



USER MANUAL

# Gocator 2300 & 2880 Series

Document revision: B

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This product is designated for use solely as a component and as such it does not comply with the standards relating to laser products specified in U.S. FDA CFR Title 21 Part 1040.

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# Introduction

The Gocator 2300 series of laser profiling sensors is 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.

## Notational Conventions

This guide uses the following notational conventions:



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



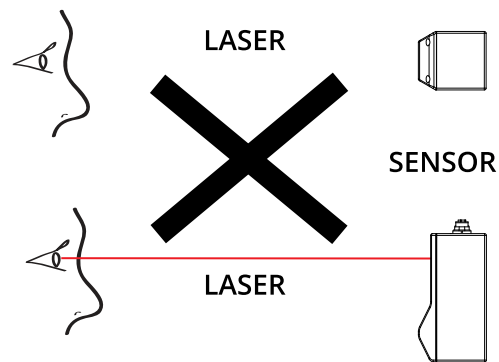
Consider this information in order to make best use of the product.

# 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. 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 references 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.

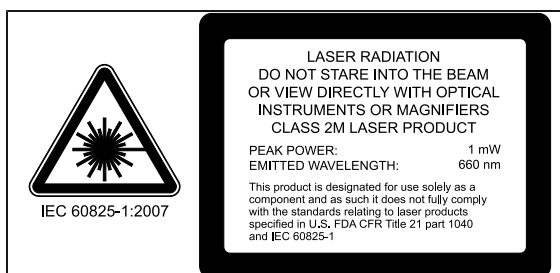
## References

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 <http://www.fda.gov/cdrh/rad-health.html>

## Laser Classes

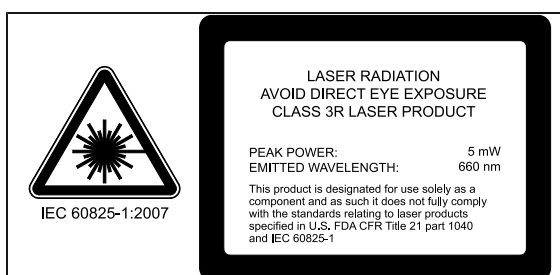
### Class 2M laser components

Class 2M laser components would not cause permanent damage to the eye under reasonably foreseeable conditions of operation, provided that any exposure can be terminated by the blink reflex (assumed to take 0.25 seconds). Because classification assumes the blink reflex, the wavelength of light must be in the visible range (400 nm to 700 nm). The Maximum Permissible Exposure (MPE) for visible radiation for 0.25 seconds is 25 watts per square meter, which is equivalent to 1 mW entering an aperture of 7 mm diameter (the assumed size of the pupil).



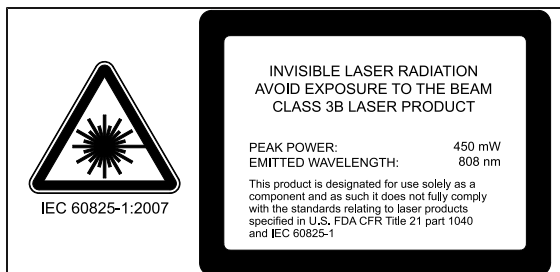
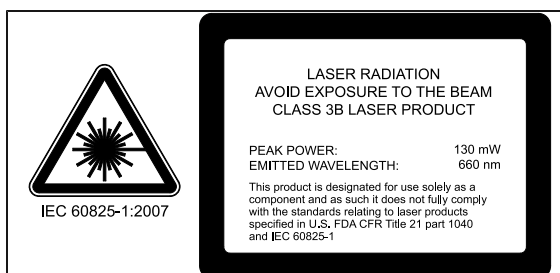
### Class 3R laser components

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.



### Class 3B laser components

Class 3B components are unsafe for eye exposure. Usually only ocular protection will be required. Diffuse reflections are safe if viewed for less than 10 seconds.



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

## 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.*

## 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. On some LMI laser sensors, the beam attenuator is



supplied with the sensor as an integrated mechanical shutter.

### 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 allows the user to 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                |

| Model | Laser Class | Model Constant | Class I MPE (mW) | Class II MPE (mw) | Class I NOHD (mm) | Class II NOHD (mm) |
|-------|-------------|----------------|------------------|-------------------|-------------------|--------------------|
| 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               |
| 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 <http://www.fda.gov/cdrh>.

## 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 2300 & 2880 I/O Connector* (page 369) for a description of connector pins used with Gocator 2300 series sensors.

### **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.

## **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.

## Sensor Maintenance

### **Keep sensor windows clean**

Gocator sensors are high-precision optical instruments. To ensure the highest accuracy is achieved in all measurements, the windows on the front of the sensor should be kept clean and clear of debris.

### **Use care when cleaning sensor windows**

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 3D measurement 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.

# Getting Started

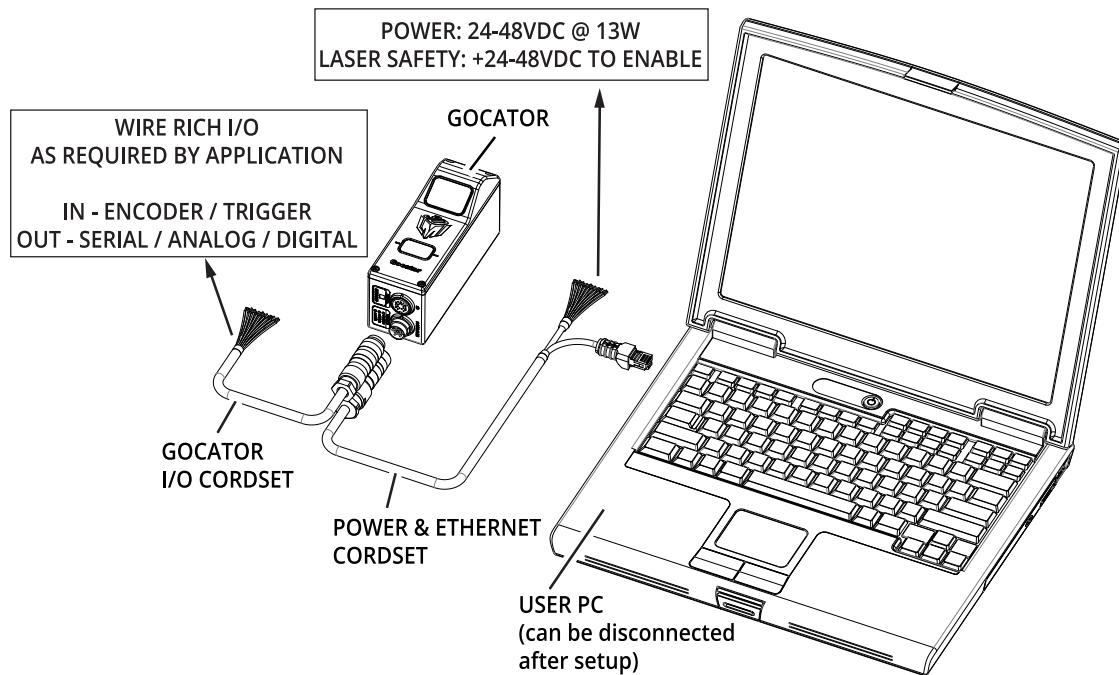
The following sections provide system and hardware overviews, in addition to installation and setup procedures.

## 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.

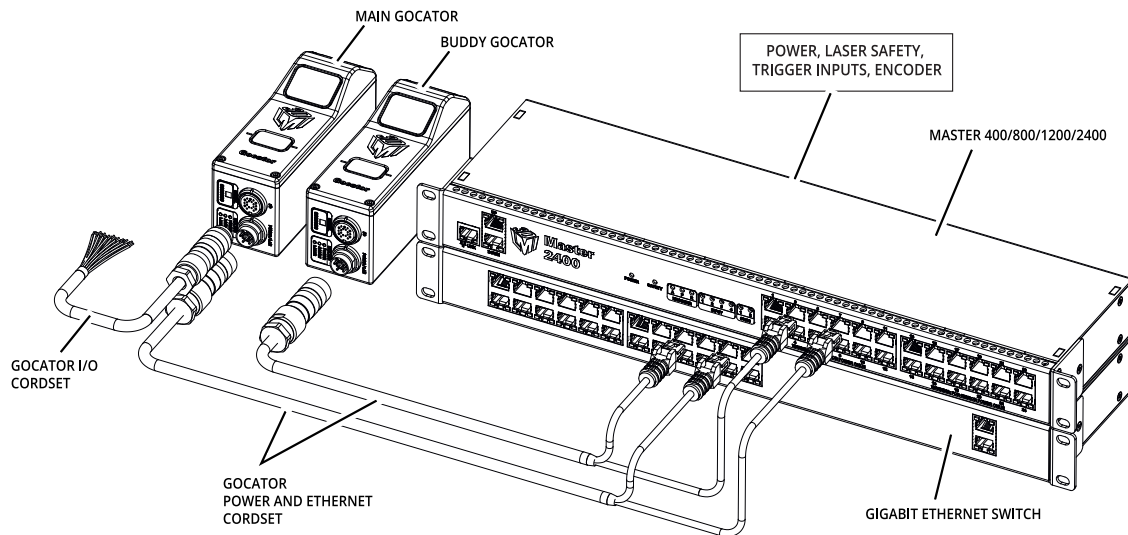


### Dual-Sensor System

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 400/800/1200/2400 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

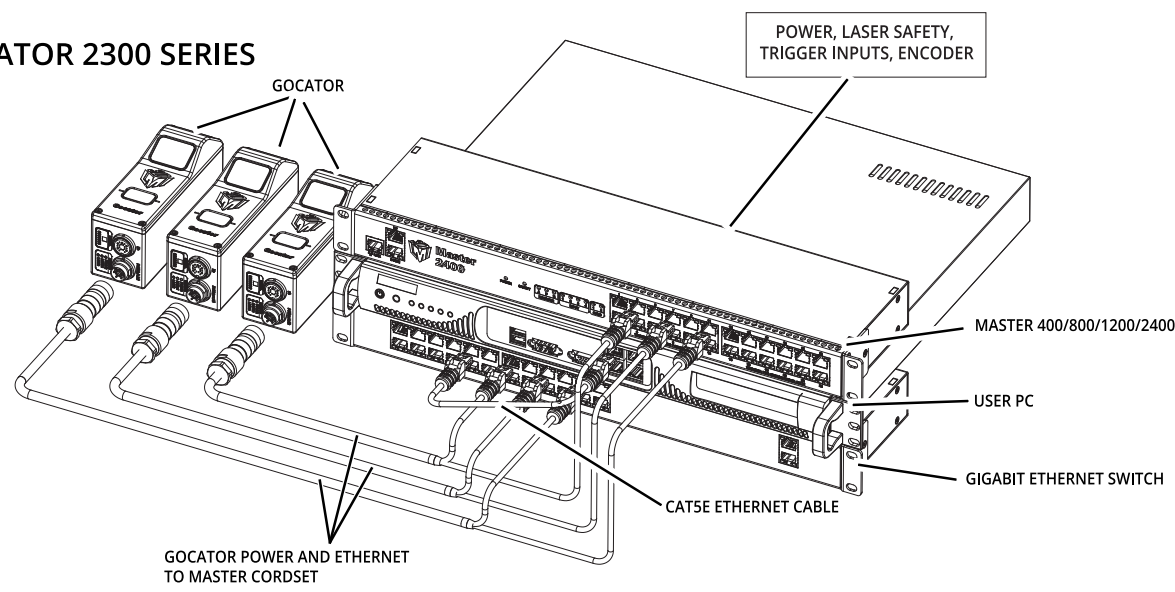


## Multi-Sensor System

Master 400/800/1200/2400 networking hardware 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 400/800/1200/2400 networking hardware does not support digital, serial, or analog output.

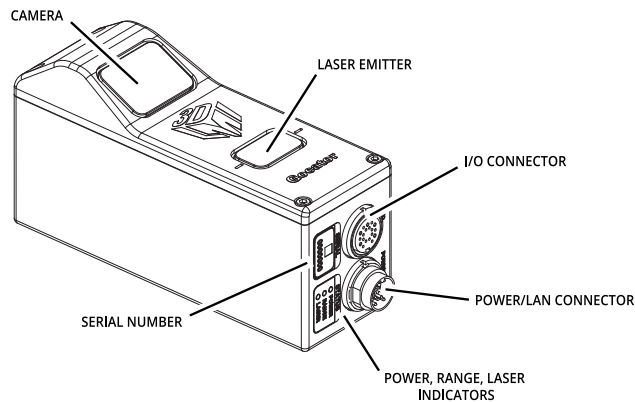
GOCATOR 2300 SERIES



# Hardware Overview

The following sections describe Gocator and its associated hardware.

## Gocator 2300 & 2880 Sensor



Gocator 2330

| 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.                                                         |

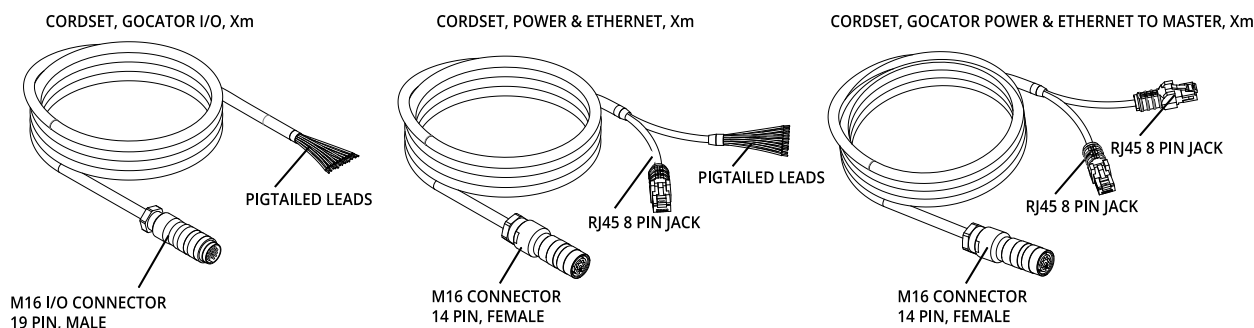
## Gocator 2300 & 2880 Cordsets

Gocator 2300 and 2880 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 400/800/1200/2400.

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



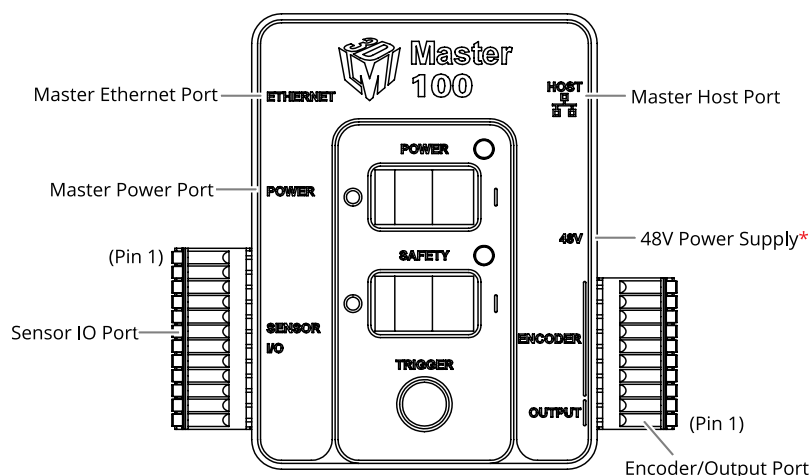


The maximum cordset length is 60 m. See *Gocator 2300 & 2880 I/O Connector* (page 369) and for pinout details.

See *Parts and Accessories* (page 382) 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 the Gocator 2300 series for standalone system setup.

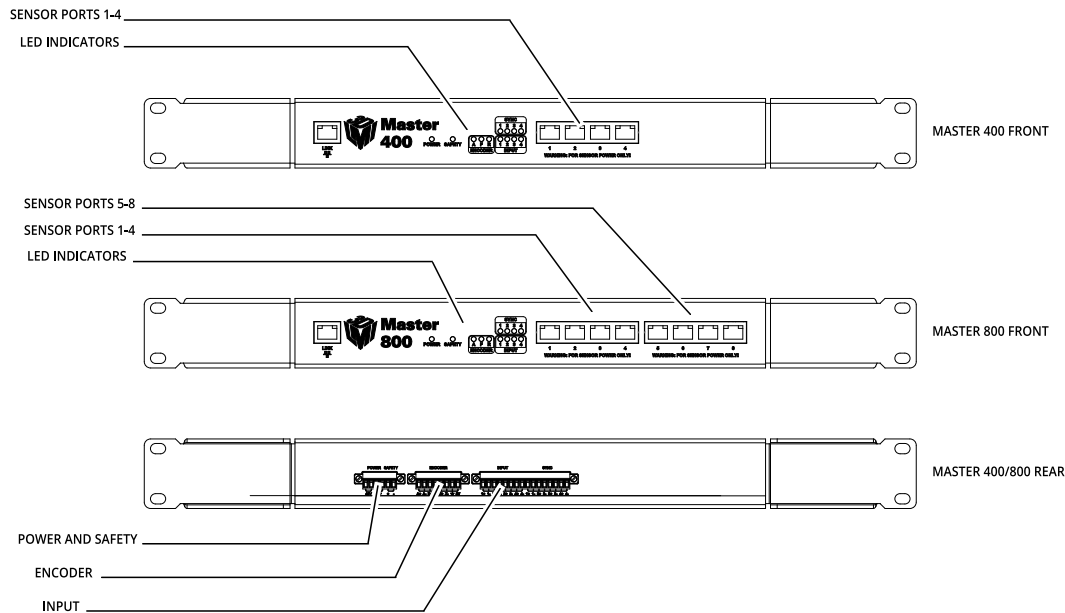


| Item                 | Description                                                                                                                           |
|----------------------|---------------------------------------------------------------------------------------------------------------------------------------|
| 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* (page 374) for pinout details.

## Master 400/800

The Master 400 and the Master 800 allow you to connect more than two sensors. The Master 400 accepts four sensors, and the Master 800 accepts eight sensors.

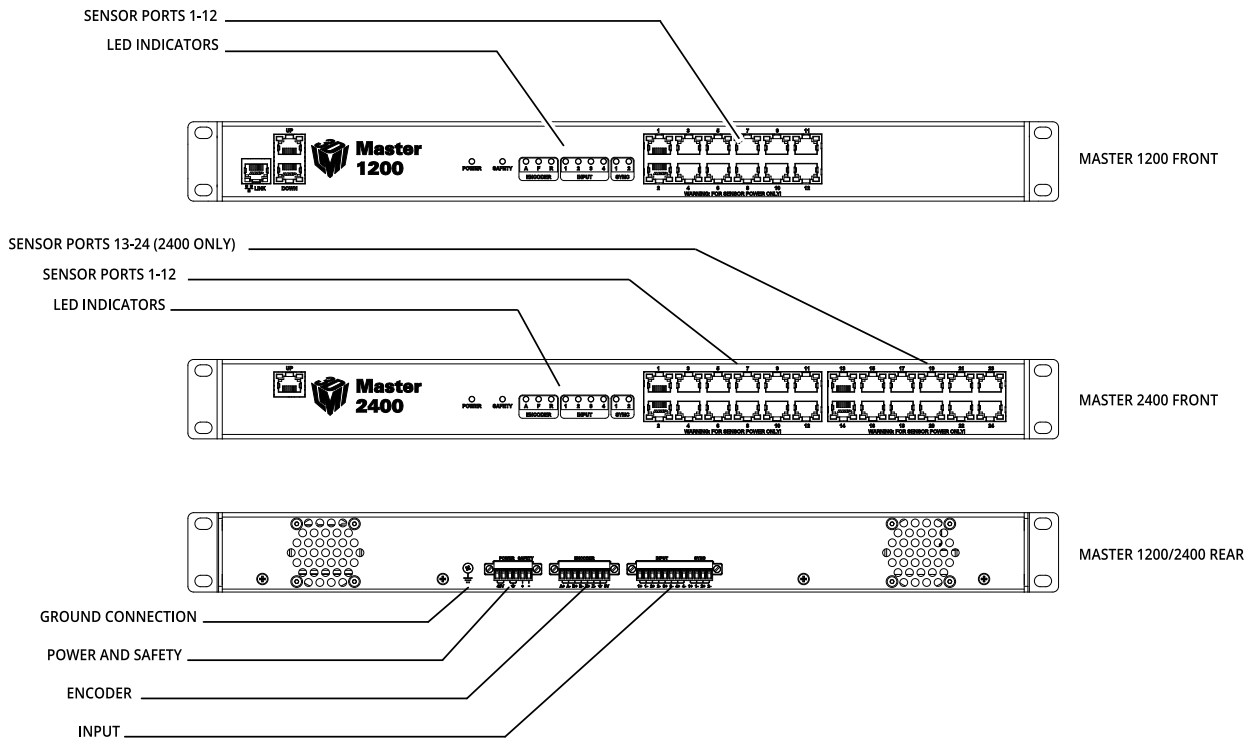


| Item              | Description                                                         |
|-------------------|---------------------------------------------------------------------|
| Sensor Ports      | Master connection for Gocator sensors (no specific order required). |
| Ground Connection | Earth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

See *Master 400/800* (page 376) for pinout details.

