 mV | -50 mV | 1 MHz         |



Gocator only supports differential RS485 signalling. Both + and - signals must be connected.

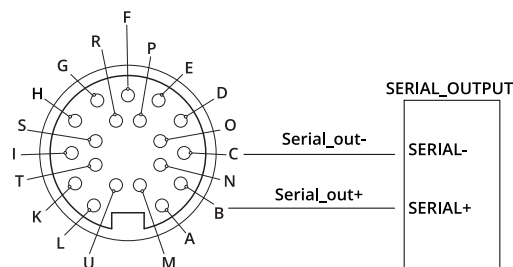


Encoders are normally specified in *pulses* per revolution, where each pulse is made up of the four quadrature *signals* (A+ / A- / B+ / B-). Because Gocator reads each of the four quadrature signals, you should choose an encoder accordingly, given the resolution required for your application.

Serial Output

Serial RS-485 output is connected to Serial\_out as shown below.

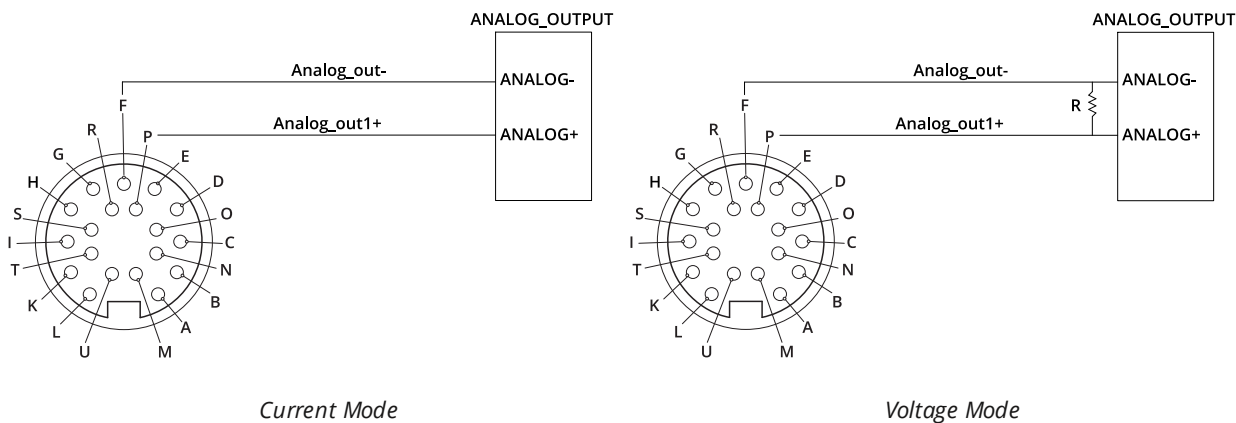
| Function   | Pins |
|------------|------|
| Serial_out | B, C |



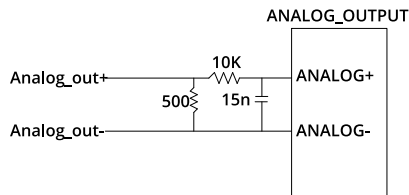
Analog Output

The Sensor I/O Connector defines one analog output interface: Analog\_out.

| Function   | Pins | Current Range |
|------------|------|---------------|
| Analog_out | P, F | 4 – 20 mA     |



To configure for voltage output, connect a 500 Ohm ¼ Watt resistor between Analog\_out+ and Analog\_out- and measure the voltage across the resistor. To reduce the noise in the output, we recommend using an RC filter as shown below.



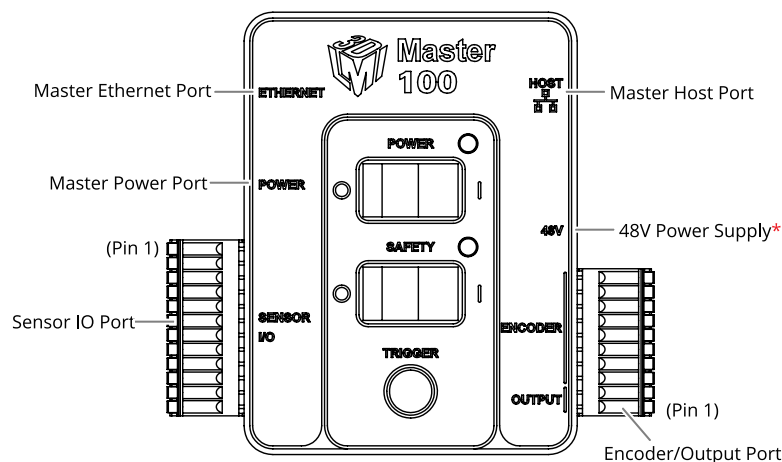
# Master Network Controllers

The following sections provide the specifications of Master network controllers.

For information on maximum external input trigger rates, see *Maximum Input Trigger Rate* on page 98.

## Master 100

The Master 100 accepts connections for power, safety, and encoder, and provides digital output.



\*Contact LMI for information regarding this type of power supply.

Connect the Master Power port to the Gocator's Power/LAN connector using the Gocator Power/LAN to Master cordset. Connect power RJ45 end of the cordset to the Master Power port. The Ethernet RJ45 end of the cordset can be connected directly to the Ethernet switch, or connect to the Master Ethernet port. If the Master Ethernet port is used, connect the Master Host port to the Ethernet switch with a CAT5e Ethernet cable.

To use encoder and digital output, wire the Master's Gocator Sensor I/O port to the Gocator IO connector using the Gocator I/O cordset.

### Sensor I/O Port Pins

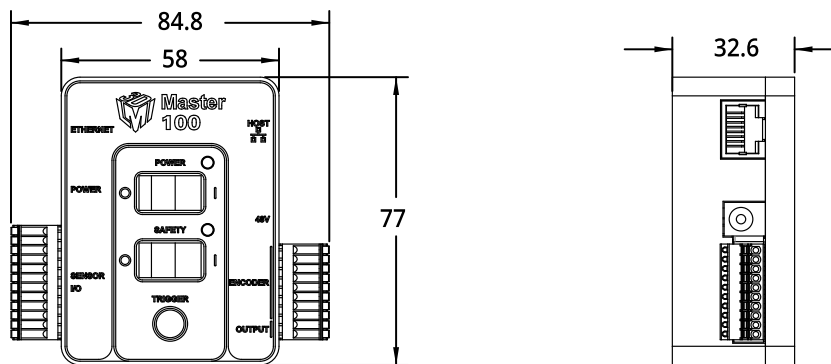
| Gocator I/O Pin | Master Pin | Conductor Color     |
|-----------------|------------|---------------------|
| Encoder_A+      | 1          | White/Brown & Black |
| Encoder_A-      | 2          | Brown/Black         |
| Encoder_Z+      | 3          | White/Green & Black |
| Encoder_Z-      | 4          | Green/Black         |
| Trigger_in+     | 5          | Grey                |
| Trigger_in-     | 6          | Pink                |
| Out_1-          | 7          | Blue                |
| Out_1+          | 8          | Red                 |
| Encoder_B+      | 11         | Black               |
| Encoder_B-      | 12         | Violet              |

The rest of the wires in the Gocator I/O cordset are not used.