## Master 1200/2400

The Master 1200 and the Master 2400 allow you to connect more than two sensors. The Master 1200 accepts twelve sensors, and the Master 2400 accepts twenty-four sensors.



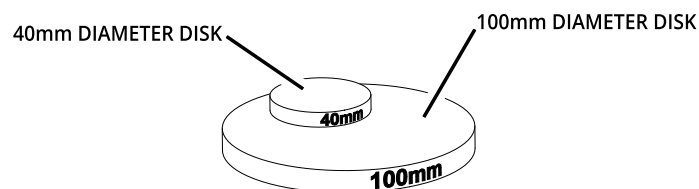
| Item              | Description                                                         |
|-------------------|---------------------------------------------------------------------|
| Sensor Ports      | Master connection for Gocator sensors (no specific order required). |
| Ground Connection | Earth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

See *Master 1200/2400* (page 379) for pinout details.

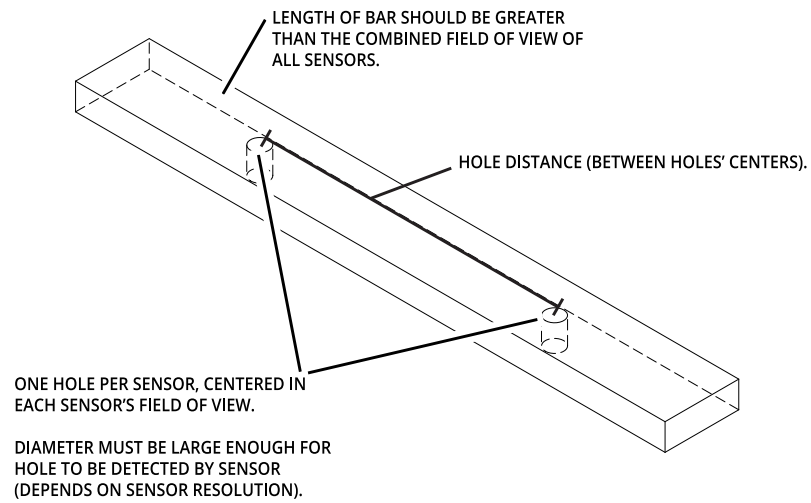
## Calibration Targets

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 *Parts and Accessories* (page 382) for disk part numbers.



For wide, 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* (page 84) for more information on alignment.

# Installation

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

## 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.

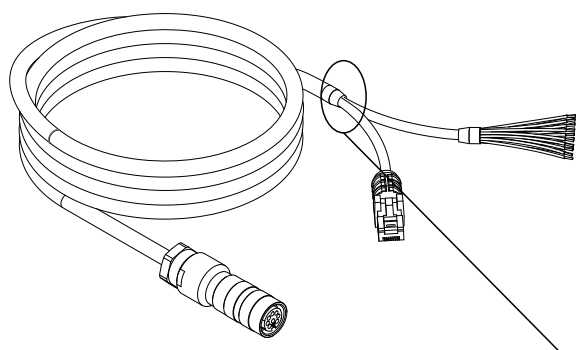


The frame or electrical cabinet that the Gocator is mounted to must be connected to earth ground.

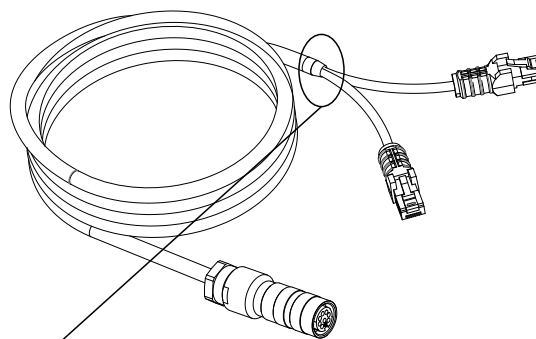
## Recommended Grounding Practices - Cordsets

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



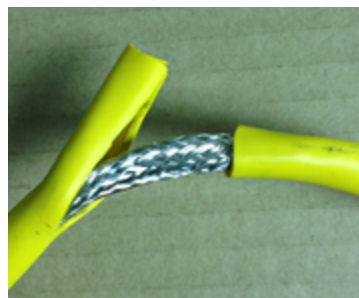
CORDSET, GOCATOR POWER & ETHERNET TO MASTER, Xm



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.



## Grounding - Master 400/800/1200/2400

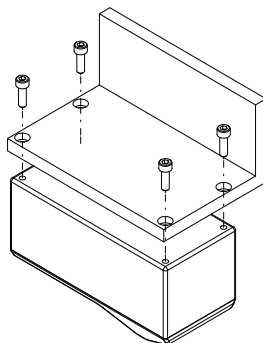
The mounting brackets of all Masters have been designed to provide adequate grounding through the use of star washers. Always check grounding with a multi-meter by ensuring electrical continuity between the mounting frame and RJ45 connectors on the front.



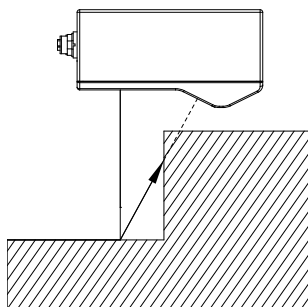
The frame or electrical cabinet that the Master is mounted to must be connected to earth ground.

## Mounting

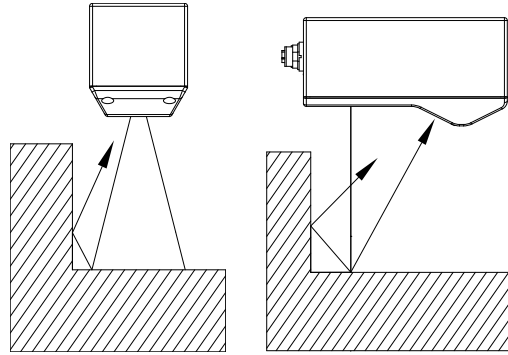
Sensors should be mounted using four or six (depending on the model) M5 x 0.8 pitch screws of suitable length. The recommended thread engagement into the housing is 8 - 10 mm. Proper care should be taken in order to ensure that the internal threads are not damaged from cross-threading or improper insertion 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.



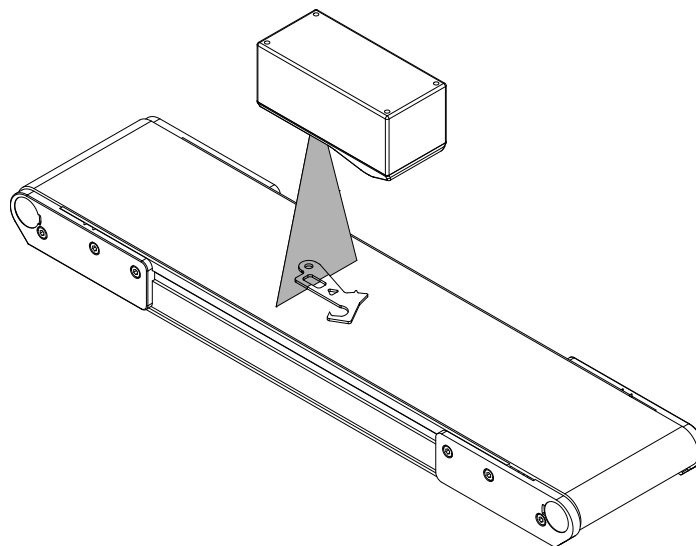
Gocator sensors are high-accuracy devices. The temperature of all of its components must be in equilibrium. When the sensor is powered up, a warm-up time of at least one hour is required to reach a consistent spread of temperature within the sensor.

## Orientations

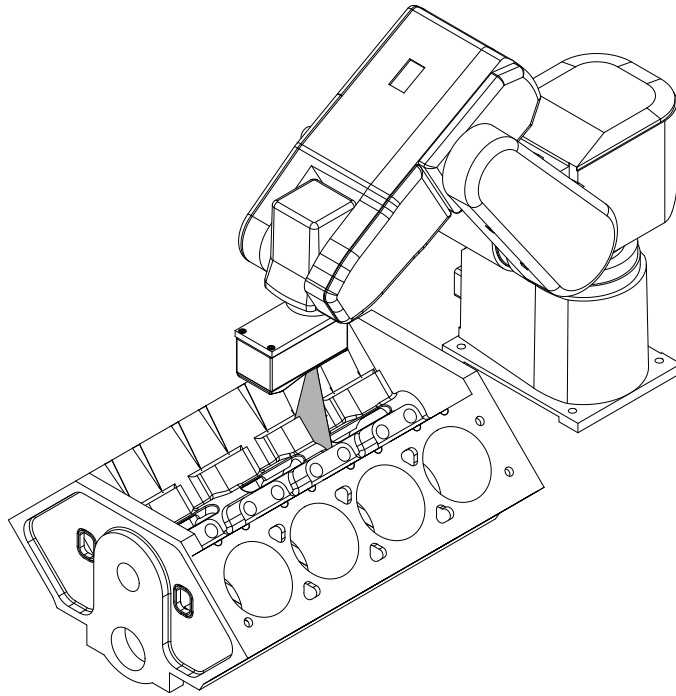
The examples below illustrate the possible mounting orientations for standalone and dual-sensor systems.

See *Dual-Sensor System Layout* (page 52) for more information on orientations.

### Standalone Orientations

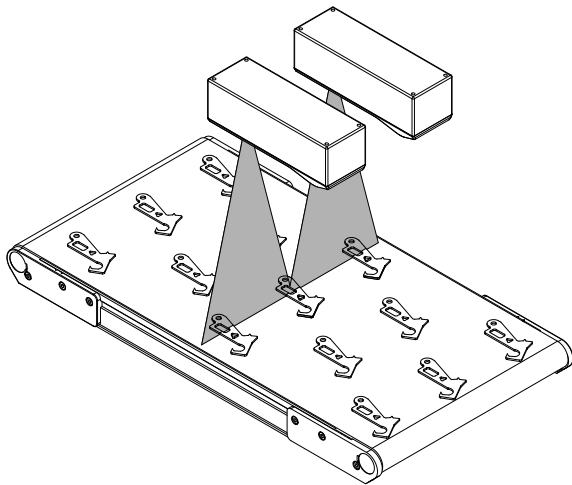


*Single sensor above conveyor*

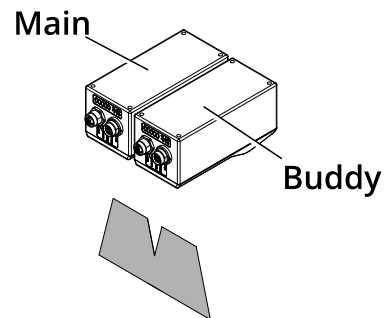


*Single sensor on robot arm*

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

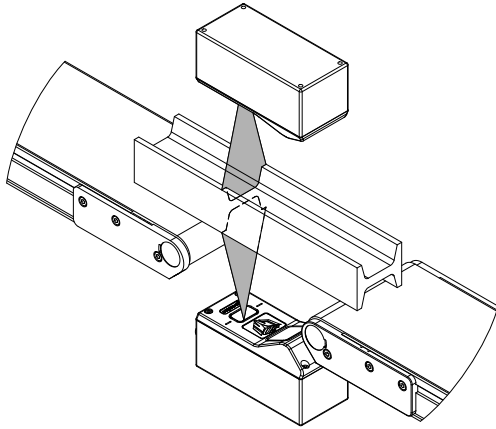


*Side-by-side for wide-area measurement (Wide)*

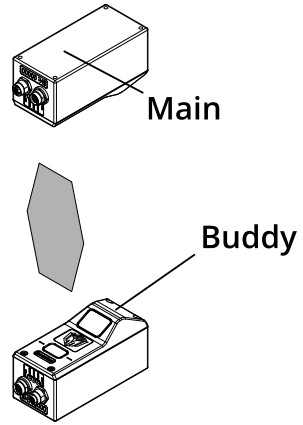


*Main must be on the left side (when looking into the connector) of the Buddy (Wide)*





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



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

# Network Setup

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

## Client Setup

Sensors are shipped with the following default network configuration:

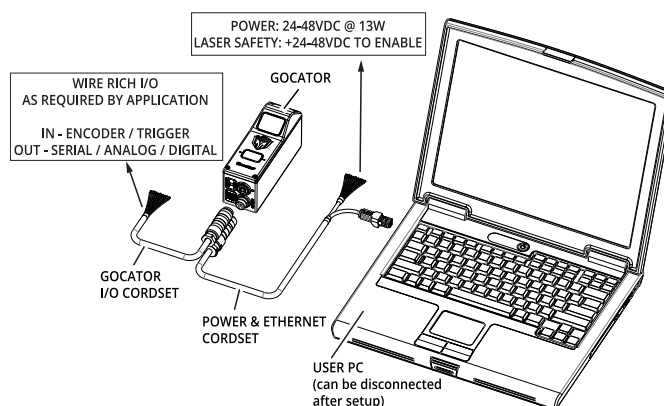
| Setting     | Default       |
|-------------|---------------|
| DHCP        | Disabled      |
| IP Address  | 192.168.1.10  |
| Subnet Mask | 255.255.255.0 |
| Gateway     | 0.0.0.0       |



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 *Running a Dual-Sensor System* (page 33) to assign each sensor a unique address.

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

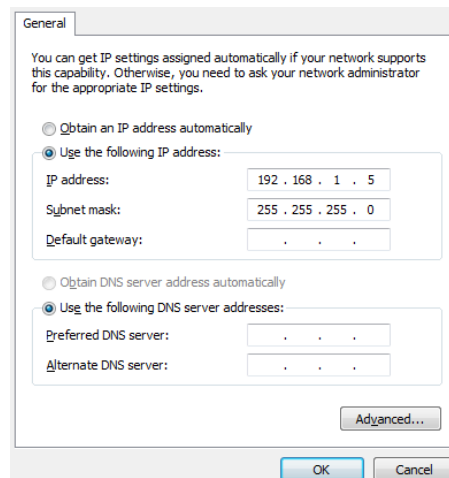
1. Connect cables and apply power.  
Sensor cabling is illustrated in *System Overview* (page 17).



2. Change the client PC's network settings.

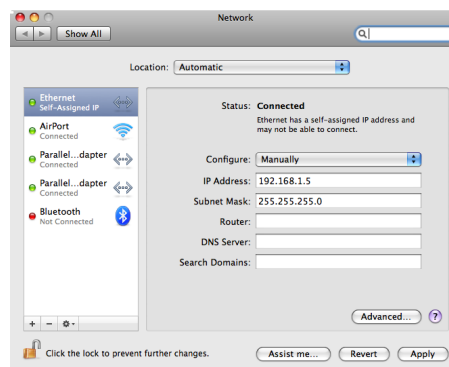
#### *Windows 7*

- 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* (page 345) if you experience any problems while attempting to establish a connection to the sensor.

## Gocator Setup

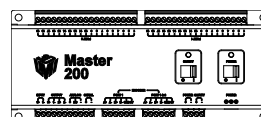
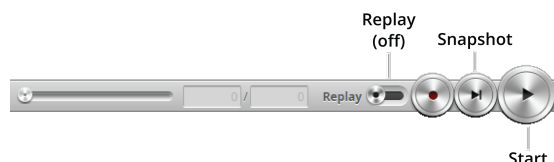
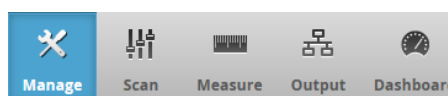
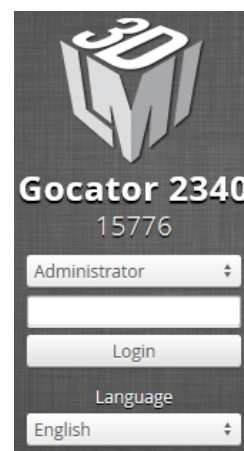
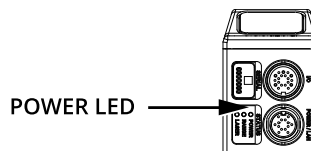
The Gocator is shipped with a default configuration that will produce laser profiles on most targets.

The following sections walk you through the steps required 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

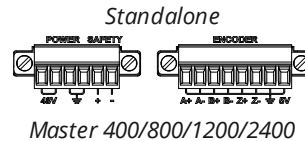
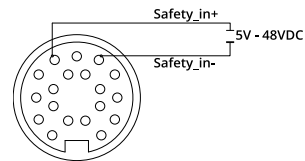
*To configure a standalone sensor system:*

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.
3. Log in as Administrator with no password.  
The interface display language can be changed using the language option. After selecting the language, the browser will refresh and the web interface will display in the selected language.
4. Go to the **Manage** page.
5. Ensure that **Replay** mode is off (the slider is set to the left).
6. Ensure that the Laser Safety Switch is enabled or the Laser Safety input is high.
7. Go to the **Scan** page.
8. Press the **Start** button or the **Snapshot** on the **Toolbar** to start the sensor.  
The **Start** button is used to run sensors continuously.

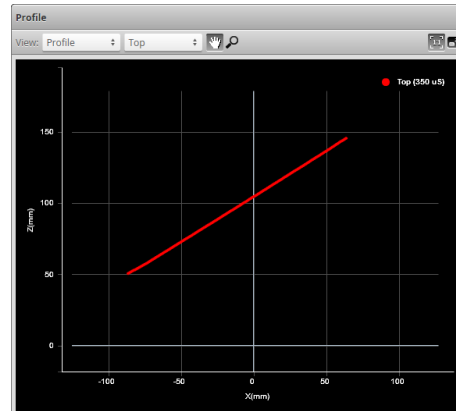


Master 200

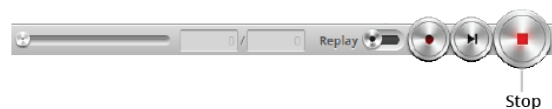
The **Snapshot** button is used to trigger the capture of a single profile.



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* (page 345).



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:*

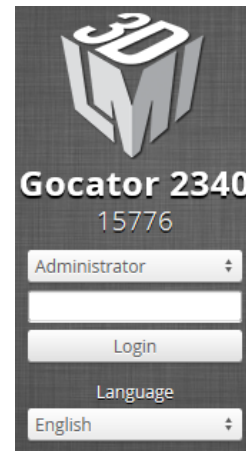
1. Turn off the sensors and unplug the Ethernet network connection of the Main sensor.  
All sensors are shipped with a default IP address of 192.168.1.10. Ethernet networks require a unique IP address for each device. Skip step 1 to 3 if the Buddy sensor's IP address is already set up with a unique 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



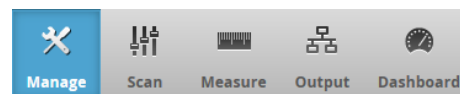
browser.

This will log into the Buddy sensor.

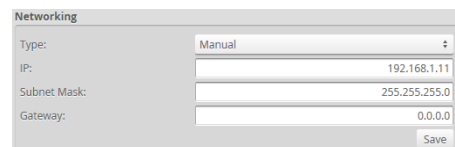
4. Log in as Administrator with no password.



5. Go to the **Manage** Page.



6. 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.



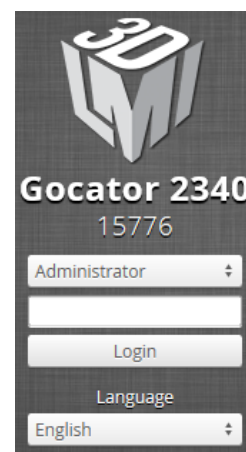
7. Turn off the sensors, re-connect the Main sensor's Ethernet connection and power-cycle the sensors.  
After changing network configuration, the sensors must be reset or power-cycled before the change will take effect.

8. Enter the sensor's IP address 192.168.1.10 in a web browser.

This will log into the Main sensor.



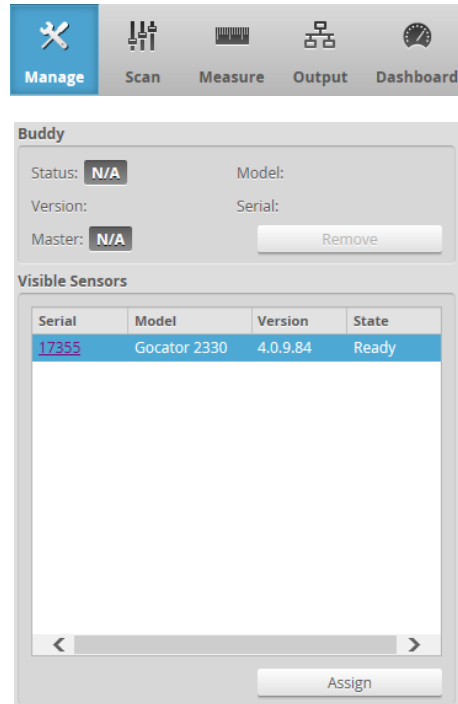
9. Log in as Administrator with no password.  
The interface display language can be changed using the language option. After selecting the language, the browser will refresh and the web interface will display in the selected language.



10. Select the **Manage** page.

11. 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.

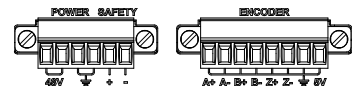


12. Select the Buddy sensor and click the **Assign** button.

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* (page 62) to upgrade the sensors.

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



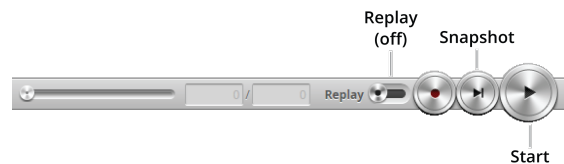
Master 400/800/1200/2400

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

15. Go to the the **Scan** page.

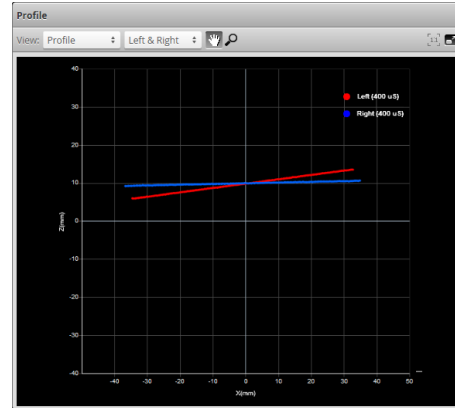
16. Press the **Start** or the **Snapshot** button on the **Toolbar** to start the sensors.

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

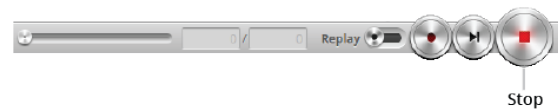


17. Move a target into the laser plane.

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* (page 345).



18. 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:

### System Management and Maintenance (page 50)

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

### Scan Setup and Alignment (page 64)

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

### Measurement (page 123)

Contains built-in measurement tools and their settings.

### Output (page 195)

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

### Dashboard (page 206)

Provides monitoring of measurement statistics and sensor health.

### Toolbar (page 43)

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



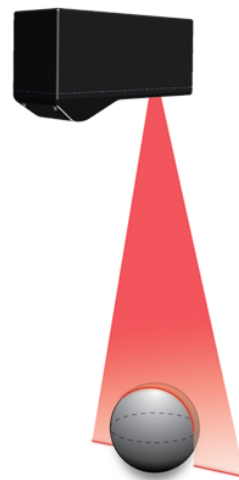
# Theory of Operation

The following sections describe the theory of operation of Gocator sensors.

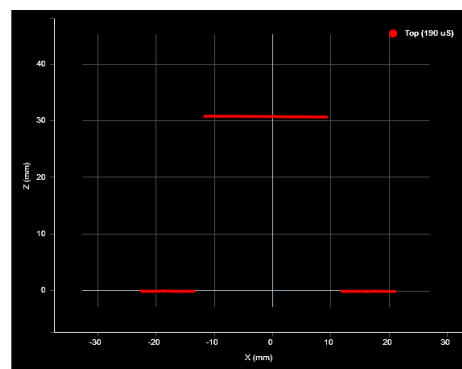
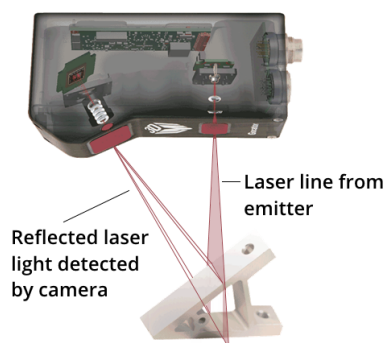
## 3D Acquisition

### Principle of 3D Acquisition

The Gocator 2300 series sensors are line profiler sensors, meaning that they capture a single 3D profile for each camera exposure. The sensor projects a laser line onto the target. The sensor's camera views the laser from an angle, and captures the reflection of the light off the target. Because of this triangulation angle, the laser line appears in different positions on the camera depending on the 3D shape of the target. Gocator sensors are always pre-calibrated to deliver 3D data in engineering units throughout the specified measurement range.



Target objects are typically moved under the sensor on a transportation mechanism, such as a conveyor belt. The sensor captures a series of 3D slices, building up the 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.



Resulting laser profile

## Resolution and Accuracy

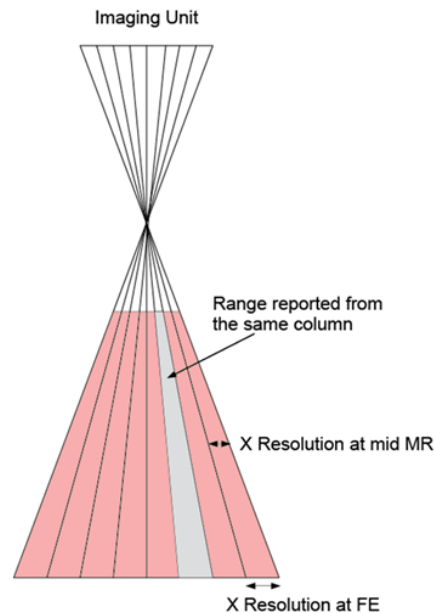
### X Resolution

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

Since the FOV is trapezoidal, 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 how accurately the width of a target can be measured.

NOTE: 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.

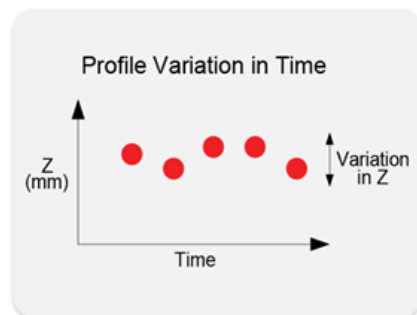


### Z Resolution

Z resolution is the variability of the height measurement, in each individual 3D point, with the target at a fixed position. This variability is caused by camera imager and sensor electronics.

Like X resolution, the Z resolution is better at the close range and worse at the far range. This is reflected in the Gocator data sheet as the two numbers quoted for Z resolution.

Z Resolution gives an indication of the smallest detectable height difference.

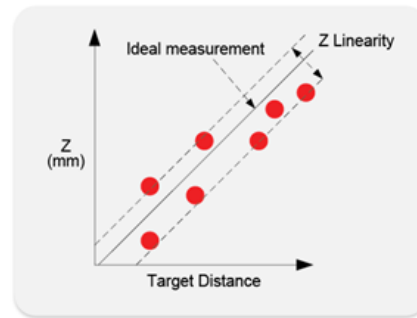


## Z Linearity

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

Z Linearity gives an indication of the sensor's ability to measure absolute distance



# Profile Output

Gocator measures the height of the object calculated from laser triangulation. The Gocator reports a series of ranges along the laser line, with each range representing the distance from the sensor's origin plane. Each range contains a height and a position 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

Before alignment, individual sensors use the coordinate system shown here.

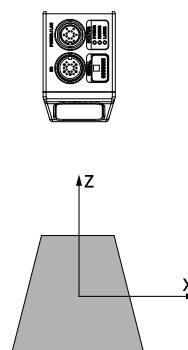
The Z axis represents the sensor's measurement range (MR), with the values increasing towards the sensor.

The X axis represents the sensor's field of view (FOV).

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).

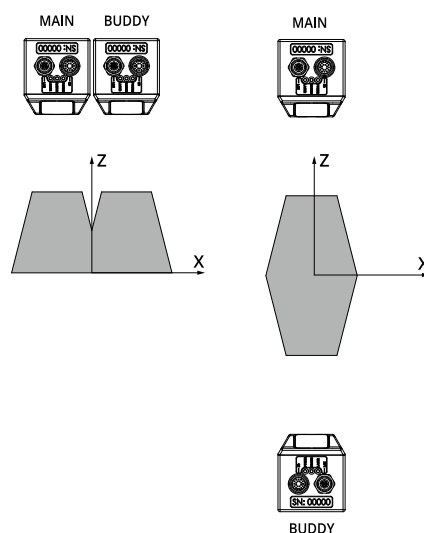


### System Coordinates

Alignment is used with a single sensor to compensate for mounting misalignment and to set a zero reference, such as a conveyor belt surface. Alignment is also used to set a common coordinate system for dual-sensor systems. In both cases, alignment determines the adjustments to X, Z, and tilt (rotation in the X-Z plane) needed to align sensor data. The adjustments resulting from alignment are called transformations. See *Alignment* (page 82) for more information on alignment.

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. Similar to the sensor coordinates, Y positions increase when the encoder increases.

For Wide and Opposite layouts, profiles and

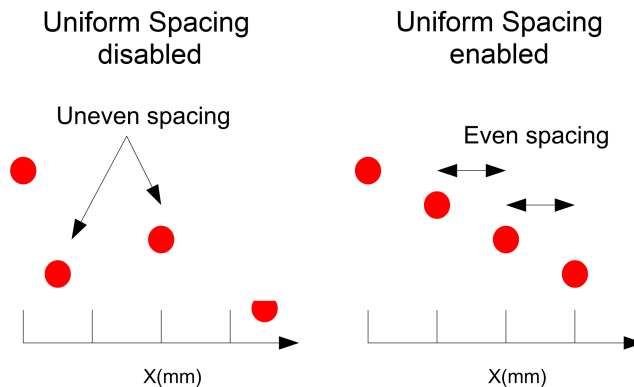


measurements from the Main and Buddy sensors are expressed in a unified coordinate system. Isolated layouts express results using a separate coordinate system for each sensor.

## Resampled and Uniform Spacing Profile Format

Profile 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.

With uniform spacing 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.



As a result, in the Ethernet data channel, only the range values (Z) are reported and the X positions can be reconstructed through the array index at the receiving end (the client).

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.

In contrast, the profile format without uniform spacing set requires no processing on the sensor. Ranges are reported in (X, Z) coordinate pairs. This frees up processing resources in the Gocator, but usually requires more complicated processing on the client side.

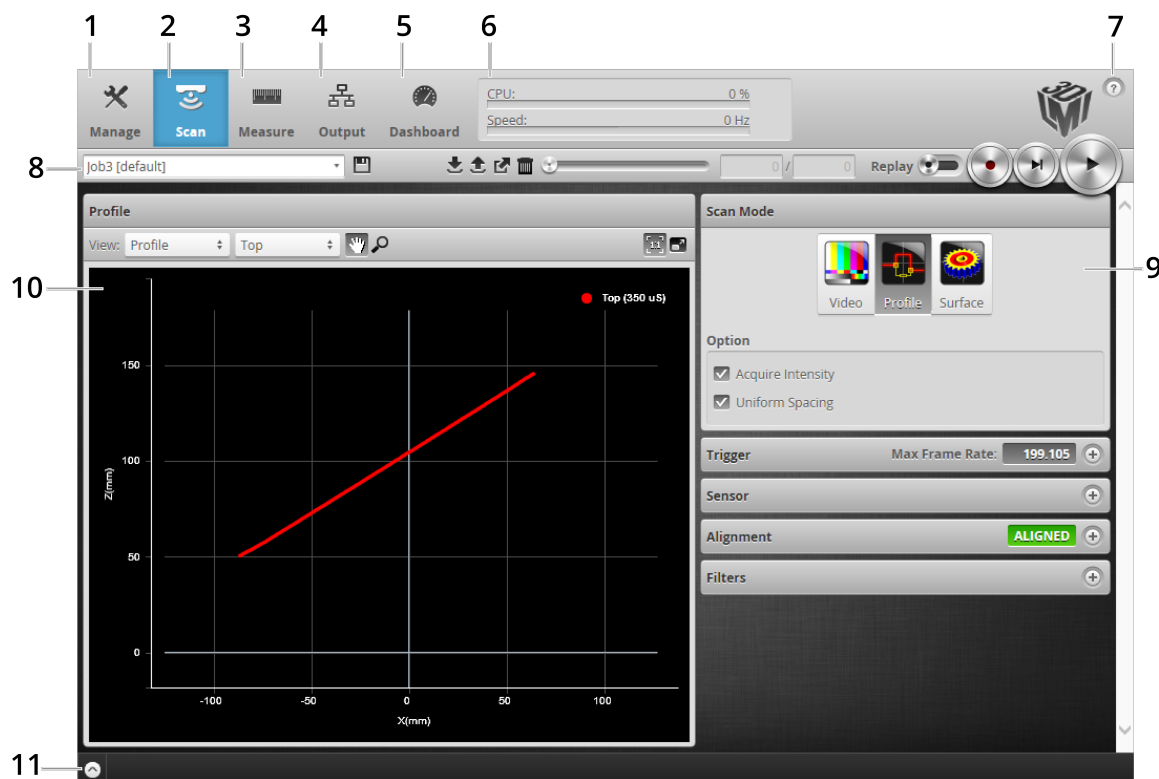
All built-in measurement tools in the Gocator operate on profiles with uniform spacing in both Profile and Surface mode.

# 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.



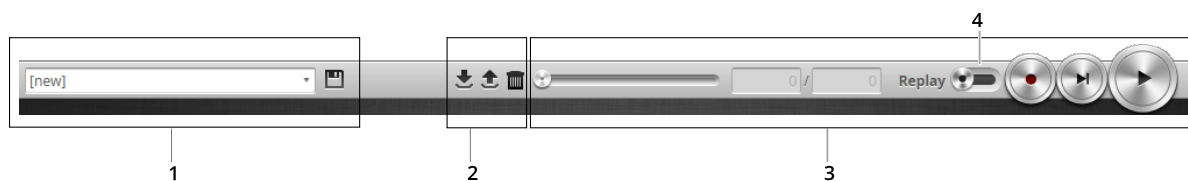
| Element        | Description                                                                                                                                                               |
|----------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 1 Manage page  | Contains settings for sensor system layout, network, motion and alignment, handling jobs, and sensor maintenance. See <i>System Management and Maintenance</i> (page 50). |
| 2 Scan page    | Contains settings for scan mode, trigger source, detailed sensor configuration, and performing alignment. See <i>Scan Setup and Alignment</i> (page 64).                  |
| 3 Measure page | Contains built-in measurement tools and their settings. See <i>Measurement</i> (page 123).                                                                                |

|    | Element            | Description                                                                                                                                                                                                        |
|----|--------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 4  | Output page        | Contains settings for configuring output protocols used to communicate measurements to external devices. See <i>Output</i> (page 195).                                                                             |
| 5  | Dashboard page     | Provides monitoring of measurement statistics and sensor health. See <i>Dashboard</i> (page 206).                                                                                                                  |
| 6  | CPU Load and Speed | Provides important sensor performance metrics. See <i>Metrics Area</i> (page 48).                                                                                                                                  |
| 7  | Help               | Provides links to the user manual and SDK. Also lets you download support files from the sensor, which can be used with the emulator; See <i>Gocator Emulator</i> (page 209) for more information on the emulator. |
| 8  | Toolbar            | Controls sensor operation, manages jobs, 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 97 for its use when the <b>Scan</b> page is active and on page 124 for its use when the <b>Measure</b> page is active. |
| 11 | Log                | Displays messages from the sensor (errors, warnings, and other information). See <i>Log</i> (page 48).                                                                                                             |

## Common Elements

### Toolbar

The toolbar is used for performing common operations. This section explains how to use the toolbar to manage jobs and to operate the sensor.



|   | Element                           | Description                                                                                      |
|---|-----------------------------------|--------------------------------------------------------------------------------------------------|
| 1 | Job controls                      | For saving and loading different jobs.                                                           |
| 2 | Recorded data controls            | For downloading, uploading, and exporting recorded data.                                         |
| 3 | Sensor operation / replay control | Use the sensor operation controls to start sensors, enable recording, and control recorded data. |
| 4 | Replay switch                     | Toggles the sensor data source between live and replay.                                          |

## Saving and Loading Settings

When you change sensor settings using the Gocator web interface, 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                                                                                                                                                                                                                                                                                                                                                                                                             |
|-----------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 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.                                                                                                                                                                                                                                         |
| 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. |

The job drop-down list shows the list of 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 save a job:

1. Select a job in the job drop-down list.
  - If you are creating a new job, choose **[New]** in the job drop-down list and enter a name for the job.
  - If you are saving changes to an existing job, choose the job in the job drop-down list.
2. Press the **Enter** key or click the **Save** button .  
The job will be 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 activate an existing job:

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

Detailed management of jobs is handled in the **Jobs** panel in the **Manage** page. See *Jobs* (page 57) for more information.



## Managing Multiple Settings

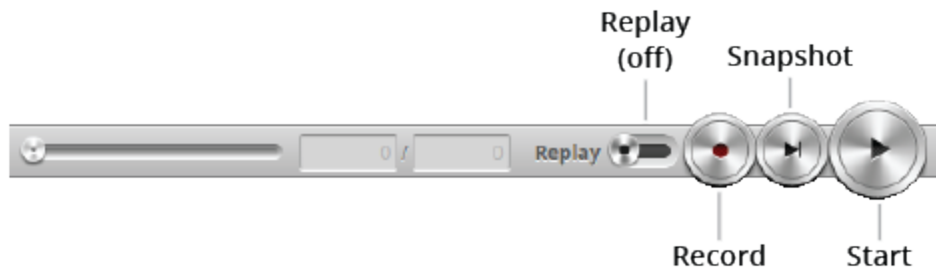
A Gocator can store several hundred jobs. Being able to switch between different jobs is useful when a Gocator is used with different constraints during separate production runs (for example, width decision constraints might be loose during one production run and tight during another depending on the desired grade of the part).

Switching active jobs can be done manually through the web interface as described under *To activate an existing job* in *Saving and Loading Settings (previous page)*. Switching active jobs can also be done programmatically using the supported industrial protocols (Modbus, EtherNet/IP, and ASCII), the Gocator's native Ethernet protocol, and through the SDK.

## Recording, Playback, and Measurement Simulation

Gocator sensors can record and replay data, and can 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 by using the toolbar controls.



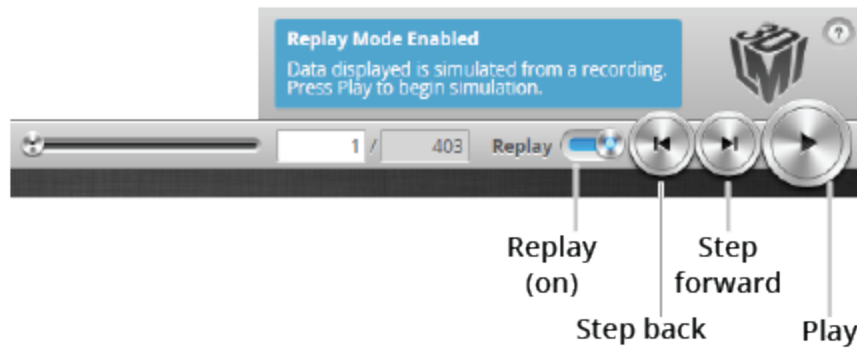
*Recording and playback controls when replay is off*

*To record live data:*

1. Toggle **Replay** mode off by setting the slider to the left in the **Toolbar**.
2. Press the **Record** button to enable recording.  
When replay is off and recording is enabled, the sensor will store the most recent data as it runs. Remember to disable recording if you no longer wish to record live data (press the **Record** button again to disable recording).
3. Press the **Snapshot** button or **Start** button.  
The **Snapshot** 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.



*Recording and playback controls when replay is on*

#### *To replay recorded data:*

1. Toggle **Replay** mode on by setting the slider to the right in the **Toolbar**.  
The slider's background will turn blue and a Replay Mode Enabled message will be 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 the current replay location backward and forward by a single frame, respectively.  
The **Play** button advances the replay location continuously, animating the playback.  
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 recorded data:*

1. Toggle **Replay** mode on by setting the slider to the right in the **Toolbar**.  
The slider's background will turn blue and a Replay Mode Enabled message will be displayed.
2. Go to the **Measure** page.  
Modify settings for existing measurements, add new measurement tools, or delete measurement tools as desired.
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; see *Dashboard* (page 206).