#### Encoder/Output Port Pins

| Function                     | Pin |
|------------------------------|-----|
| Output_1+ (Digital Output 0) | 1   |
| Output_1- (Digital Output 0) | 2   |
| Encoder_Z+                   | 3   |
| Encoder_Z-                   | 4   |
| Encoder_A+                   | 5   |
| Encoder_A-                   | 6   |
| Encoder_B+                   | 7   |
| Encoder_B-                   | 8   |
| Encoder_GND                  | 9   |
| Encoder_5V                   | 10  |

## Master 100 Dimensions



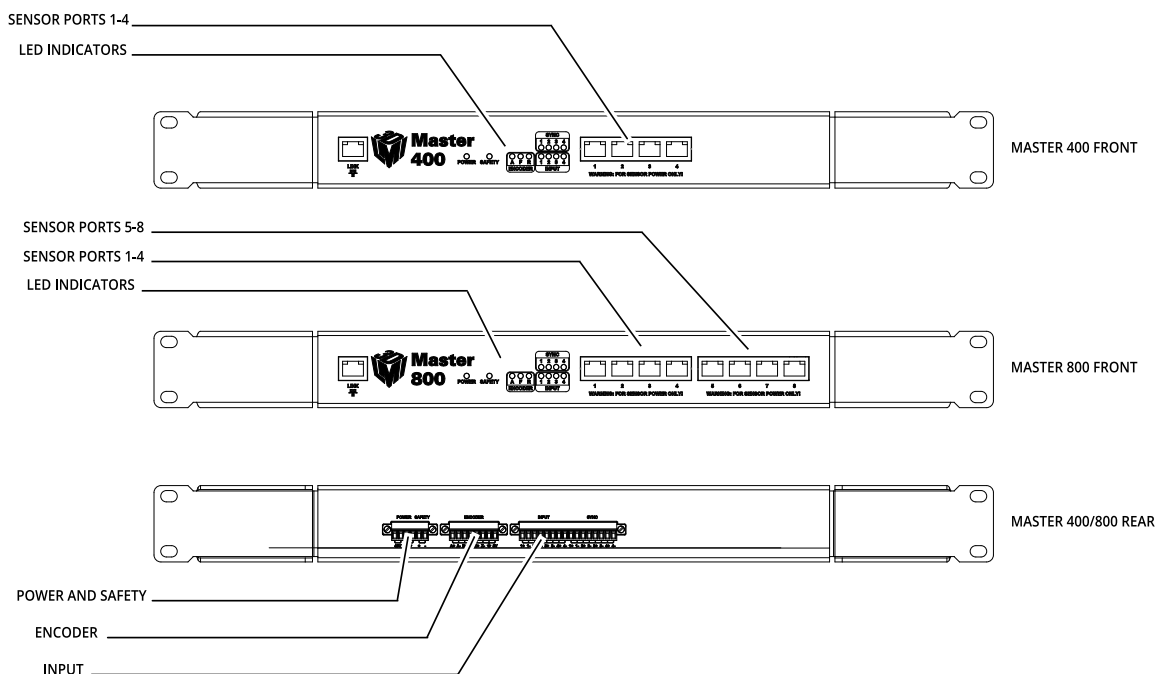


## Master 400/800

Master 400 and 800 network controllers provide sensor power and safety interlock, and broadcast system-wide synchronization information (i.e., time, encoder count, encoder index, and digital I/O states) to all devices on a sensor network.



The Phoenix connectors on Master 400/800/1200/2400 are not compatible with the connectors on Master 810/2410. For this reason, if you are switching models in your network, you must rewire the connections to the Master.



### Power and Safety (6 pin connector)

| Function        | Pin |
|-----------------|-----|
| +48VDC          | 1   |
| +48VDC          | 2   |
| GND (24-48VDC)  | 3   |
| GND (24-48VDC)  | 4   |
| Safety Control+ | 5   |
| Safety Control- | 6   |



The +48VDC power supply must be isolated from AC ground. This means that AC ground and DC ground are not connected.



The Safety Control requires a voltage differential of 24 VDC to 48 VDC across the pin to enable the laser.

#### *Input (16 pin connector)*

| Function    | Pin |
|-------------|-----|
| Input 1     | 1   |
| Input 1 GND | 2   |
| Reserved    | 3   |
| Reserved    | 4   |
| Reserved    | 5   |
| Reserved    | 6   |
| Reserved    | 7   |
| Reserved    | 8   |
| Reserved    | 9   |
| Reserved    | 10  |
| Reserved    | 11  |
| Reserved    | 12  |
| Reserved    | 13  |
| Reserved    | 14  |
| Reserved    | 15  |
| Reserved    | 16  |



The Input connector does not need to be wired up for proper operation.

#### *Encoder (8 pin connector)*

| Function   | Pin |
|------------|-----|
| Encoder_A+ | 1   |
| Encoder_A- | 2   |
| Encoder_B+ | 3   |
| Encoder_B- | 4   |
| Encoder_Z+ | 5   |
| Encoder_Z- | 6   |
| GND        | 7   |
| +5VDC      | 8   |

## Master 400/800 Electrical Specifications

#### *Electrical Specifications*

| Specification               | Value   |
|-----------------------------|---------|
| Power Supply Voltage        | +48 VDC |
| Power Supply Current (Max.) | 10 A    |

| Specification               | Value                                                       |
|-----------------------------|-------------------------------------------------------------|
| Power Draw (Min.)           | 5.76 W                                                      |
| Safety Input Voltage Range  | +24 VDC to +48 VDC                                          |
| Encoder Signal Voltage      | Differential (12 VDC)                                       |
| Digital Input Voltage Range | Logical LOW: 0 to +0.1 VDC<br>Logical HIGH: +3.3 to +24 VDC |



When using a Master hub, the chassis must be well grounded.