#### *To clear recorded data:*

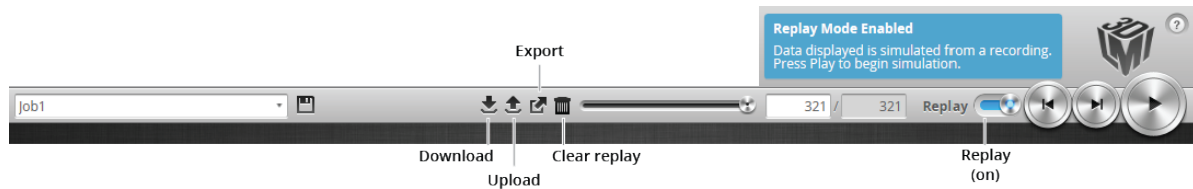
1. Stop the sensor if it is running by clicking on the **Stop** button.
2. Click on the **Clear Replay Data** button .

### **Downloading, Exporting, and Uploading Recorded Data**

Recorded data can be downloaded or exported to the client computer or uploaded to the Gocator. Export is often used for processing the recorded data using third-party tools. Recorded data can also be

downloaded in a binary format, which is used to back up the data for reviewing in the future.

 Recorded data is not saved or loaded when you save or activate jobs in the toolbar.



#### *To download recorded data:*

1. Toggle **Replay** mode on by setting the slider to the right in the **Toolbar**.  
The slider's background will turn blue and a Replay Mode Enabled message will be displayed.
2. Click the **Download** button .

#### *To upload recorded data:*

1. Toggle **Replay** mode on by setting the slider to the left in the **Toolbar**.  
The slider's background will turn blue and a Replay Mode Enabled message will be displayed.
2. Click the **Upload** button .
3. Select the directory and the file name to upload from the client computer and click on **OK**.

Recorded data can be exported using the CSV format. If **Acquire Intensity** has been enabled in the **Scan Mode** panel on the **Scan** page, intensity data will be included in the exported CSV file.



#### *To export recorded data to CSV:*

1. Toggle **Replay** mode on by setting the slider to the right in the **Toolbar**.  
The slider's background will turn blue and a Replay Mode Enabled message will be displayed.
2. Click the **Export** button  and select **Export Range 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; see *To replay recorded data in Recording, Playback, and Measurement Simulation (page 45)* for more information on playback.
3. Optionally, convert exported data to another format using the CSV Converter Tool.  
See *CSV Converter Tool (page 343)* for more information on this tool.

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.

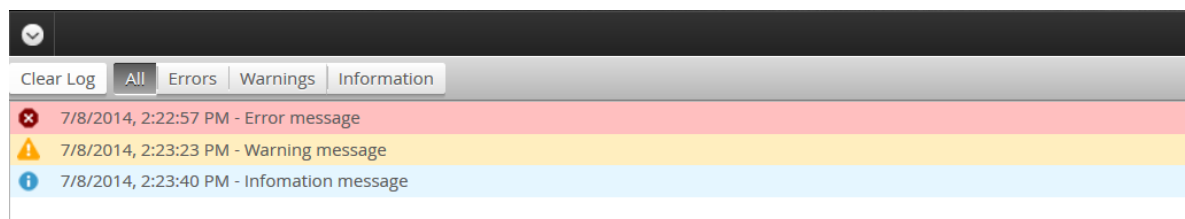


*To export recorded intensity data to BMP:*

1. Toggle **Replay** mode on by setting the slider to the right in the **Toolbar**.  
The slider's background will turn blue and a Replay Mode Enabled message will be displayed.
2. 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; see *To replay recorded data in Recording, Playback, and Measurement Simulation (page 45)* for more information on playback.

## 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.



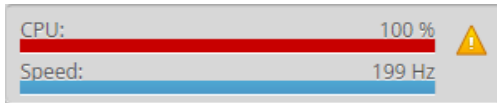
*To use the log:*

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.

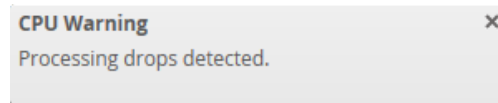
## Metrics Area

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%*



*CPU warning message*

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.

In both cases, a warning message will be temporarily displayed in the lower right corner of the web interface. Click on the warning symbol (⚠) to redisplay the warning message.

Open the log for details on the warning. See *Log* (previous page) for more information.

## 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 regions of interest. Depending on the selected operation mode (page 65), the data viewer can display video images, 3D profiles, or 3D surfaces. For details, see *Data Viewer* (page 97).

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* (page 124).



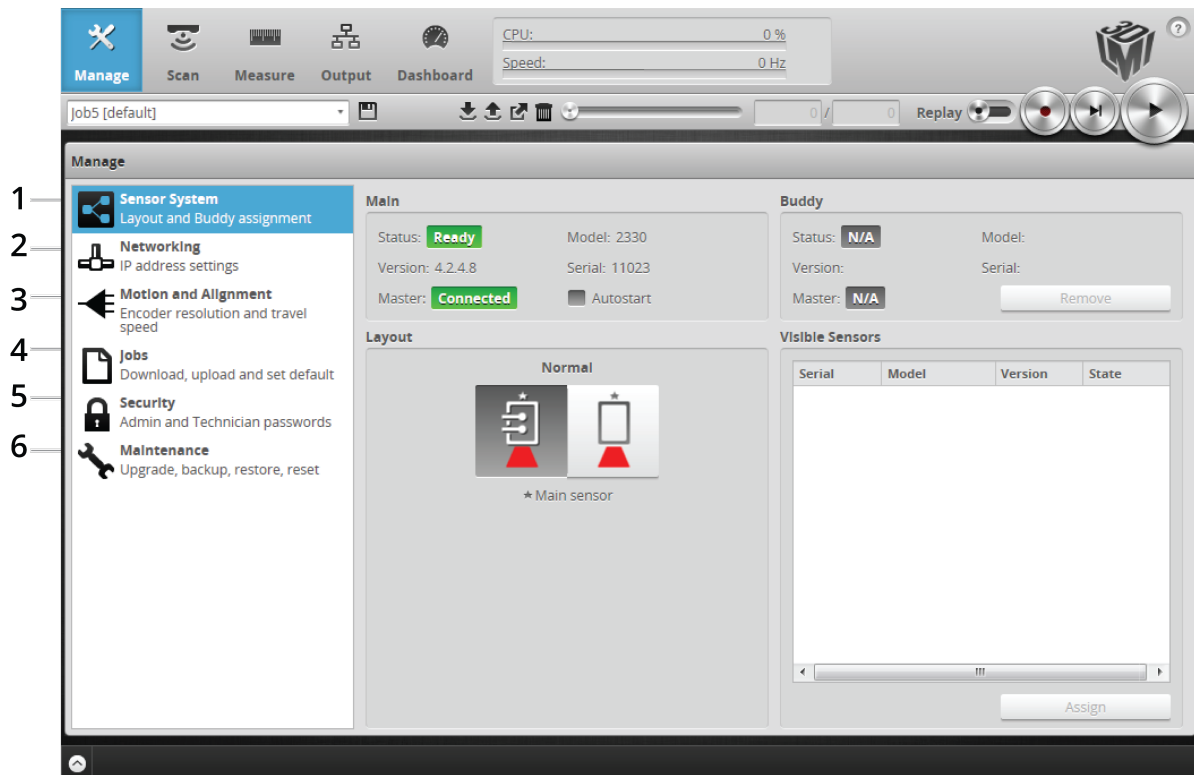
Because Gocator 2880 has two cameras, two profiles are displayed in the Gocator web interface.

# System Management and Maintenance

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

## Manage Page Overview

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

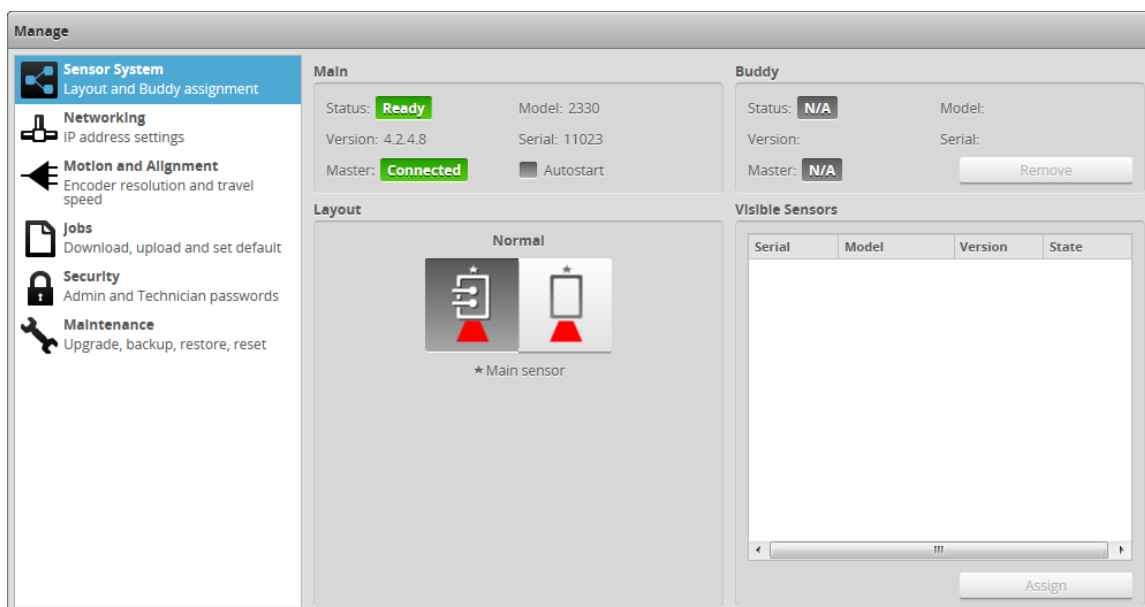


| Element                | Description                                                                                                    |
|------------------------|----------------------------------------------------------------------------------------------------------------|
| 1 Sensor System        | Contains settings for configuring sensor system and layout, and boot-up. See <i>Sensor System</i> (next page). |
| 2 Networking           | Contains settings for configuring the network. See <i>Networking</i> (page 54).                                |
| 3 Motion and Alignment | Contains settings to configure the encoder. See <i>Motion and Alignment</i> (page 55).                         |
| 4 Jobs                 | Lets you manage jobs stored on the sensor. See <i>Jobs</i> (page 56).                                          |

| Element | Description                                                                                                            |
|---------|------------------------------------------------------------------------------------------------------------------------|
|         | 57).                                                                                                                   |
| 5       | Security<br>Lets you change passwords. See <i>Security</i> (page 59).                                                  |
| 6       | Maintenance<br>Lets you upgrade firmware, create/restore backups, and reset sensors. See <i>Maintenance</i> (page 60). |

## Sensor System

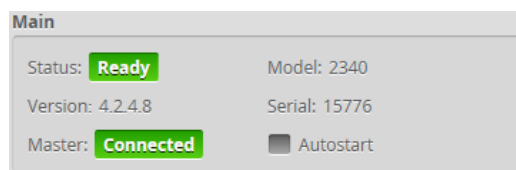
The following sections describe the **Sensor System** category on the **Manage** page. This category lets you choose the layout standalone or dual-sensor systems, and provides other system settings.



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

## 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.

## Dual-Sensor System Layout

Mounting orientations must be specified for a dual-sensor system. This information allows the alignment procedure to determine the correct system-wide coordinates for laser profiling and measurements. See *Coordinate Systems* (page 40) for more information on sensor and system coordinates.

### Supported Layouts

|  | Orientation                                                                                                                                                                                                        | Example |
|--|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---------|
|  | <b>Standalone</b><br>The sensor operates as an isolated device.                                                                                                                                                    |         |
|  | <b>Reverse</b><br>The sensor operates as an isolated device, but in a reverse orientation.                                                                                                                         |         |
|  | <b>Wide</b><br>Sensors are mounted in Left (Main) and Right (Buddy) positions for a larger combined field of view. Sensors may be angled to avoid occlusions.                                                      |         |
|  | <b>Reverse</b><br>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. |         |
|  | <b>Opposite</b><br>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.                         |         |



To specify the layout:

1. Go to the **Manage** page and click on the **Sensor System** category.
2. Select an assigned Buddy sensor in the **Visible Sensors** list.  
See *Buddy Assignment* (below) for information on assigning a Buddy Sensor.
3. Select a layout by clicking on one of the Layout buttons.  
See the table above for information on layouts.

## Buddy Assignment

In a dual-sensor system, the *Main* sensor assumes control of the *Buddy* sensor after the Buddy sensor is assigned to the Main sensor. Configuration for both sensors can be performed 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 outline 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.

**Buddy**

Status: **N/A**      Model:   
Version:      Serial:   
Master: **N/A**      **Remove**

**Visible Sensors**

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

**Assign**

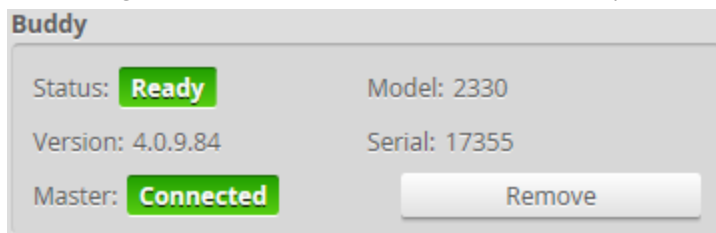
To assign a Buddy sensor:

1. Go to the **Manage** page and click on the **Sensor System** category.
2. Select a sensor in the **Visible Sensors** list.

3. Click the **Assign** button.

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. The **Assign** button will be greyed out if a sensor cannot be assigned as a Buddy.

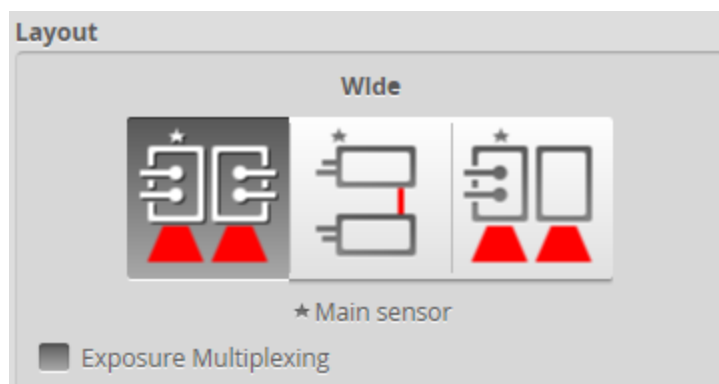
The Buddy sensor will be assigned to the Main sensor and its status will be updated in the **System** panel.



To remove a Buddy, click on the **Remove** button.

## Exposure Multiplexing

If the Main and Buddy sensors are mounted such that the camera from one sensor can detect the laser from the other sensor, the **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 the **Exposure Multiplexing** option may reduce the maximum frame rate.

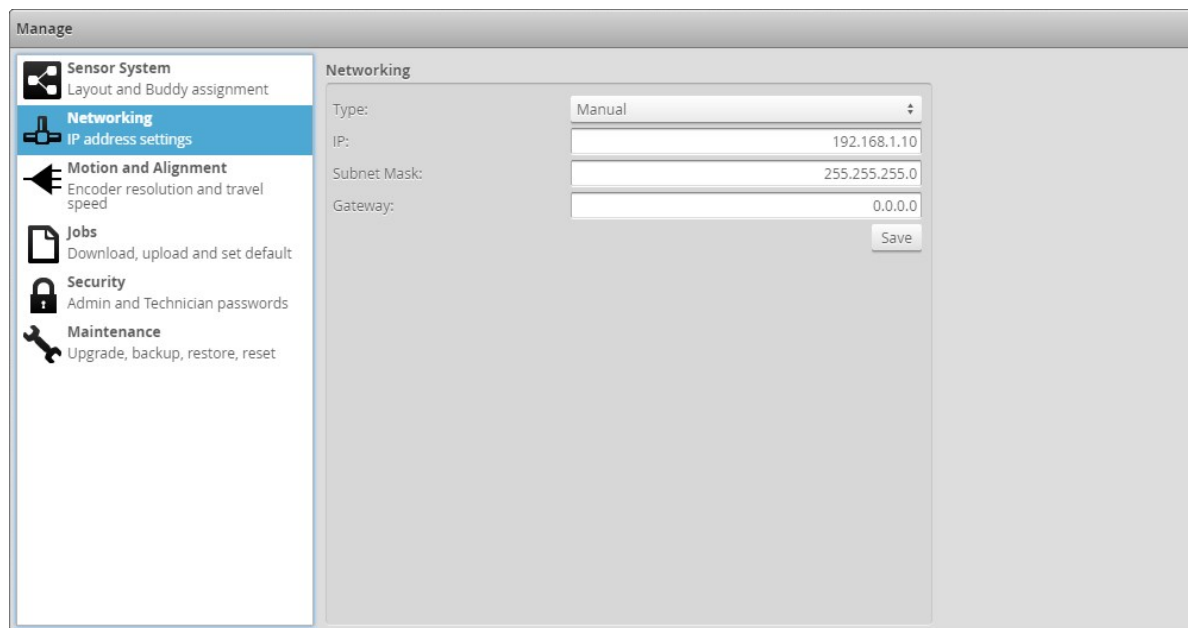


*To enable/disable exposure multiplexing:*

1. Go to the **Manage** page and click on the **Sensor System** category.
2. In the Layout section, check/uncheck the **Exposure Multiplexing** option.  
This option is only displayed if a buddy is assigned.

## 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.



*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.

**Manage**

- Sensor System**  
Layout and Buddy assignment
- 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

**Alignment**

Alignment Reference: Fixed

**Encoder**

Resolution: 1 mm/tick

Encoder Value: 0 ticks

Encoder Frequency: 0 Hz

**Speed**

Travel Speed: 100 mm/s

## Alignment Reference

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

**Alignment**

Alignment Reference: Fixed

| 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.

A configuration panel titled "Encoder" with three input fields. The first field is labeled "Resolution:" and contains the value "1" with the unit "mm/tick". The second field is labeled "Encoder Value:" and contains the value "0" with the unit "ticks". The third field is labeled "Encoder Frequency:" and contains the value "0" with the unit "Hz".

| Encoder            |           |
|--------------------|-----------|
| Resolution:        | 1 mm/tick |
| Encoder Value:     | 0 ticks   |
| Encoder Frequency: | 0 Hz      |

Encoder resolution is expressed in millimeters per tick.

*To configure encoder resolution:*

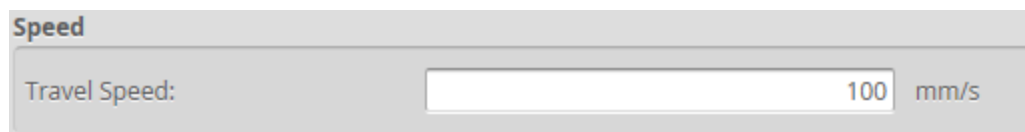
1. Go to the **Manage** page and click on the **Motion and Alignment** category.
2. In the **Encoder** section, enter a value in the **Resolution** field.

### 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.

A configuration panel titled "Speed" with one input field. The field is labeled "Travel Speed:" and contains the value "100" with the unit "mm/s".

| Speed         |          |
|---------------|----------|
| Travel Speed: | 100 mm/s |

Travel speed is expressed in millimeters per second.

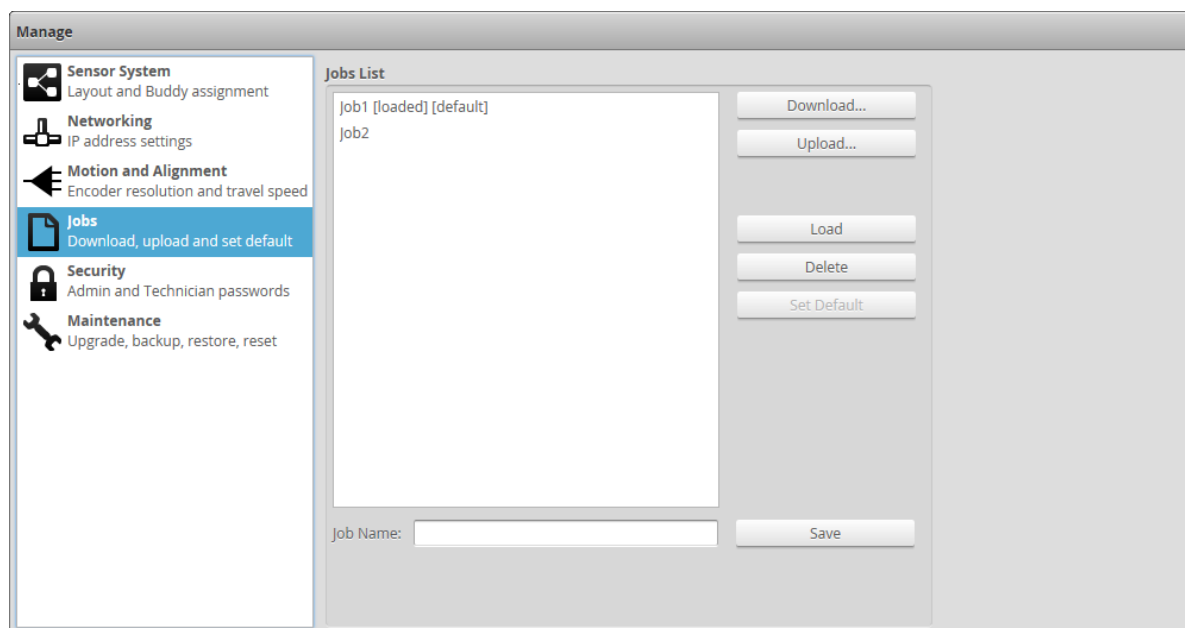
*To manually configure travel speed:*

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 page 84).

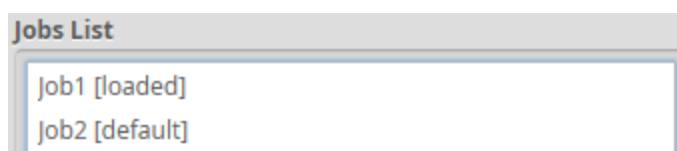
## Jobs

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

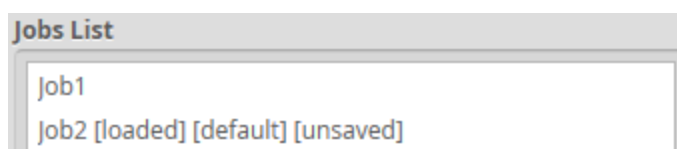


| Element               | Description                                                                                                                                 |
|-----------------------|---------------------------------------------------------------------------------------------------------------------------------------------|
| 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>Job Name</b> field.                                                              |
| Load button           | Loads the job that is selected in the file list. Reloading the current job discards any unsaved changes.                                    |
| Delete button         | Deletes the job that is selected in the jobs list.                                                                                          |
| Set as Default button | Sets the selected job as the default to be loaded at boot time. When the default job is selected, this button is used to clear the default. |
| Download... button    | Downloads the selected jobs to the client computer.                                                                                         |
| Upload... button      | Uploads a job from the client computer.                                                                                                     |

Jobs can be loaded 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 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.

*To save a job:*

1. Go to the **Manage** page and click on the **Jobs** category.
2. Provide a name in the **Job Name** field.  
To save an existing job under a different name, click on it in the **Jobs** list and then modify it in the **Job 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 the sensor is restarted.

## Security

Gocator sensors can be secured with passwords to prevent unauthorized access. Each sensor has two accounts: Administrator and Technician.

The screenshot shows the 'Manage' page interface. On the left is a sidebar with icons and labels for different system categories: 'Sensor System' (Layout and Buddy assignment), 'Networking' (IP address settings), 'Motion and Alignment' (Encoder resolution and travel speed), 'Jobs' (Download, upload and set default), 'Security' (Admin and Technician passwords), and 'Maintenance' (Upgrade, backup, restore, reset). The 'Security' category is currently selected and highlighted in blue. The main content area on the right is titled 'Administrator' and 'Technician' for password management. Each section contains a 'Password:' field, a 'Confirm Password:' field, and a 'Change Password' button.

### 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. By default, passwords are blank (empty).

*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.

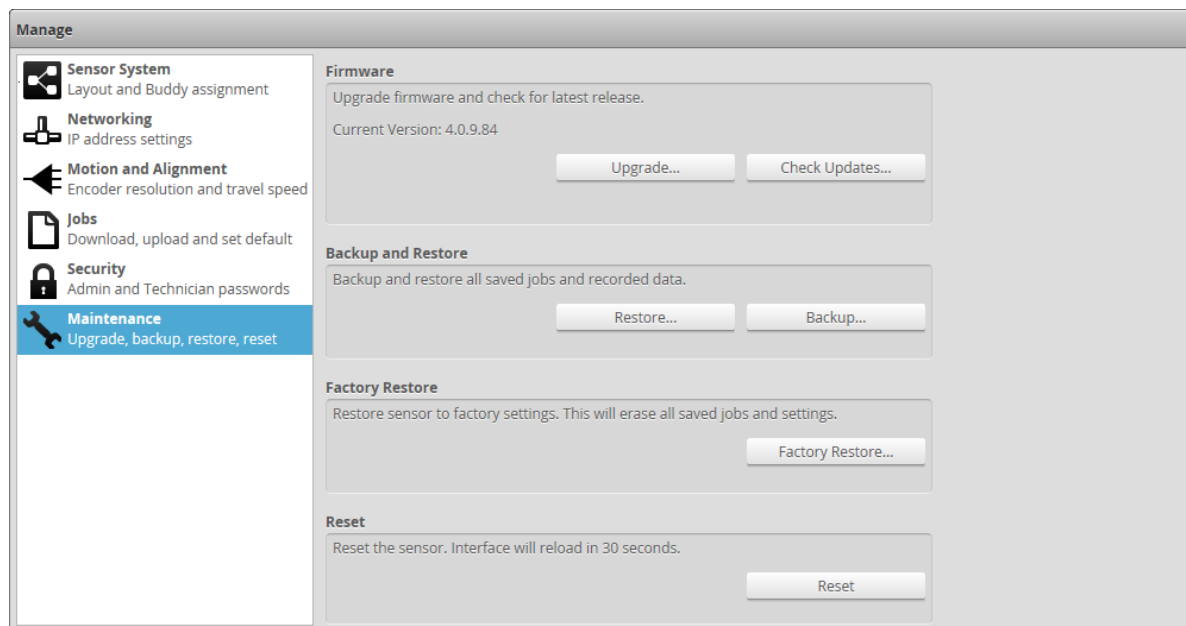
If the administrator or technician password is misplaced, the sensor can be recovered using a special software tool. See *Sensor Recovery Tool* (page 336) for more information.

## 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.





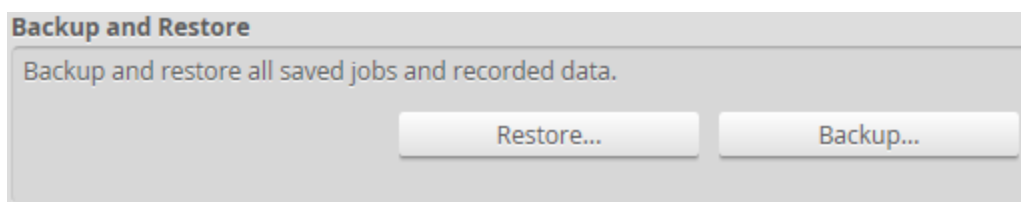
## Sensor Backups and Factory Reset

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.

### Factory Restore

Restore sensor to factory settings. This will erase all saved jobs and settings.

Factory Restore...

*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.

### Firmware

Upgrade firmware and check for latest release.

Current Version: 4.0.9.84

Upgrade...

Check Updates...

*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. Provide the location of the firmware file in the **File** dialog.
4. Wait for the upgrade to complete.

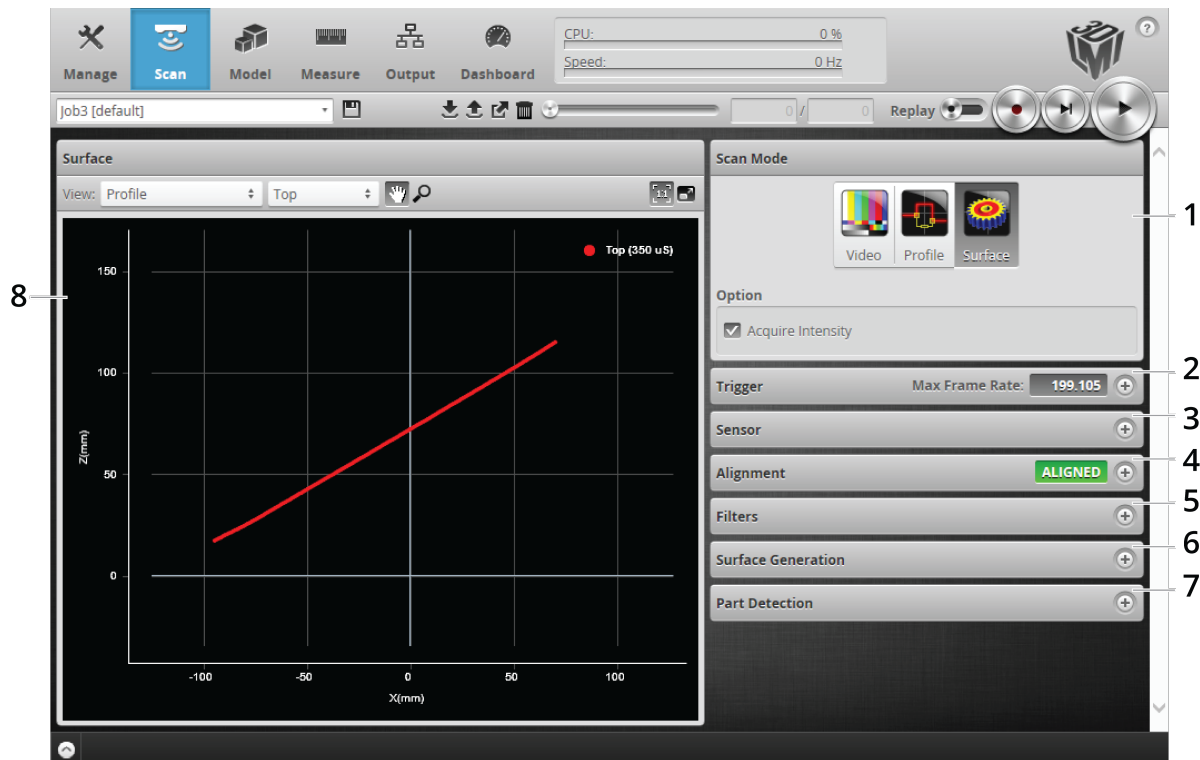
After the firmware upgrade is complete, the sensor will self-reset. If a buddy has been assigned, it will be upgraded and reset automatically.

# 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> (next page). |
| 2 Trigger panel            | Contains trigger source and trigger-related settings. See <i>Triggers</i> (page 66).                                           |
| 3 Sensor panel             | Contains settings for an individual sensor, such as active area or exposure. See <i>Sensor</i> (page 71).                      |
| 4 Alignment panel          | Used to perform alignment. See <i>Alignment</i> (page 82).                                                                     |
| 5 Filters panel            | Contains settings for post-processing of the profiles. See <i>Filters</i> (page 87).                                           |
| 6 Part Detection panel     | Used to set the part detection logic for sorting profiles into discrete objects. See <i>Part Detection</i> (page 93).          |
| 7 Surface Generation panel | Contains settings for surface generation. See <i>Surface Generation</i> (page 90).                                             |

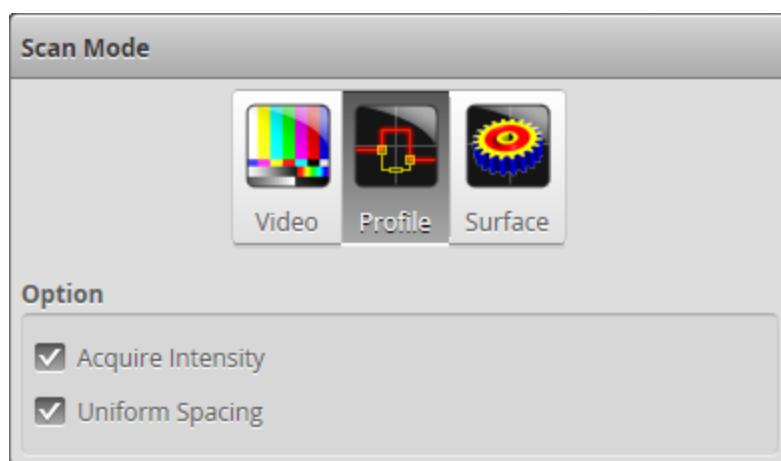
| Element       | Description                                                                                                                                                                                                   |
|---------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 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> (page 97). |

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 (next page)                                                           |
| Ensure that camera exposure is appropriate for laser profiling .                                                                               | Exposure (page 74)                                                             |
| Find the right balance between profile quality, speed, and CPU utilization.                                                                    | Active Area (page 71)<br>Exposure (page 74)<br>Gocator Device Files (page 214) |
| Specify mounting orientations for dual-sensor systems.                                                                                         | Dual-Sensor System Layout (page 52)                                            |
| 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 84)                                                     |
| Set up the part detection logic to create discrete objects from surfaces or profiles.                                                          | Part Detection (page 93)                                                       |
| Specify smoothing, gap-filling, and resampling parameters to remove effects of occlusions.                                                     | Filters (page 87)                                                              |

## 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 page 90). Part detection can be enabled on a surface to identify discrete parts (see page 93).                                                                                                                                                                                                                                                                                 |
| Uniform Spacing   | <p>When this option is enabled, ranges are resampled to a uniform spacing along the X axis (see page 41 for more information). The size of the spacing can be set in the <b>Spacing</b> tab (see page 80).</p> <p>When the option is disabled, the Gocator outputs unprocessed range data. Ranges are reported in (x,z) coordinate pairs. Disable this option to extract ranges from the Gocator at the highest possible rate. Post-profiling processing and measurements are disabled.</p> <p>This option is not available when in Surface mode.</p> |
| Acquire Intensity | When this option is enabled, an intensity value will be produced for each laser profile point.                                                                                                                                                                                                                                                                                                                                                                                                                                                        |

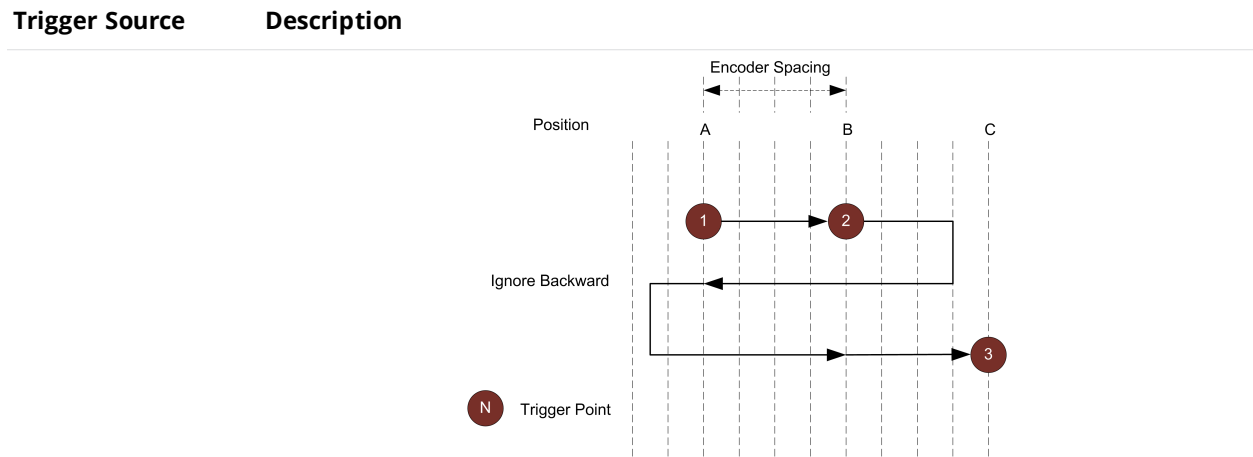
## Triggers

A trigger is an event that causes a 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.

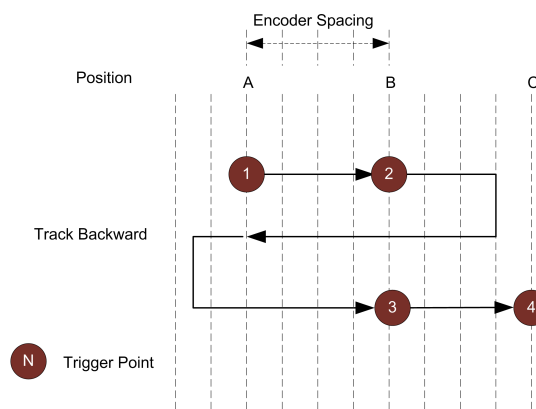
The laser and camera inside a sensor can be triggered by one of the following sources:

| 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.                                                                                                                                                                                                                                                                                                         |
| 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>Ignore 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, plus one encoder spacing, to trigger the next scan.</p> |



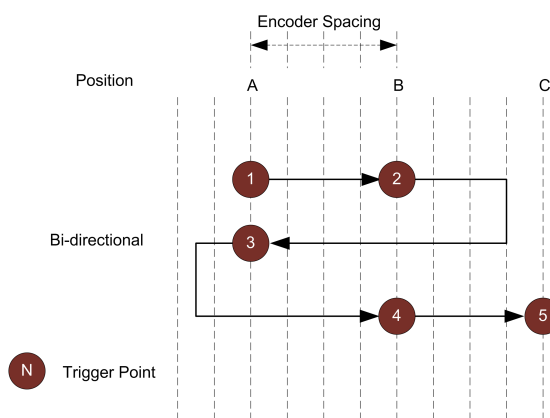
### Track Backward

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.



### Bi-directional

A scan is triggered when the target object moves forward or backward.



When triggers are received at a frequency higher than the maximum frame rate, some

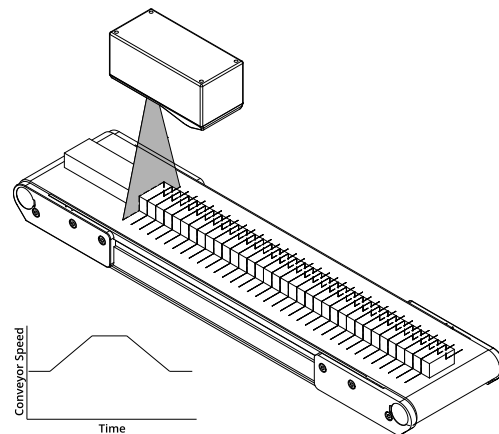
| Trigger Source | Description                                                                                                                                                                                                                                                                                                                                                                                                                                      |
|----------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
|                | <p>triggers may not be accepted. The <b>Trigger Drops Indicator</b> in the <b>Dashboard</b> can be used to check for this condition.</p> <p>The external input can be used to enable or disable the encoder triggers.</p> <p>See <i>Encoder Input</i> (page 371) for more information on connecting the encoder to Gocator sensors.</p>                                                                                                          |
| 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>See <i>Digital Inputs</i> (page 370) for more information on connecting external input to Gocator sensors.</p> |
| Software       | <p>A network command can be used to send a software trigger. See <i>Protocols</i> (page 265) for more information.</p>                                                                                                                                                                                                                                                                                                                           |

For examples of typical real-world scenarios, see below. For information on the settings used with each trigger source, see next page

## 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.

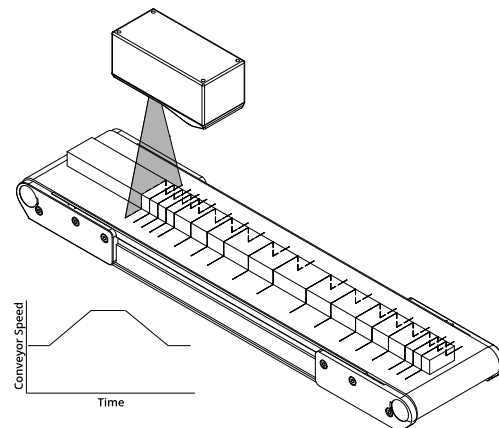


### Example: Time + Conveyor

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.

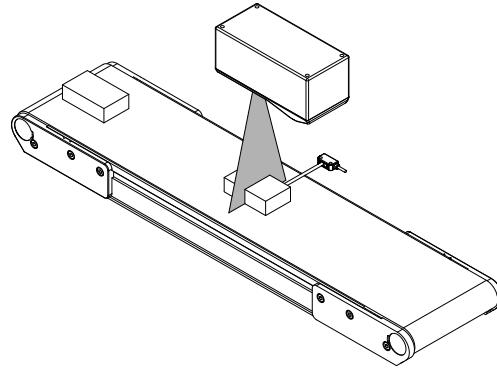
It is strongly recommended to use an encoder with transport-based systems due to the difficulty in maintaining constant transport velocity.





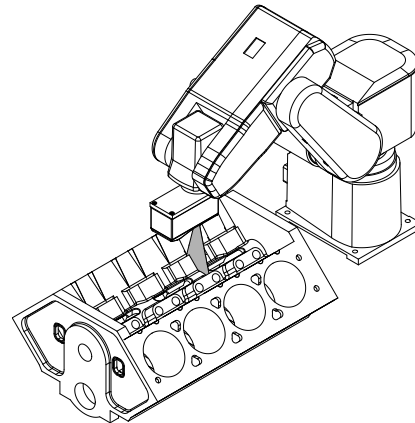
### Example: External Input + Conveyor

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 |

| Parameter              | Trigger Source           | Description<br>Software).                                                                                                                                                                                                                                                                                                                                                                                                                                                                 |
|------------------------|--------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 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            | <p>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.</p> <p>This setting is not displayed when <b>Surface Generation</b> is set to <b>Fixed Length</b>, <b>Variable Length</b>, or <b>Rotational</b> (see page 90).</p> <p>See <i>Digital Inputs</i> (page 370) for more information on connecting external input to Gocator sensors.</p> |
| 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> (page 66) 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           | <p>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.</p> <p>Trigger delay is only supported in single exposure mode; for details, see <i>Exposure</i> (page 74).</p>                                                                                              |



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 .