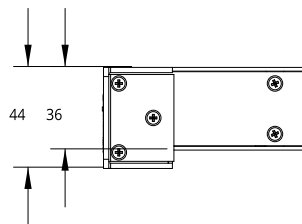
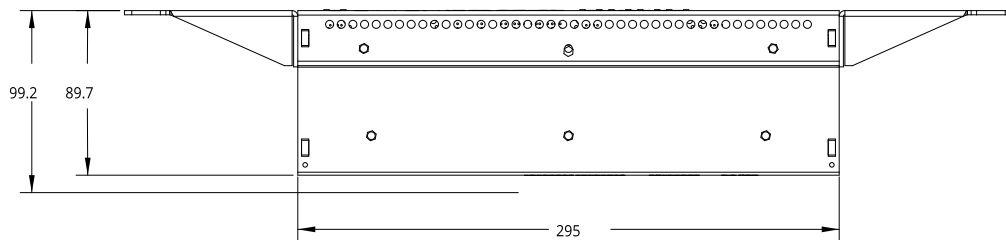
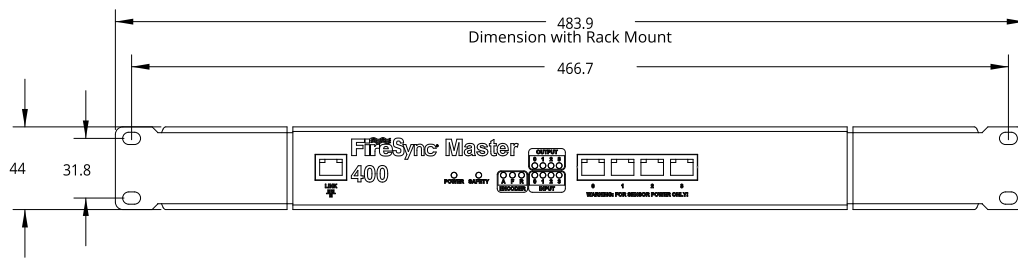
The power supply must be isolated from AC ground. This means that AC ground and DC ground are not connected.



The Power Draw specification is based on a Master with no sensors attached. Every sensor has its own power requirements that need to be considered when calculating total system power requirements.

## Master 400/800 Dimensions

The dimensions of Master 400 and Master 800 are the same.



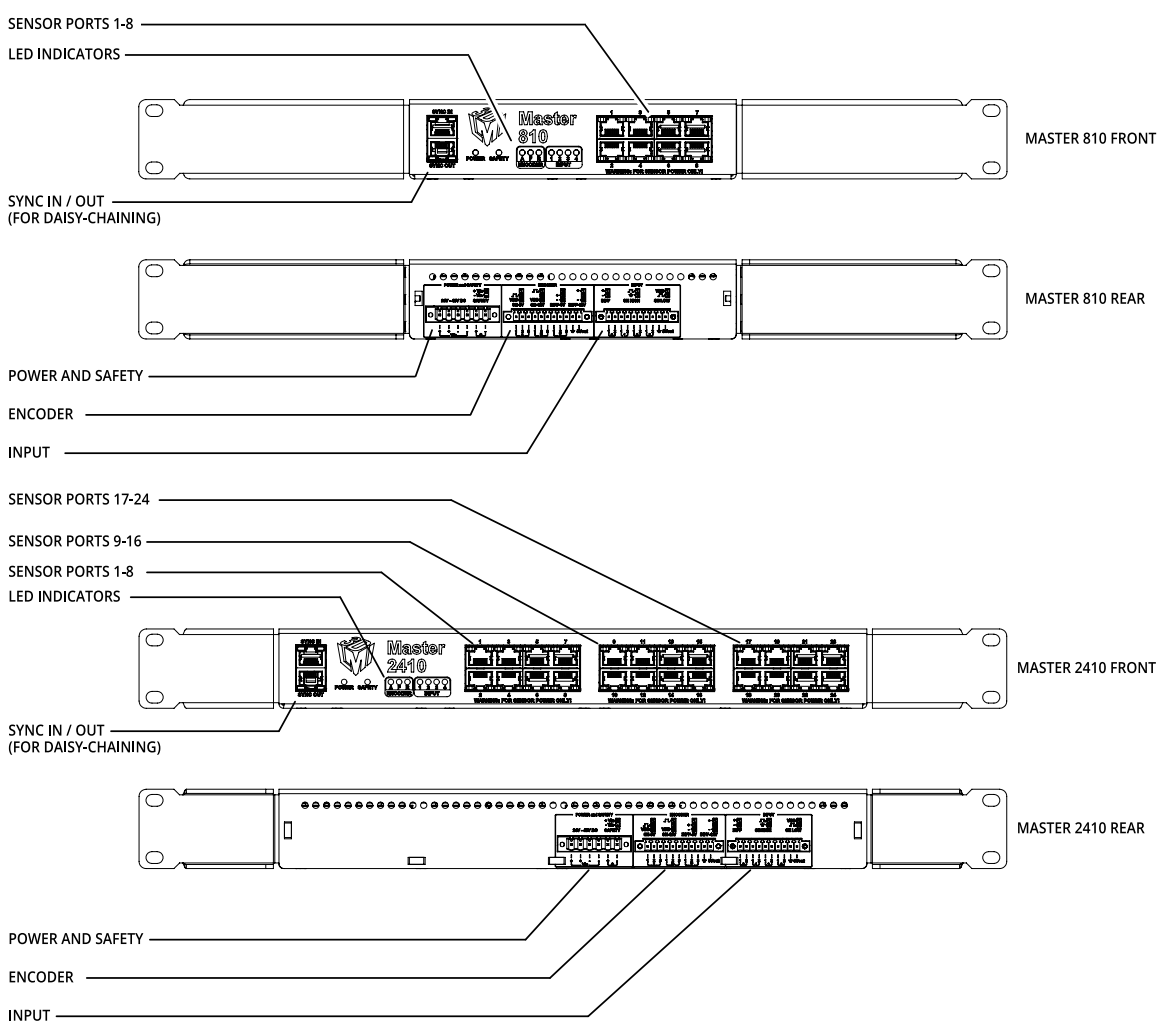
## Master 810/2410

Master 810 and 2410 network controllers provide sensor power and safety interlock, and broadcast system-wide synchronization information (i.e., time, encoder count, encoder index, and digital I/O states) to all devices on a sensor network.