## Sensor

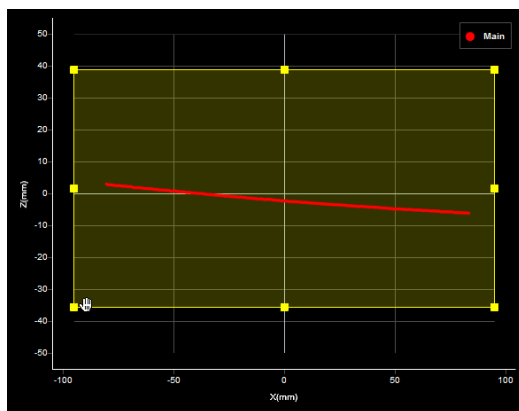
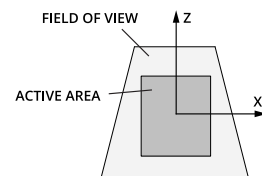
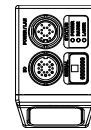
The following sections describe the settings that are configured in the **Sensor** panel on the **Scan** page.

### 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* (page 40) for more information on sensor and system coordinates.



|                    | Min | Value | Max    |
|--------------------|-----|-------|--------|
| X Field of View:   | 0   | 100   | 100 mm |
| Measurement Range: | 0   | 80    | 80 mm  |
| X Start:           | -50 | -50   | -50 mm |
| Z Start:           | -40 | -40   | -40 mm |

☐ Tracking Window

Transformation

*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 .

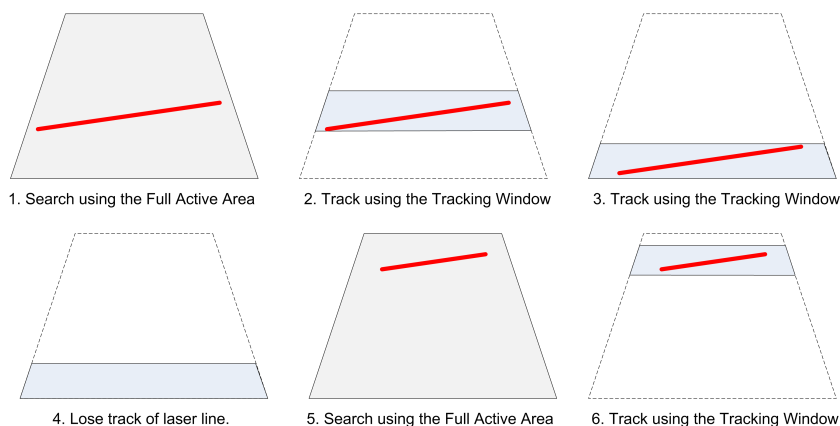


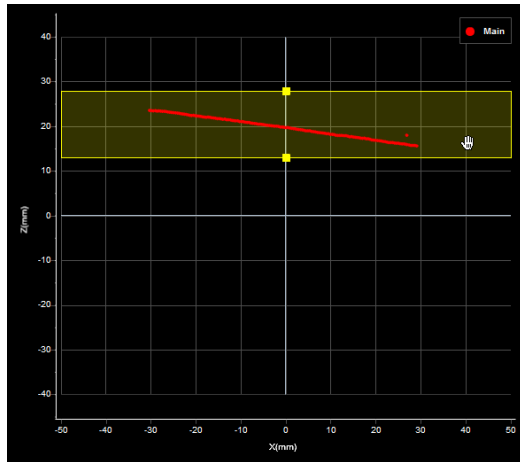
Laser profiling devices are usually more accurate at the near end of their measurement range. If your application requires a measurement range that is small compared to the maximum measurement range of the sensor, mount the sensor so that the active area can be defined at the near end of the measurement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

## Tracking Window

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 are used to control how profiles are converted from sensor coordinates to system coordinates.



| Parameter | Value  | Unit |
|-----------|--------|------|
| X Offset: | 1.638  | mm   |
| Z Offset: | 54.556 | mm   |
| Angle:    | -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:*

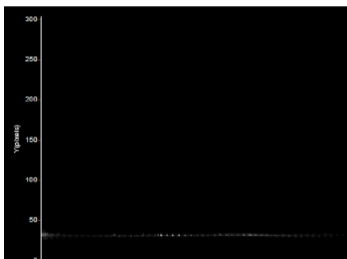
1. Go to the **Scan** page.
2. Choose Profile or Surface mode in the **Scan Mode** panel, depending on the type of measurement whose decision you need to configure.  
If one of these modes is not selected, tools will not be available in the **Measure** panel.
3. Expand the **Sensor** panel by clicking 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

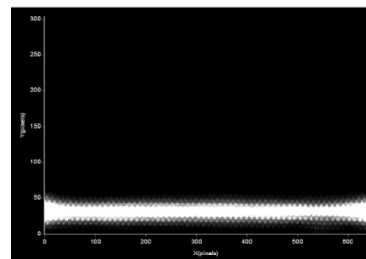
Exposure determines the duration of camera and laser on-time. Longer exposures can be helpful to detect laser signals on dark or distant surfaces, but increasing exposure time decreases the maximum speed. Different target surfaces may require different exposures for optimal results. Gocator sensors provide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

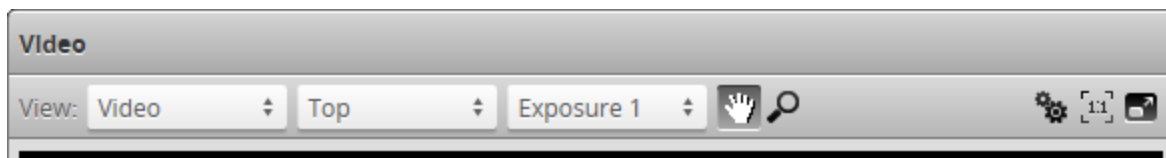


*Under exposure  
Laser line is not detected.  
Increase the exposure value.*



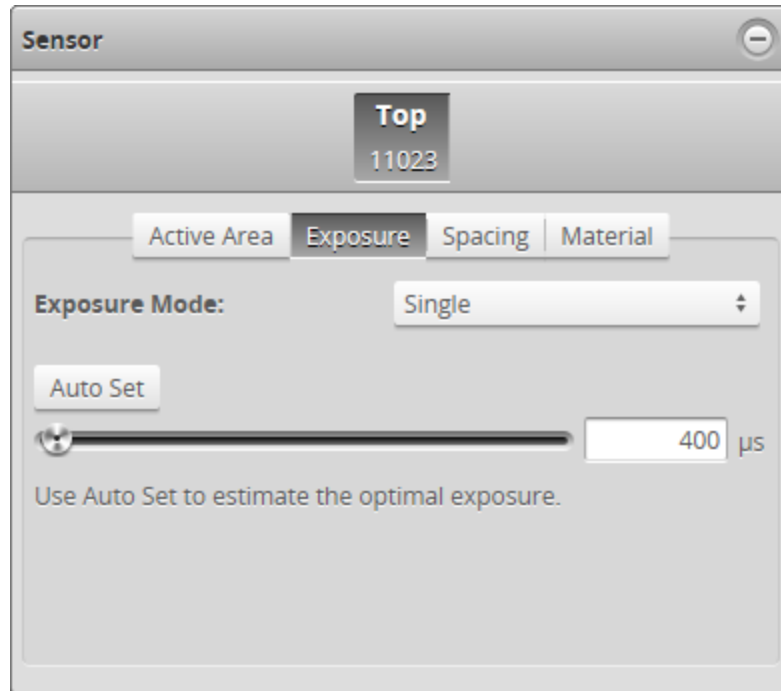
*Over exposure  
Laser line is too bright .  
Increase the exposure value.*

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.



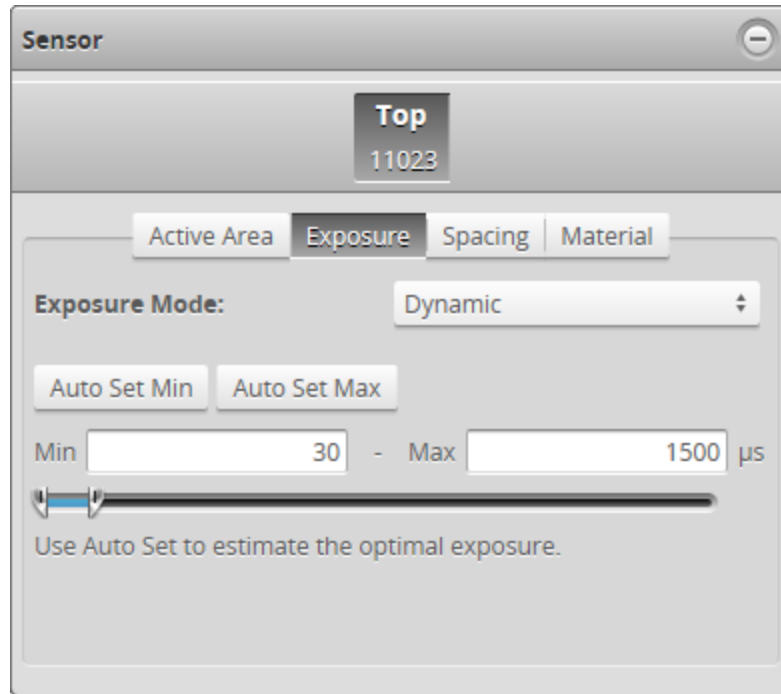
*To enable single exposure:*

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.
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 can be configured separately for each sensor.
5. Click on the **Exposure** tab.
6. Select **Single** from the **Exposure Mode** drop-down.
7. Edit the **Exposure** setting.  
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* (page 74) for details.

## Dynamic Exposure

The sensor automatically uses past profile information to adjust the exposure to yield the best profile. This is used when the target surface changes from scan to scan.





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 can be configured separately for each sensor.
4. Click on 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* (page 74) for details.

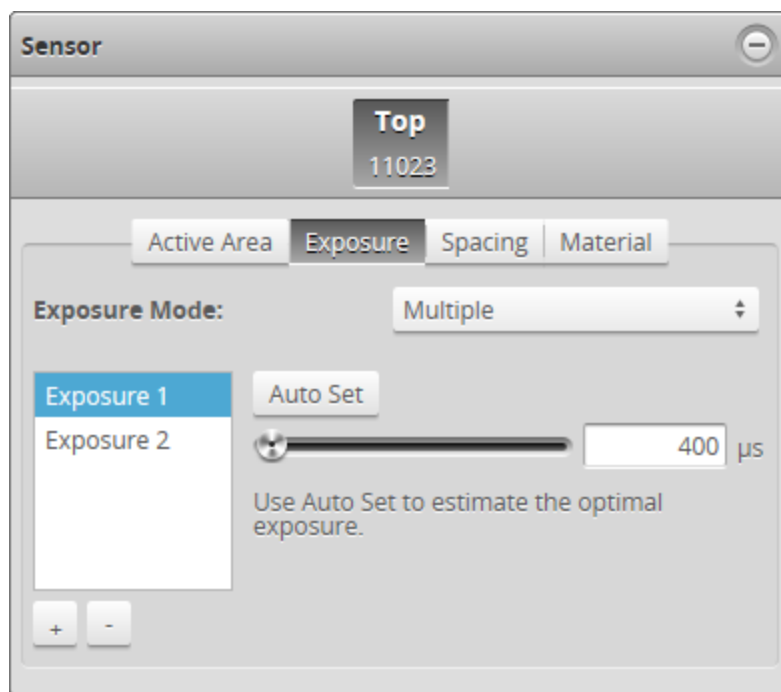
## Multiple Exposure

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 combing 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.



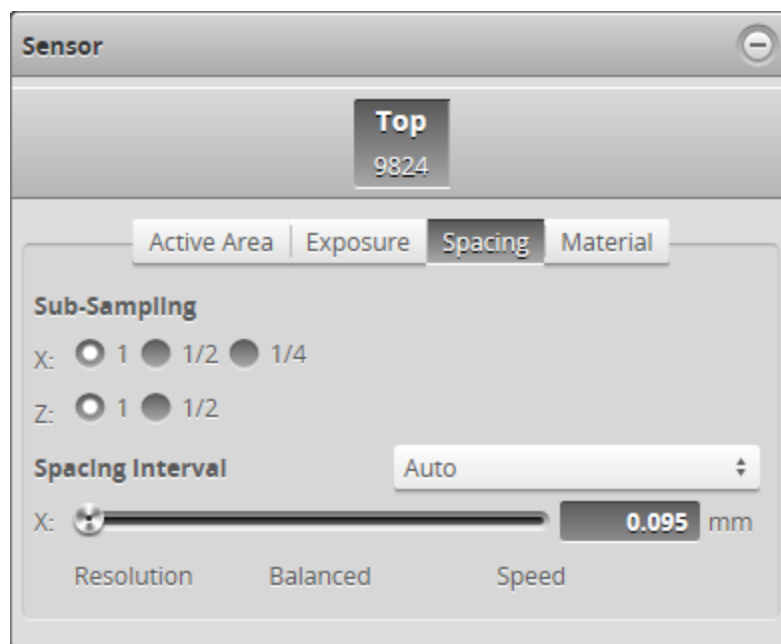
*To enable multiple exposure:*

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 can be configured separately for each sensor.
4. Click on 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.  
If **Acquire Intensity** is enabled, select the exposure step that is used to capture the intensity output.
8. If **Acquire Intensity** is enabled, select the exposure step that is used to capture the intensity output.

- 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* (page 74) 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 **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:*

- 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 can be configured separately for each sensor.
4. Click on 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 *Resampled and Uniform Spacing Profile Format* (page 41).



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 specified separately for each sensor.
5. Click on 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).

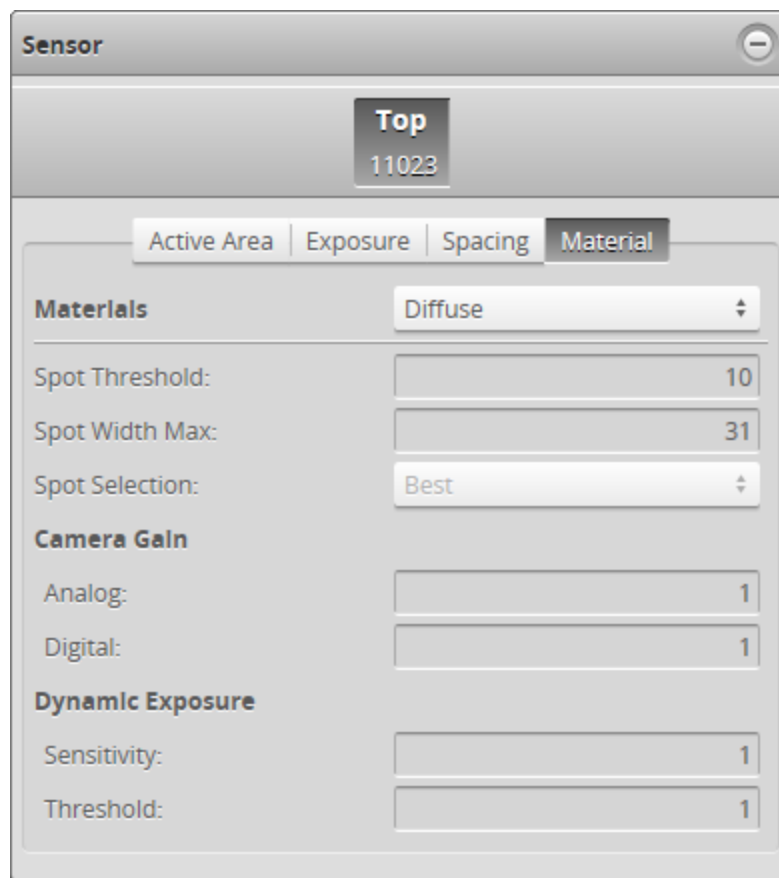
- Choose **Custom** and move the slider to a precise value.

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

## 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, the setting it is not necessary, but it can make a great difference with others.

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



The screenshot shows the 'Sensor' configuration window with the 'Materials' tab selected. The window has a title bar with a minus button. Below the title bar is a 'Top' button and a display showing '11023'. The 'Materials' tab is active, showing a dropdown menu set to 'Diffuse'. Below this are several settings: 'Spot Threshold' (10), 'Spot Width Max' (31), 'Spot Selection' (Best), 'Camera Gain' (Analog: 1, Digital: 1), and 'Dynamic Exposure' (Sensitivity: 1, Threshold: 1).

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>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.                                                                                                                                                                          |

| Setting        | Description                                                                                                                                                                                                                                                                                                                                                                                                                                                       |
|----------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
|                | 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</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 ( <b>Best</b> , <b>Top</b> , or <b>Bottom</b> ).<br><b>Best</b> selects the strongest spot in a given column on the imager. <b>Top</b> (the topmost spot or the one farthest to the left on the imager) and <b>Bottom</b> (the bottommost spot or the one farthest to the right on the imager) can be useful in applications where there are reflections, flying sparks or smoke, which are always on one side of the laser. |
| Analog         | <b>Analog</b> camera gain can be used when the application is severely exposure limited, yet dynamic range is not a critical factor.                                                                                                                                                                                                                                                                                                                              |
| Digital        | <b>Digital</b> camera gain can be used when the application is severely exposure limited, yet dynamic range is not a critical factor.                                                                                                                                                                                                                                                                                                                             |
| Sensitivity    | Controls the exposure that dynamic exposure converges to. The lower the value, the lower the exposure Gocator will settle on.<br>The trade-off is between the number of exposure spots and the possibility of over-exposing.                                                                                                                                                                                                                                      |
| Threshold      | The minimum number of spots for dynamic exposure to consider 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.                                                                                                                                                                                                                                         |

*To configure material:*

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.  
Materials can be configured separately for each sensor.
4. Click on the **Materials** tab.
5. Choose a material in the **Materials** drop-down or choose **Custom** to manually configure settings.  
See the table above for the customizable settings.
6. Save the job in the **Toolbar** by clicking the **Save** button .
7. Check that laser profiling is satisfactory.  
After adjusting the setting, confirm that laser profiling is satisfactory.

Various settings can affect how the **Material** settings behave. You can use Video mode to examine how the settings interact. See *Spots and Dropouts* (page 100) for more information.

## 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 will be displayed under **Transformations** in the **Sensor** panel; see *Transformations* (page 74) for details.

## Alignment States

A Gocator can be in one of three alignment states: None, Manual, or Auto.

### Alignment State

| State  | Explanation                                                                                  |
|--------|----------------------------------------------------------------------------------------------|
| None   | Sensor is not aligned. Profiles are reported in default sensor coordinates.                  |
| Manual | Transformations (see page 74) or encoder resolution (see page 69) have been manually edited. |
| Auto   | Sensor is aligned using the alignment procedure (see next page).                             |

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

## Alignment Types

Gocator sensors support two types of alignment, which are related to whether the target is stationary or moving.

| Type       | Description                                                                                                                                                                                 |
|------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Stationary | <b>Stationary</b> is used when the sensor mounting is constant over time and between scans, e.g., 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, e.g., 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.

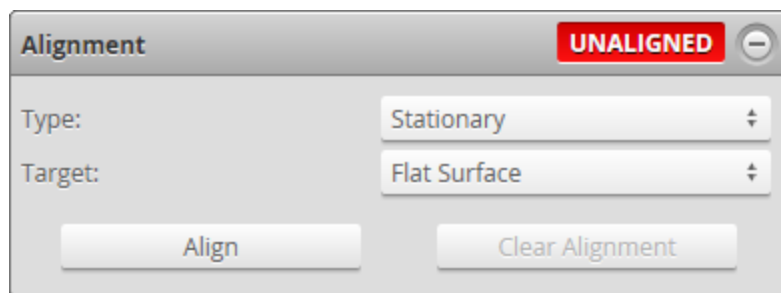
|                                 | With encoder calibration            | Without encoder calibration     |
|---------------------------------|-------------------------------------|---------------------------------|
| <b>Target Type</b>              | Calibration disk or calibration bar | Flat surface 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* (page 40) for definitions of coordinate axes. See *Calibration Targets* (page 23) for descriptions of calibration disks and bars.

See *Aligning Sensors* (below) 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).