Master 810 and 2410 can be mounted to DIN rails using the appropriate adapters (not included; for more information, see *Installing DIN Rail Clips: Master 810 or 2410* on page 32). The units are provided with removable adapters for 1U rack mounting; the mounting holes for this option are compatible with older Master models (400/800/1200/2400).



The Phoenix connectors on Master 810/2410 are not compatible with the connectors on Master 400/800/1200/2400. For this reason, if you are switching models in your network, you must rewire the connections to the Master.



#### *Power and Safety (6 pin connector)*

| Function        | Pin |
|-----------------|-----|
| Power In+       | 1   |
| Power In+       | 2   |
| Power In-       | 3   |
| Power In-       | 4   |
| Safety Control+ | 5   |
| Safety Control- | 6   |



The +24-48VDC power supply must be isolated from AC ground. This means that AC ground and DC ground are not connected.



The Safety Control requires a voltage differential of 24 VDC to 48 VDC across the pin to enable the laser.

#### *Input (10 pin connector)*

| Function                                  | Pin |
|-------------------------------------------|-----|
| Input 0 Pin 1                             | 1   |
| Input 0 Pin 2                             | 2   |
| Reserved                                  | 3   |
| Reserved                                  | 4   |
| Reserved                                  | 5   |
| Reserved                                  | 6   |
| Reserved                                  | 7   |
| Reserved                                  | 8   |
| GND (output for powering other devices)   | 9   |
| +5VDC (output for powering other devices) | 10  |



The Input connector does not need to be wired up for proper operation.



For Input connection wiring options, see *Input* on page 574.

#### *Encoder (11 pin connector)*

| Function        | Pin |
|-----------------|-----|
| Encoder_A_Pin_1 | 1   |
| Encoder_A_Pin_2 | 2   |
| Encoder_A_Pin_3 | 3   |
| Encoder_B_Pin_1 | 4   |
| Encoder_B_Pin_2 | 5   |

| Function                                     | Pin |
|----------------------------------------------|-----|
| Encoder_B_Pin_3                              | 6   |
| Encoder_Z_Pin_1                              | 7   |
| Encoder_Z_Pin_2                              | 8   |
| Encoder_Z_Pin_3                              | 9   |
| GND (output for powering external devices)   | 10  |
| +5VDC (output for powering external devices) | 11  |



For Encoder connection wiring options, see *Encoder* on the next page.

## Electrical Specifications

### Electrical Specifications

| Specification                | Value                                                                                                                                                                                                                |
|------------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Power Supply Voltage         | +24 VDC to +48 VDC                                                                                                                                                                                                   |
| Power Supply Current (Max.)* | Master 810: 9 A<br>Master 2410: 25 A<br>* Fully loaded with 1 A per sensor port.                                                                                                                                     |
| Power Draw (Min.)            | Master 810: 1.7 W<br>Master 2410: 4.8 W                                                                                                                                                                              |
| Safety Input Voltage Range   | +24 VDC to +48 VDC                                                                                                                                                                                                   |
| Encoder Signal Voltage       | Differential (5 VDC, 12 VDC)<br>Single-Ended (5 VDC, 12 VDC)<br>For more information, see <i>Encoder</i> on the next page.                                                                                           |
| Digital Input Voltage Range  | Single-Ended Active LOW: 0 to +0.8 VDC<br>Single-Ended Active HIGH: +3.3 to +24 VDC<br>Differential LOW: 0.8 to -24 VDC<br>Differential HIGH: +3.3 to +24 VDC<br>For more information, see <i>Input</i> on page 574. |



If the input voltage is above 24 V, use an external resistor, using the following formula:

$$R = [(V_{in} - 1.2V) / 10mA] - 680$$



When using a Master hub, the chassis must be well grounded.



The power supply must be isolated from AC ground. This means that AC ground and DC ground are not connected.



24 VDC power supply is only supported if all connected sensors support an input voltage of 24 VDC.



The Power Draw specification is based on a Master with no sensors attached. Every sensor has its own power requirements that need to be considered when calculating total system power requirements.

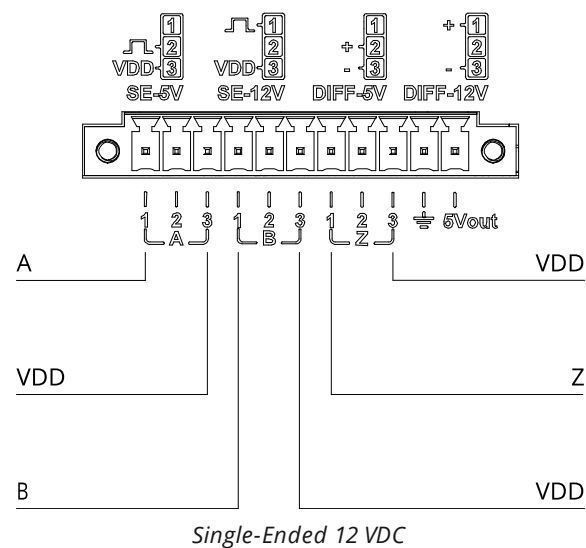
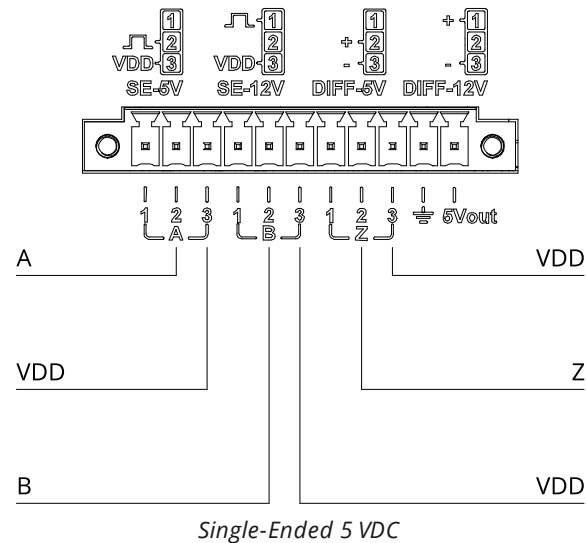
## Encoder

Master 810 and 2410 support the following types of encoder signals: Single-Ended (5 VDC, 12 VDC) and Differential (5 VDC, 12 VDC).

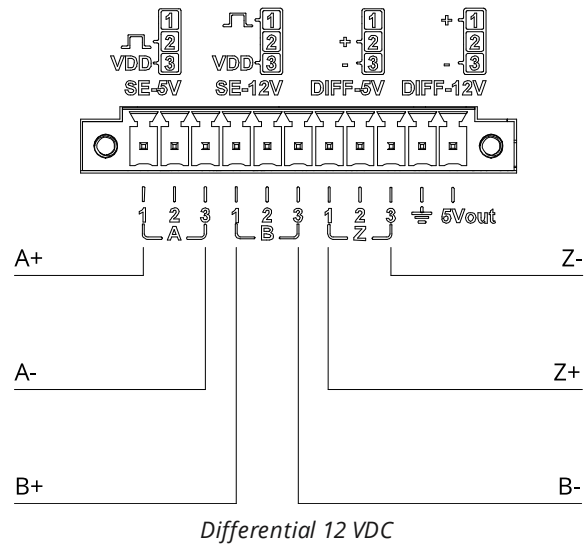
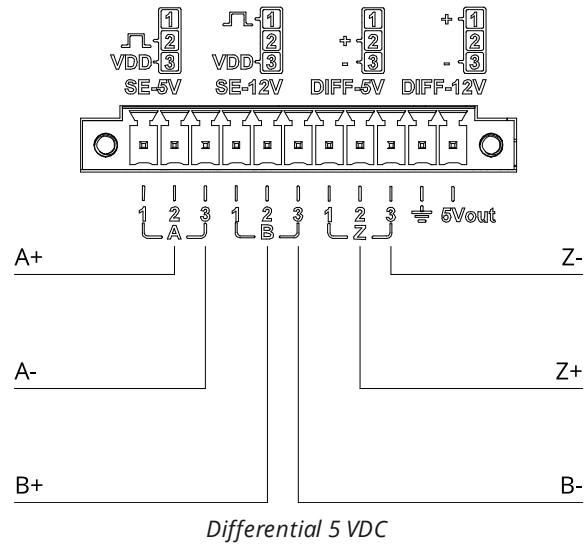
For 5 VDC operation, pins 2 and 3 of each channel are used.

For 12 VDC operation, pins 1 and 3 of each channel are used.

To determine how to wire a Master to an encoder, see the illustrations below.







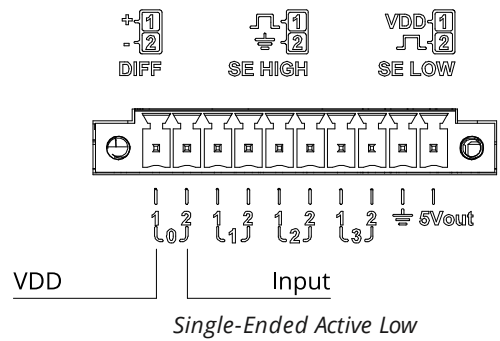
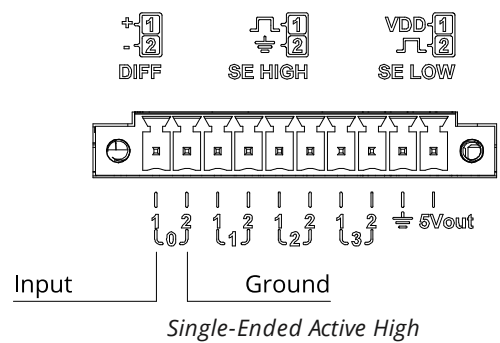
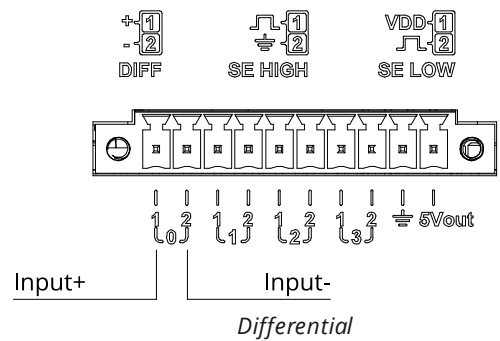
## Input

Master 810 and 2410 support the following types of input: Differential, Single-Ended High, and Single-Ended Low.



Currently, only Input 0 is supported by Gocator.

For digital input voltage ranges, see the table below.