*To prepare for alignment:*

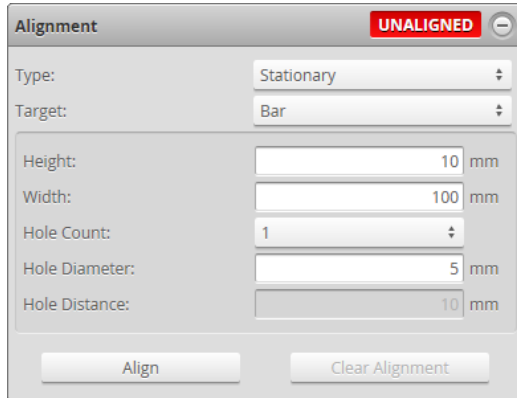
1. Choose an alignment reference in the **Manage** page if you have not already done so. See *Alignment Reference* (page 56) for more information.
2. Go to the **Scan** page.
3. Choose Profile or Surface mode in the **Scan Mode** panel, depending on the type of measurement whose decision you need to 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-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.
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* (page 23) 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 74).



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* (page 56) for more information.
  - If the system does not use an encoder, configure travel speed. See *Travel Speed* (page 57) 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* (page 23) 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 74).

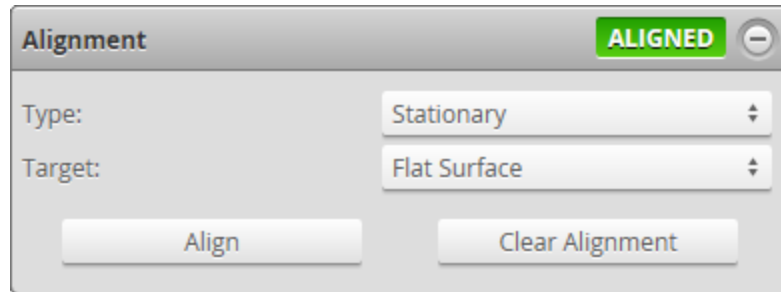
 Alignment uses the exposure defined for single exposure mode, regardless of the current exposure mode

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 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.                                                                                                                                                                                                                                          |

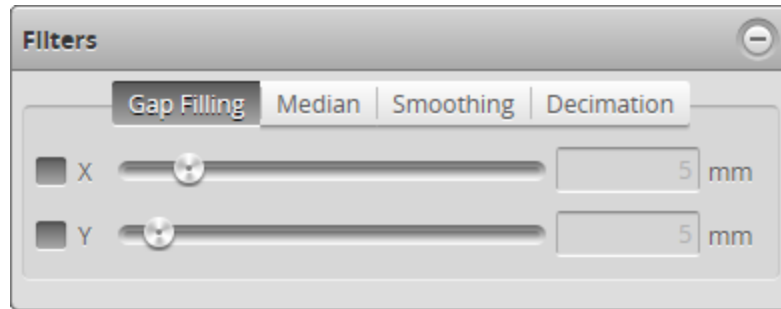
Filters are applied in the order displayed in the table above. The filters are configured in the **Filters** panel on the **Scan** page.

## 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 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.) |
|-------------------------------------------------------------------------------------|------------------------------------------------------------------------------------------|



*To configure X or Y gap filling:*

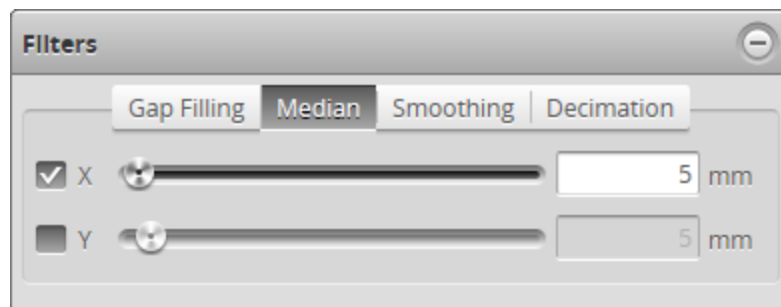
1. Go to the **Scan** page.
2. Choose Profile or Surface mode in the **Scan Mode** panel.  
If one of these modes is not selected, you will not be able to configure gap filling.
3. Expand the **Filters** panel by clicking on the panel header or the  button.
4. Click on the **Gap Filling** tab.
5. Enable 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 gap filling.

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.

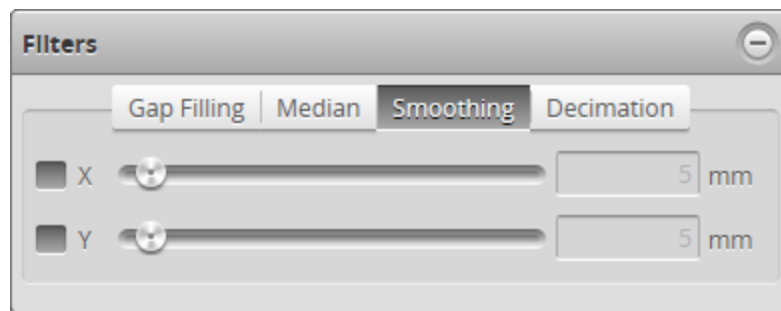
## Smoothing

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.

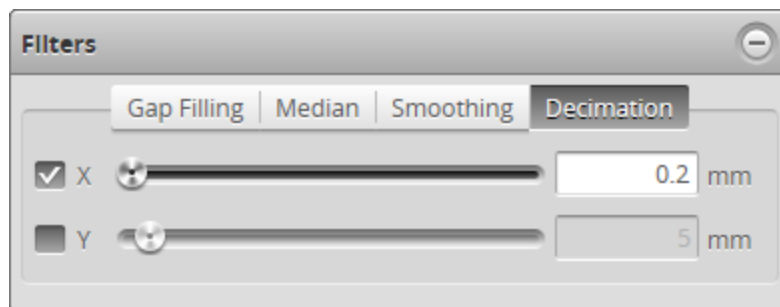


*To configure X or Y smoothing:*

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, points will be used every .2 millimeters.



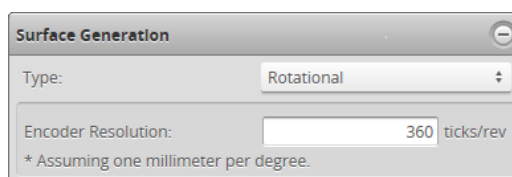
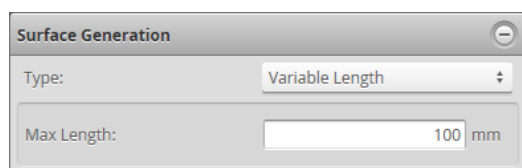
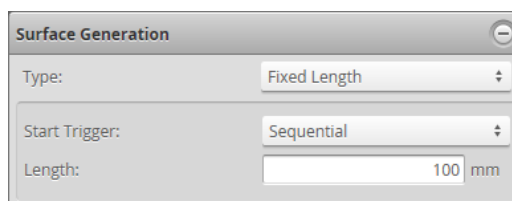
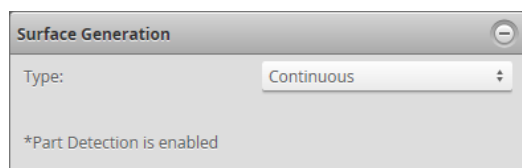
To configure X or Y decimation:

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 smoothing.
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.

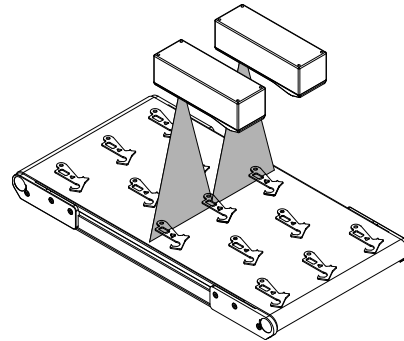


The following types correspond to the **Type** setting in the panel.



When **Type** is set to **Continuous**, part detection is automatically enabled. When Type is set to anything else, part detection can be enabled and disabled in the **Part Detection** panel. See *Part Detection* (page 93) for descriptions of the settings that control detection logic.

**Continuous:** The sensor continuously generates surfaces of parts that are detected under the sensor.

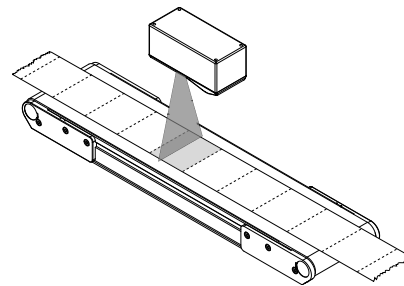


**Fixed Length:** The sensor generates surfaces of a fixed length (in mm) using the value in the **Length** setting.

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

The **Type** setting provides two types of start triggers:

- **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 page 370. 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.

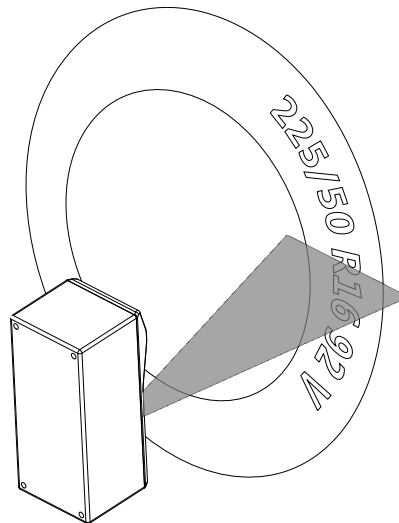
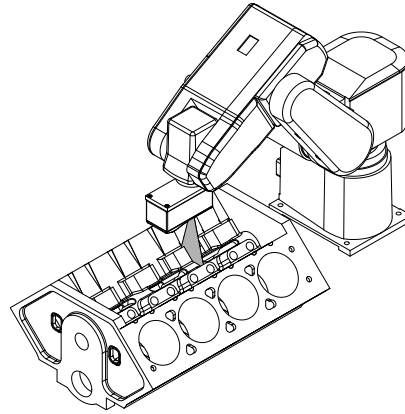
**Variable Length:** The sensor generates surfaces of variable length. Profiles collected while the external digital input is held high are combined to form a surface. If the value of the **Max Length** setting is reached while external input is still high, the next surface starts immediately with the next profile. 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 page 370. 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.

**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.



To scan exactly one revolution of a circular target without knowing the circumference, manually set the encoder resolution





(page 56) to 1, the encoder trigger spacing (page 66) 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.

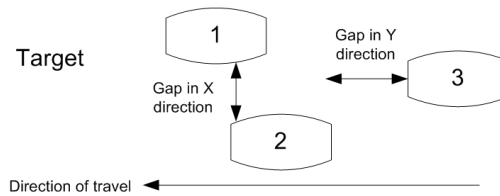
## Part Detection

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 automatically 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* (page 84) 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 66).</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                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         |

| Setting            | Description                                                                                                                                                                                                                                        |
|--------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
|                    | 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.                   |
| 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 ( see page 90 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 159) 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 159).

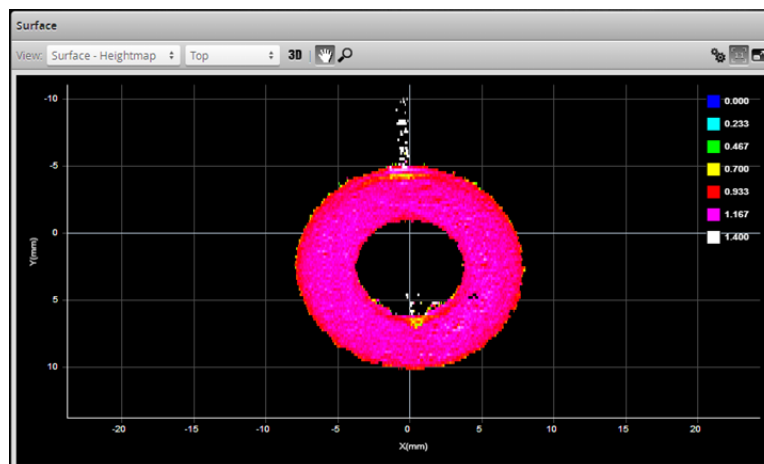
|                |                                        |
|----------------|----------------------------------------|
| Edge Filtering | See <i>Edge Filtering</i> (next page). |
|----------------|----------------------------------------|

To set up part detection:

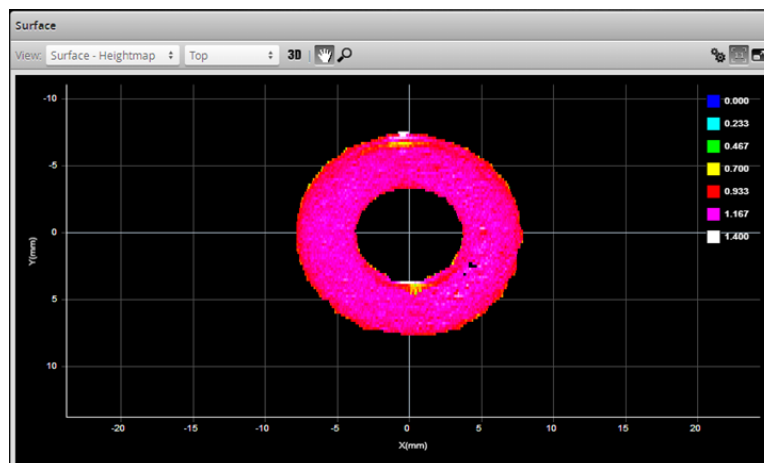
1. Go to the **Scan** page and choose **Surface** in the **Scan Mode** panel.  
If this mode is not selected, you will not be able to configure part detection.
2. Expand the **Part Detection** panel by clicking on the panel header or the  button.
3. If necessary, check the **Enabled** option.  
When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

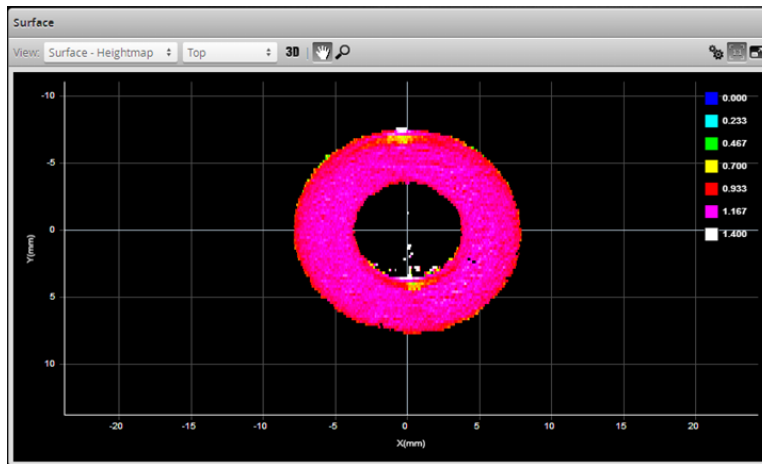
Part scans sometimes contain noise around the edges of the target. This noise is usually caused by the sensor's light being reflected off almost vertical sides, rounded corners, etc. Edge filtering helps reduce edge noise in order to produce more accurate and repeatable volume and area measurements, 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.



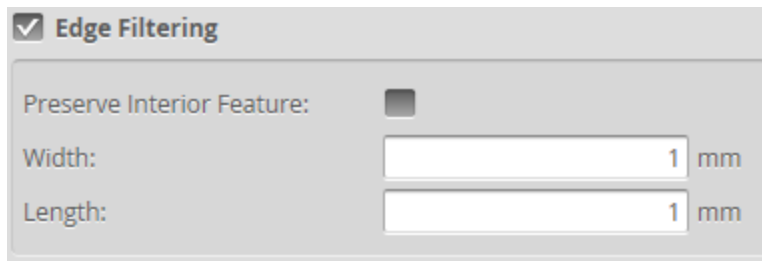
*Edge Filtering disabled (scan shows reflection noise)*



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



*Edge Filtering enabled, Preserve Interior Feature enabled.*



*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.

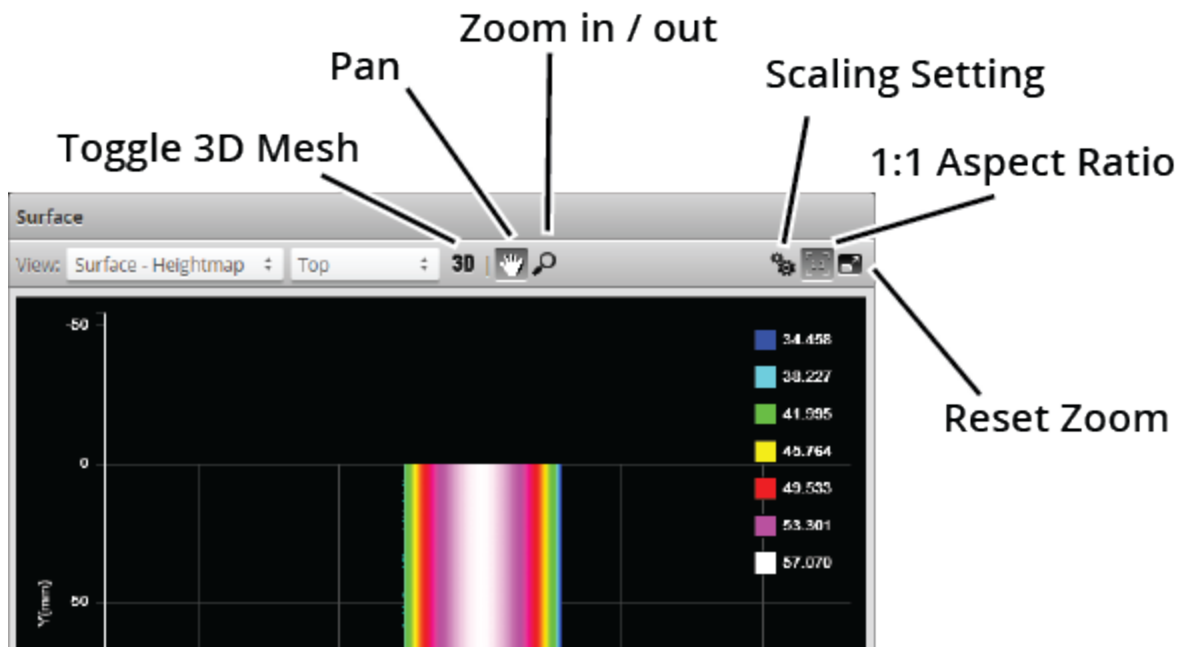
## Data Viewer

The data viewer can display video images, profile plots, height maps, and intensity images. It is also used to configure the active area (see page 71) and measurement tools (see page 123). 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

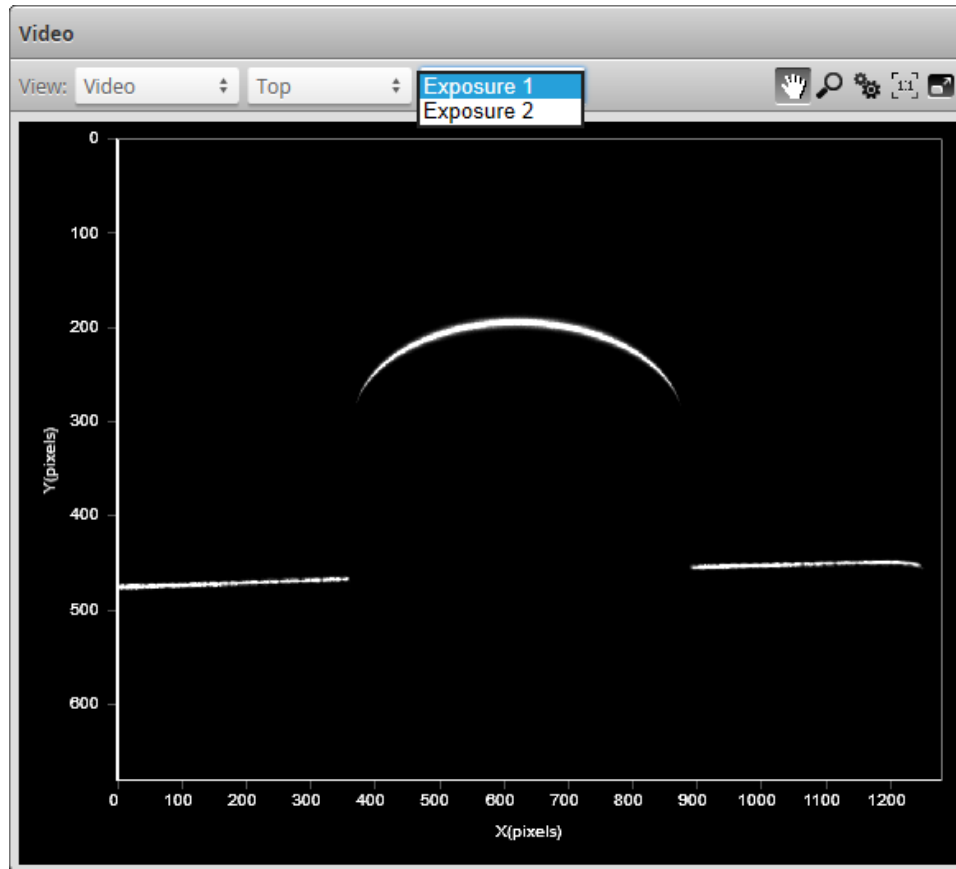
In Video scan mode, the data viewer displays a camera image. In a dual-sensor system, camera images from the Main or the Buddy sensor can be displayed.