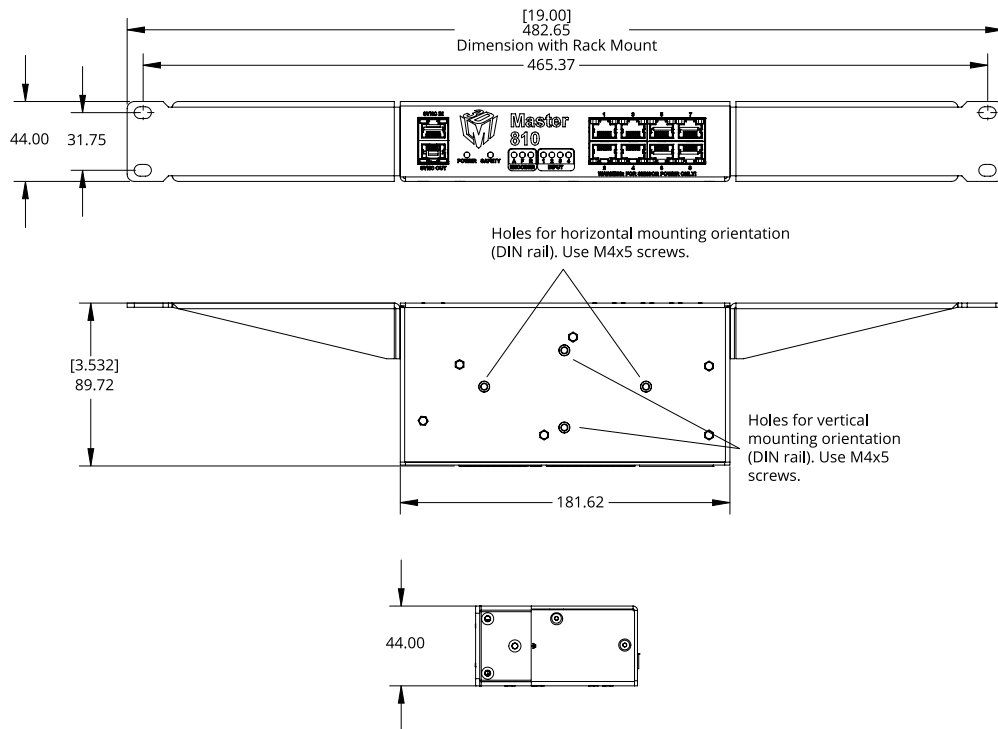


Digital Input Voltage Ranges

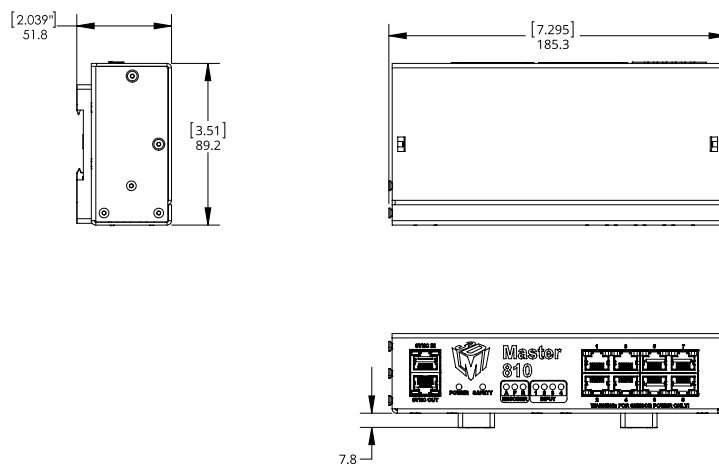
|                          | Input Status | Min (VDC)               | Max (VDC)               |
|--------------------------|--------------|-------------------------|-------------------------|
| Single-ended Active High | Off          | 0                       | +0.8                    |
|                          | On           | +3.3                    | +24                     |
| Single-ended Active Low  | Off          | (V <sub>DD</sub> - 0.8) | V <sub>DD</sub>         |
|                          | On           | 0                       | (V <sub>DD</sub> - 3.3) |
| Differential             | Off          | -24                     | +0.8                    |
|                          | On           | +3.3                    | +24                     |

## Master 810 Dimensions

With 1U rack mount brackets:



With DIN rail mount clips:

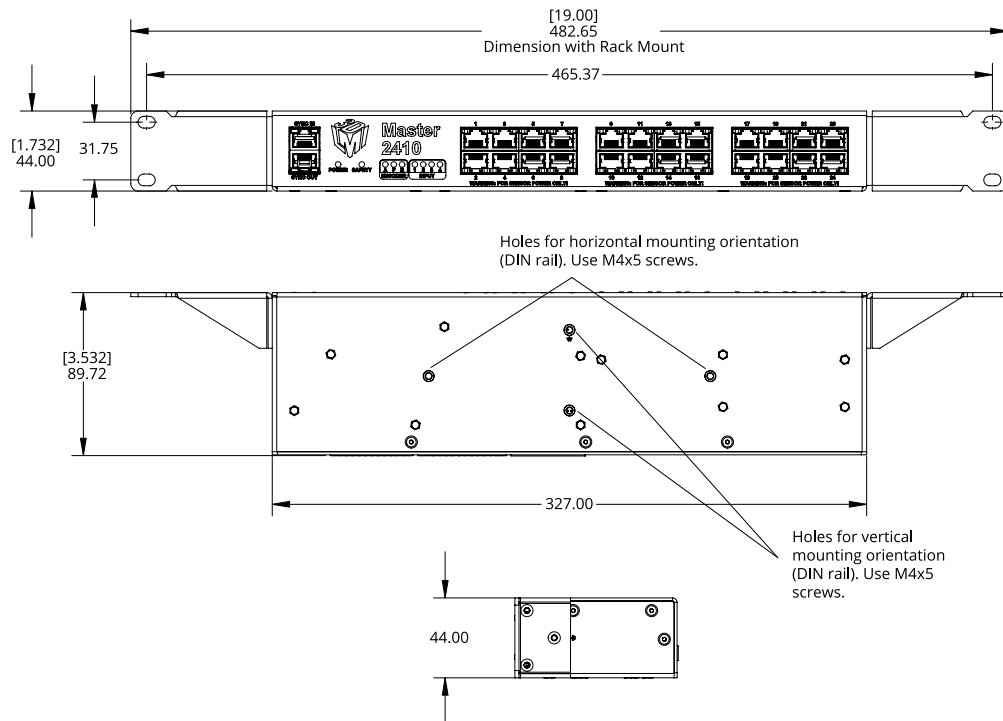


For information on installing DIN rail clips, see *Installing DIN Rail Clips: Master 810 or 2410* on page 32.

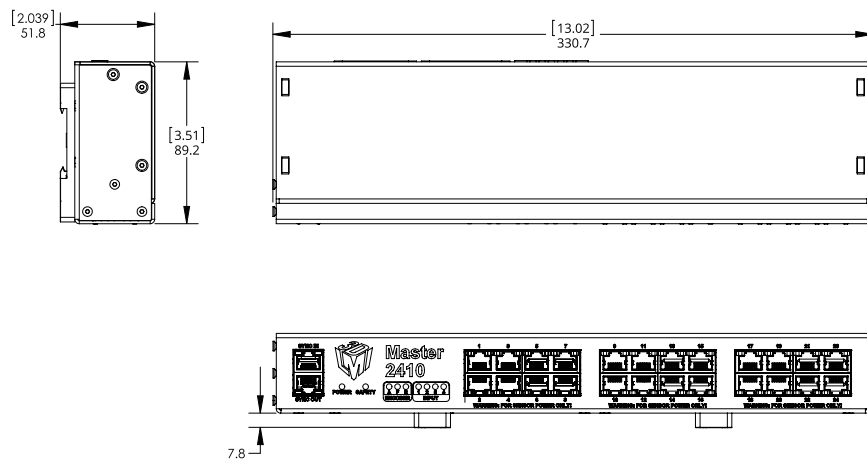
The CAD model of the DIN rail clip is available at <https://www.winford.com/products/cad/dinm12-rc.igs>.

## Master 2410 Dimensions

With 1U rack mount brackets:



With DIN rail mount clips:



For information on installing DIN rail clips, see *Installing DIN Rail Clips: Master 810 or 2410* on page 32.

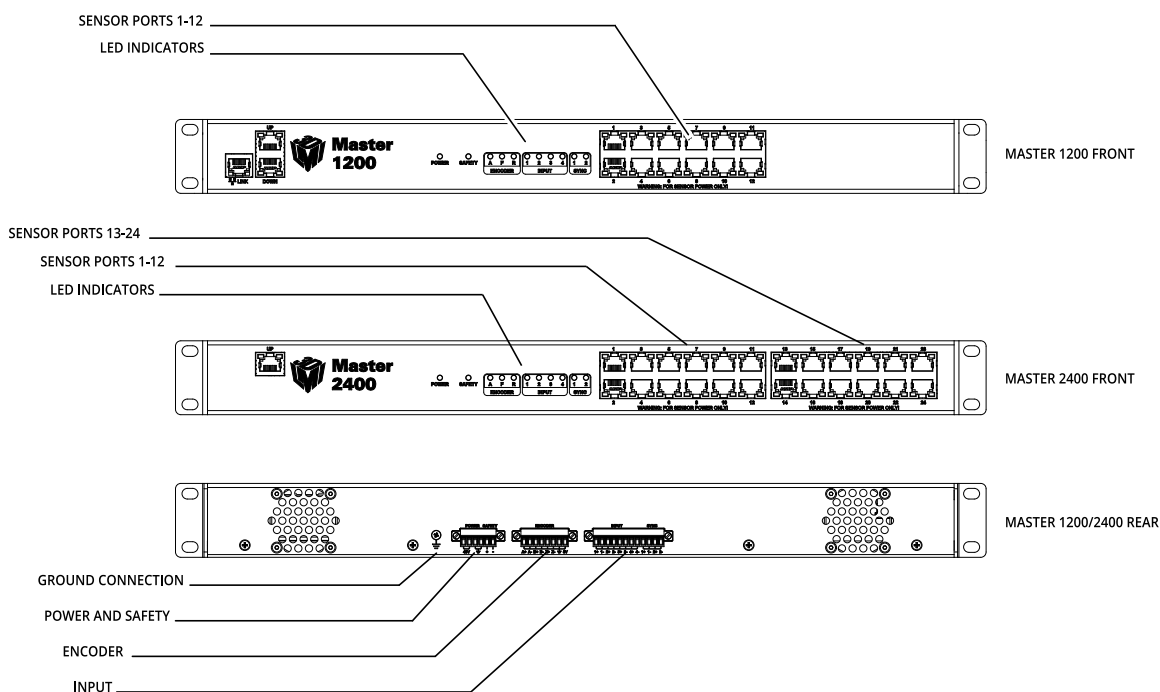
The CAD model of the DIN rail clip is available at <https://www.winford.com/products/cad/dinm12-rc.igs>.

## Master 1200/2400

Master 1200 and 2400 network controllers provide sensor power and safety interlock, and broadcast system-wide synchronization information (i.e., time, encoder count, encoder index, and digital I/O states) to all devices on a sensor network.



The Phoenix connectors on Master 400/800/1200/2400 are not compatible with the connectors on Master 810/2410. For this reason, if you are switching models in your network, you must rewire the connections to the Master.



### Power and Safety (6 pin connector)

| Function        | Pin |
|-----------------|-----|
| +48VDC          | 1   |
| +48VDC          | 2   |
| GND (24-48VDC)  | 3   |
| GND (24-48VDC)  | 4   |
| Safety Control+ | 5   |
| Safety Control- | 6   |



The +48VDC power supply must be isolated from AC ground. This means that AC ground and DC ground are not connected.



The Safety Control requires a voltage differential of 24 VDC to 48 VDC across the pin to enable the laser.

#### *Input (12 pin connector)*

| Function    | Pin |
|-------------|-----|
| Input 1     | 1   |
| Input 1 GND | 2   |
| Reserved    | 3   |
| Reserved    | 4   |
| Reserved    | 5   |
| Reserved    | 6   |
| Reserved    | 7   |
| Reserved    | 8   |
| Reserved    | 9   |
| Reserved    | 10  |
| Reserved    | 11  |
| Reserved    | 12  |



The Input connector does not need to be wired up for proper operation.

#### *Encoder (8 pin connector)*

| Function   | Pin |
|------------|-----|
| Encoder_A+ | 1   |
| Encoder_A- | 2   |
| Encoder_B+ | 3   |
| Encoder_B- | 4   |
| Encoder_Z+ | 5   |
| Encoder_Z- | 6   |
| GND        | 7   |
| +5VDC      | 8   |

## Master 1200/2400 Electrical Specifications

#### *Electrical Specifications*

| Specification               | Value                                                        |
|-----------------------------|--------------------------------------------------------------|
| Power Supply Voltage        | +48 VDC                                                      |
| Power Supply Current (Max.) | 10 A                                                         |
| Power Draw (Min.)           | 5.76 W                                                       |
| Safety Input Voltage Range  | +24 VDC to +48 VDC                                           |
| Encoder Signal Voltage      | Differential (12 VDC)                                        |
| Digital Input Voltage Range | Logical LOW: 0 to +0.1 VDC<br>Logical HIGH: +3.5 to +6.5 VDC |



When using a Master hub, the chassis must be well grounded.



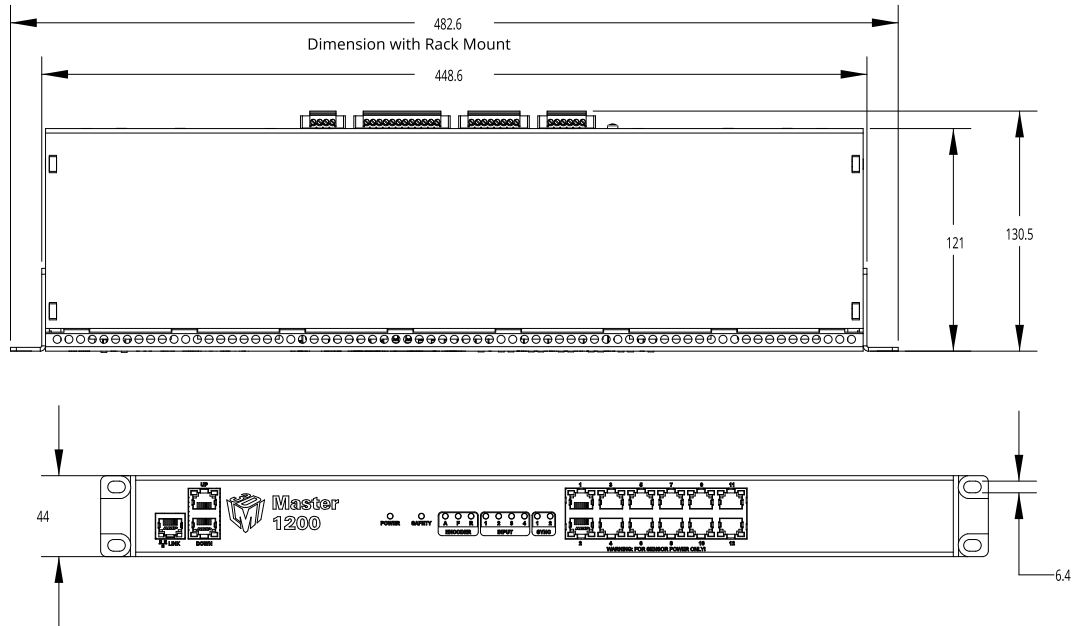
The power supply must be isolated from AC ground. This means that AC ground and DC ground are not connected.



The Power Draw specification is based on a Master with no sensors attached. Every sensor has its own power requirements that need to be considered when calculating total system power requirements.

## Master 1200/2400 Dimensions

The dimensions of Master 1200 and Master 2400 are the same.



# Accessories

## *Masters*

| Description                                       | Part Number |
|---------------------------------------------------|-------------|
| Master 100 - for single sensor (development only) | 30705       |
| Master 810 - for networking up to 8 sensors       | 301114      |
| Master 2410 - for networking up to 24 sensors     | 301115      |

## *Cordsets*

| Description                                                   | Part Number |
|---------------------------------------------------------------|-------------|
| 1.2m I/O cordset, open wire end                               | 30864-1.2m  |
| 2m I/O cordset, open wire end                                 | 30864-2m    |
| 5m I/O cordset, open wire end                                 | 30864-5m    |
| 10m I/O cordset, open wire end                                | 30864-10m   |
| 15m I/O cordset, open wire end                                | 30864-15m   |
| 20m I/O cordset, open wire end                                | 30864-20m   |
| 25m I/O cordset, open wire end                                | 30864-25m   |
| 2m Power and Ethernet cordset, 1x open wire end, 1x RJ45 end  | 30861-2m    |
| 5m Power and Ethernet cordset, 1x open wire end, 1x RJ45 end  | 30861-5m    |
| 10m Power and Ethernet cordset, 1x open wire end, 1x RJ45 end | 30861-10m   |
| 15m Power and Ethernet cordset, 1x open wire end, 1x RJ45 end | 30861-15m   |
| 20m Power and Ethernet cordset, 1x open wire end, 1x RJ45 end | 30861-20m   |
| 25m Power and Ethernet cordset, 1x open wire end, 1x RJ45 end | 30861-25m   |
| 1.2m Power and Ethernet to Master cordset, 2x RJ45 ends       | 30858-1.2m  |
| 2m Power and Ethernet to Master cordset, 2x RJ45 ends         | 30858-2m    |
| 5m Power and Ethernet to Master cordset, 2x RJ45 ends         | 30858-5m    |
| 10m Power and Ethernet to Master cordset, 2x RJ45 ends        | 30858-10m   |
| 15m Power and Ethernet to Master cordset, 2x RJ45 ends        | 30858-15m   |
| 20m Power and Ethernet to Master cordset, 2x RJ45 ends        | 30858-20m   |
| 25m Power and Ethernet to Master cordset, 2x RJ45 ends        | 30858-25m   |

## *Cordsets - 90-degree*

| Description                           | Part Number |
|---------------------------------------|-------------|
| 2m I/O cordset, 90-deg, open wire end | 30883-2m    |
| 5m I/O cordset, 90-deg, open wire end | 30883-5m    |



| <b>Description</b>                                                    | <b>Part Number</b> |
|-----------------------------------------------------------------------|--------------------|
| 10m I/O cordset, 90-deg, open wire end                                | 30883-10m          |
| 15m I/O cordset, 90-deg, open wire end                                | 30883-15m          |
| 20m I/O cordset, 90-deg, open wire end                                | 30883-20m          |
| 25m I/O cordset, 90-deg, open wire end                                | 30883-25m          |
| 2m Power and Ethernet cordset, 90-deg, 1x open wire end, 1x RJ45 end  | 30880-2m           |
| 5m Power and Ethernet cordset, 90-deg, 1x open wire end, 1x RJ45 end  | 30880-5m           |
| 10m Power and Ethernet cordset, 90-deg, 1x open wire end, 1x RJ45 end | 30880-10m          |
| 15m Power and Ethernet cordset, 90-deg, 1x open wire end, 1x RJ45 end | 30880-15m          |
| 20m Power and Ethernet cordset, 90-deg, 1x open wire end, 1x RJ45 end | 30880-20m          |
| 25m Power and Ethernet cordset, 90-deg, 1x open wire end, 1x RJ45 end | 30880-25m          |
| 2m Power and Ethernet to Master cordset, 90-deg, 2x RJ45 ends         | 30877-2m           |
| 5m Power and Ethernet to Master cordset, 90-deg, 2x RJ45 ends         | 30877-5m           |
| 10m Power and Ethernet to Master cordset, 90-deg, 2x RJ45 ends        | 30877-10m          |
| 15m Power and Ethernet to Master cordset, 90-deg, 2x RJ45 ends        | 30877-15m          |
| 20m Power and Ethernet to Master cordset, 90-deg, 2x RJ45 ends        | 30877-20m          |
| 25m Power and Ethernet to Master cordset, 90-deg, 2x RJ45 ends        | 30877-25m          |

### *Accessories*

| <b>Description</b>      | <b>Part Number</b> |
|-------------------------|--------------------|
| Calibration Disk, 40mm  | 30727              |
| Calibration Disk, 100mm | 30728              |

Contact LMI for information on creating cordsets with custom length or connector orientation. The maximum cordset length is 60 m.

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## **Return Policy**

Before returning the product for repair (warranty or non-warranty) a Return Material Authorization (RMA) number must be obtained from LMI. Please call LMI to obtain this RMA number.

Carefully package the sensor in its original shipping materials (or equivalent) and ship the sensor prepaid to your designated LMI location. Please ensure that the RMA number is clearly written on the outside of the package. Inside the return shipment, include the address you wish the shipment returned to, the name, email and telephone number of a technical contact (should we need to discuss this repair), and details of the nature of the malfunction. For non-warranty repairs, a purchase order for the repair charges must accompany the returning sensor.

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