### Exposure View

Exposure can be set to **Single**, **Dynamic**, or **Multiple**. Different exposures can be displayed in the data viewer if more than one exposure has been set. For details on setting exposure in the **Exposure** tab in the **Sensor** panel, see page 74.

If the **Multiple** option is selected in the **Exposure** tab and multiple exposures have been set, a drop-down is displayed at the top of the data viewer. This drop-down lists the exposures that have been added. Choosing an exposure changes the view of the data viewer to that exposure.

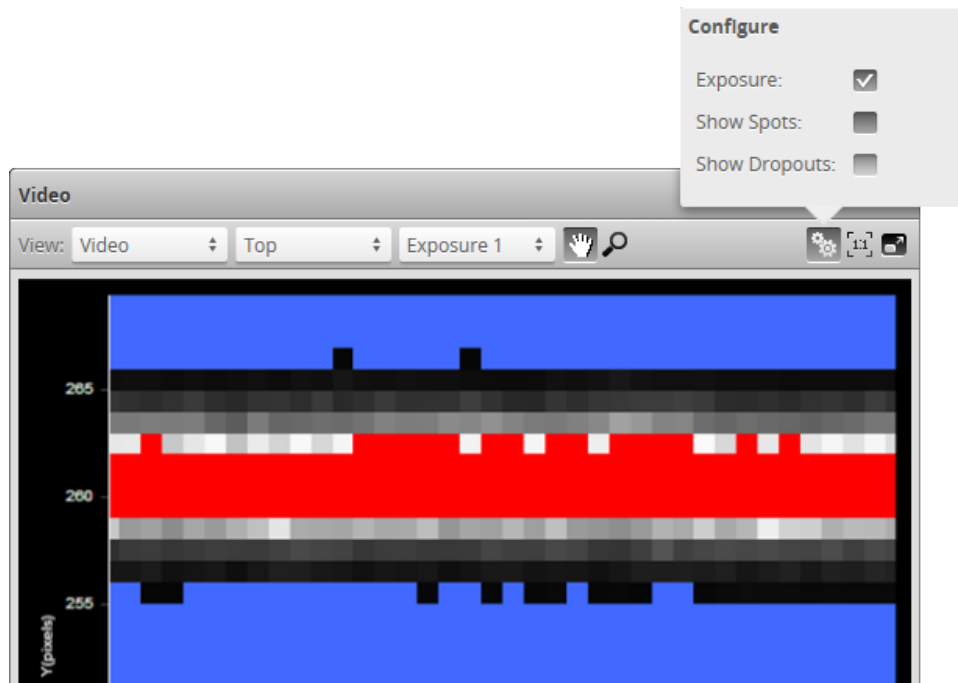
If the **Single** or **Dynamic** option is selected in the **Exposure** tab, the exposure drop-down will not be shown and only one exposure will be displayed.



*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.  
Select **Main** or **Buddy** from the first drop-down list next to **View** at the top of the data viewer.
3. Select the exposure.  
Select the exposure from the second drop-down list next to **View** at the top of the data viewer. This drop-down is only be visible if the **Multiple** option has been selected.

To display a color exposure overlay on the video image to help set the correct exposure, check **Exposure Indication** at the top of the data viewer.



**Exposure Indication** uses the following colors:

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

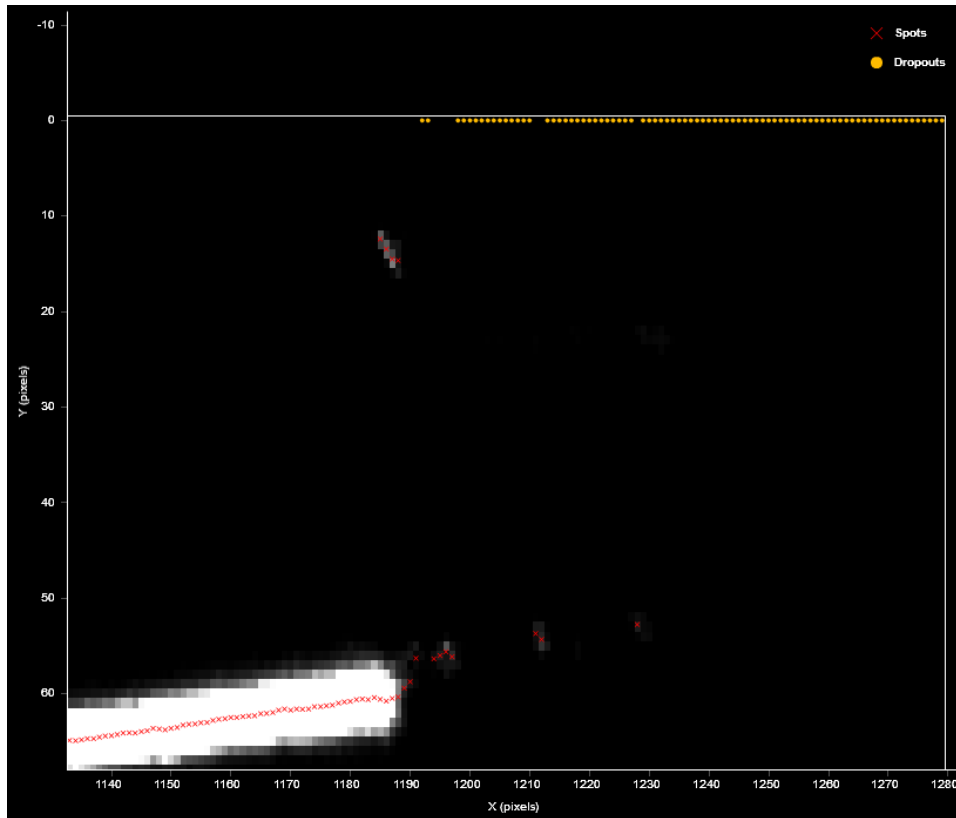
Correct tuning of exposure depends on the reflective properties of the target material and on the requirements of the application. Settings should be carefully evaluated for each application, but often a good starting point is to set the exposure so that there are 2 to 3 red pixels in the center of the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

### Spots and Dropouts

Various settings can affect how the **Material** settings behave. Video mode can be used to examine how the **Material** settings are affected. To do this, check the **Show Spots** option at the top of the data viewer to overlay spot data in the data viewer. To show data dropouts, check the **Show Dropouts** option at the top of 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 camera sensor as yellow dots.

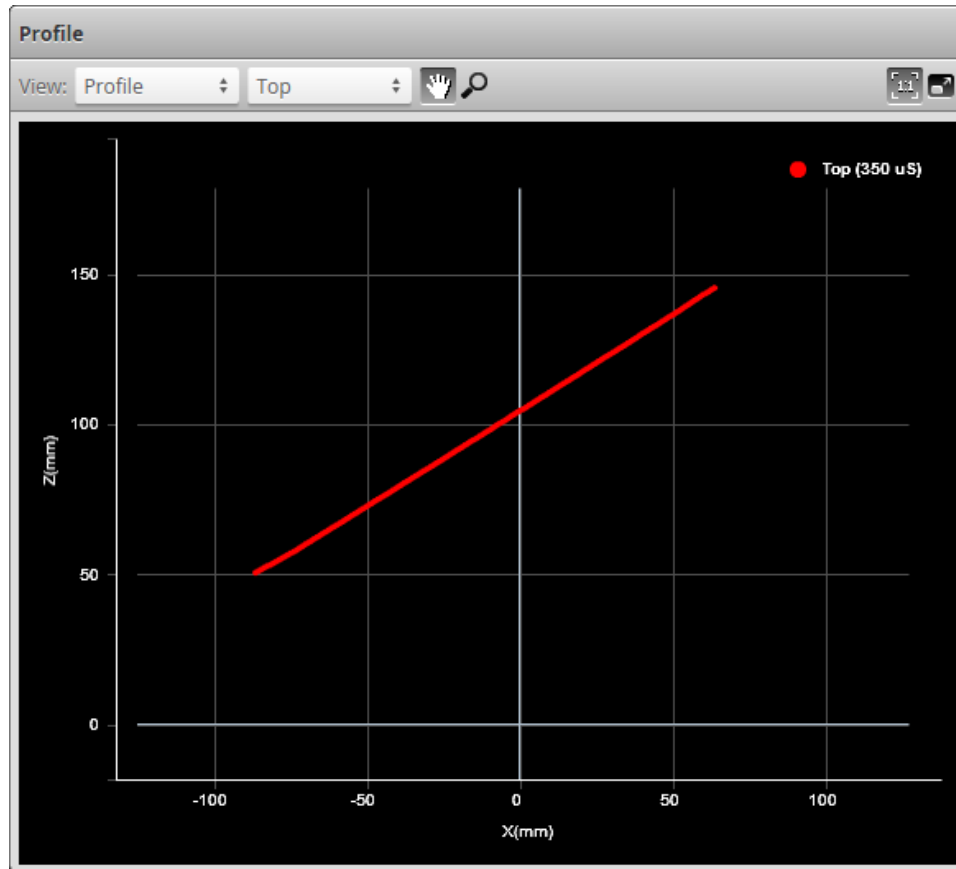




See *Material* (page 81) for more information on settings for different materials.

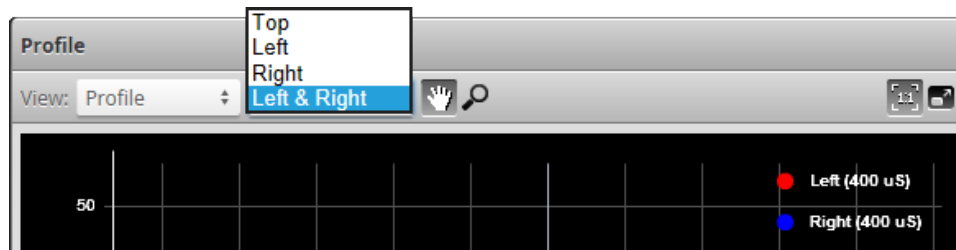
## Profile Mode

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.

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.

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.

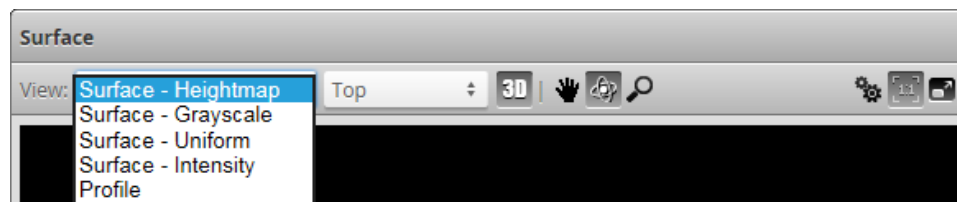
**Left & Right:** Views from both sensors, displayed at the same time in the data viewer, using the coordinate systems of each sensor.

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.

Clicking on the **3D** button displays Surface data in the 3D viewer. The 3D model is overlaid with the information that corresponds to the selected **View** option.

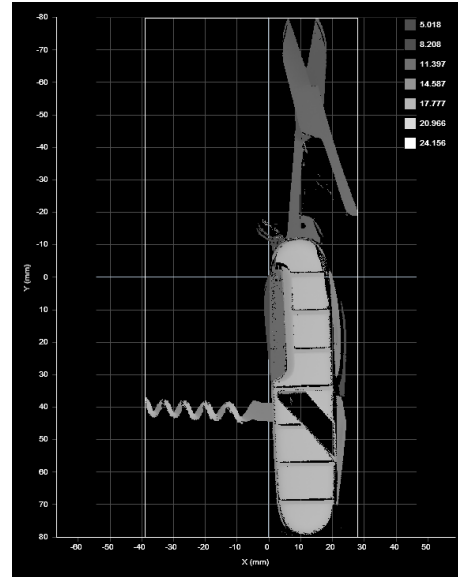


| View Option         | Information                                                                                                                                                                  |
|---------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 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>( <b>Acquire Intensity</b> must be checked in the <b>Scan Mode</b> panel.) |

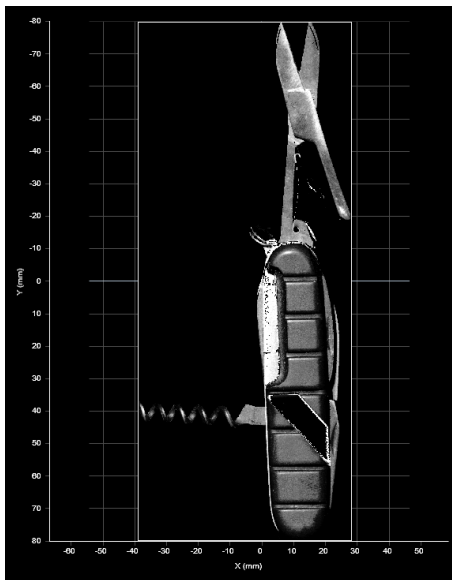
Choosing the Profile view option will switch the data viewer out of the 3D viewer and display the profile plot.



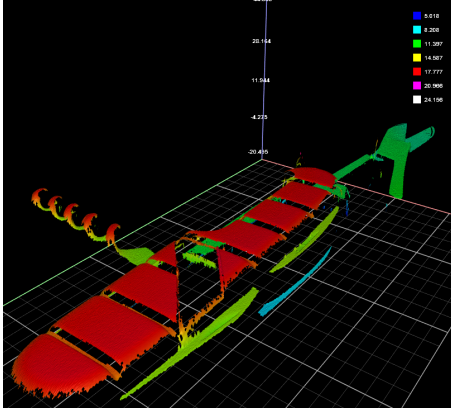
*2D viewer with height map overlay*



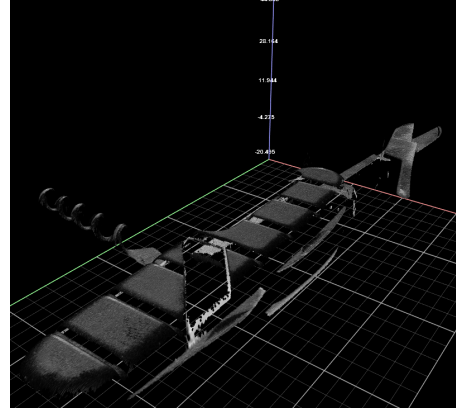
*2D viewer with grayscale overlay*



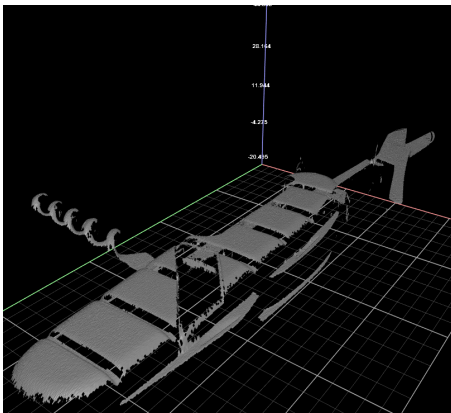
*2D viewer with intensity overlay*



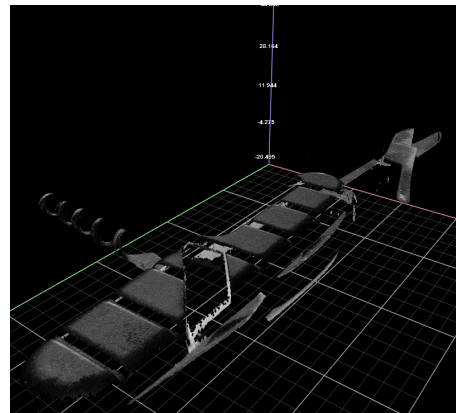
3D viewer with height map overlay



3D viewer with grayscale overlay



3D viewer with uniform overlay



3D viewer with uniform overlay

Clicking on the **3D** button toggles between the 2D and 3D viewer. See *Data Viewer Controls* (page 98) for explanations on the available controls.

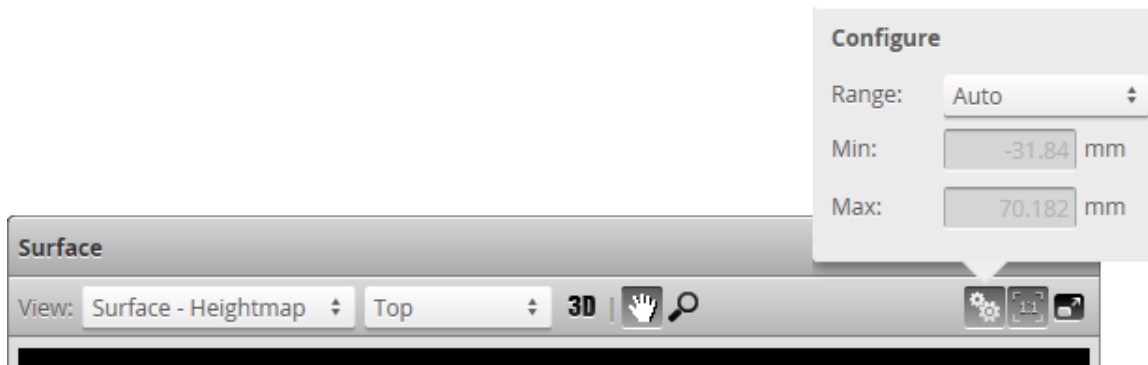
In a dual-sensor system, data from individual sensors or from a combined view can be selected. While in the **Scan** page, selecting a panel (e.g., **Sensor** or **Part Detection** panel) will automatically set the display to the most appropriate display type and display view.

*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.



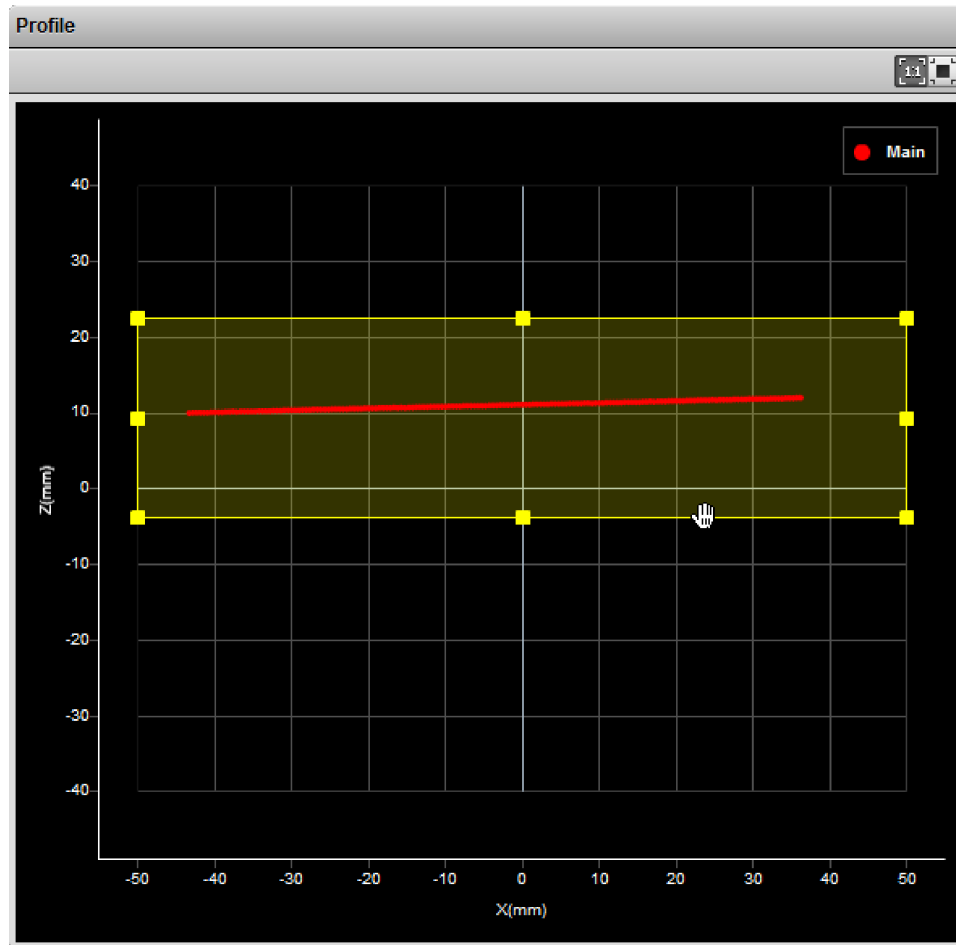
*To change the scaling of the height map:*

1. Select **Heightmap** from the 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 page 71.



*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 the **Acquire Intensity** checkbox in the **Scan Mode** panel.



## Models and Part Matching

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

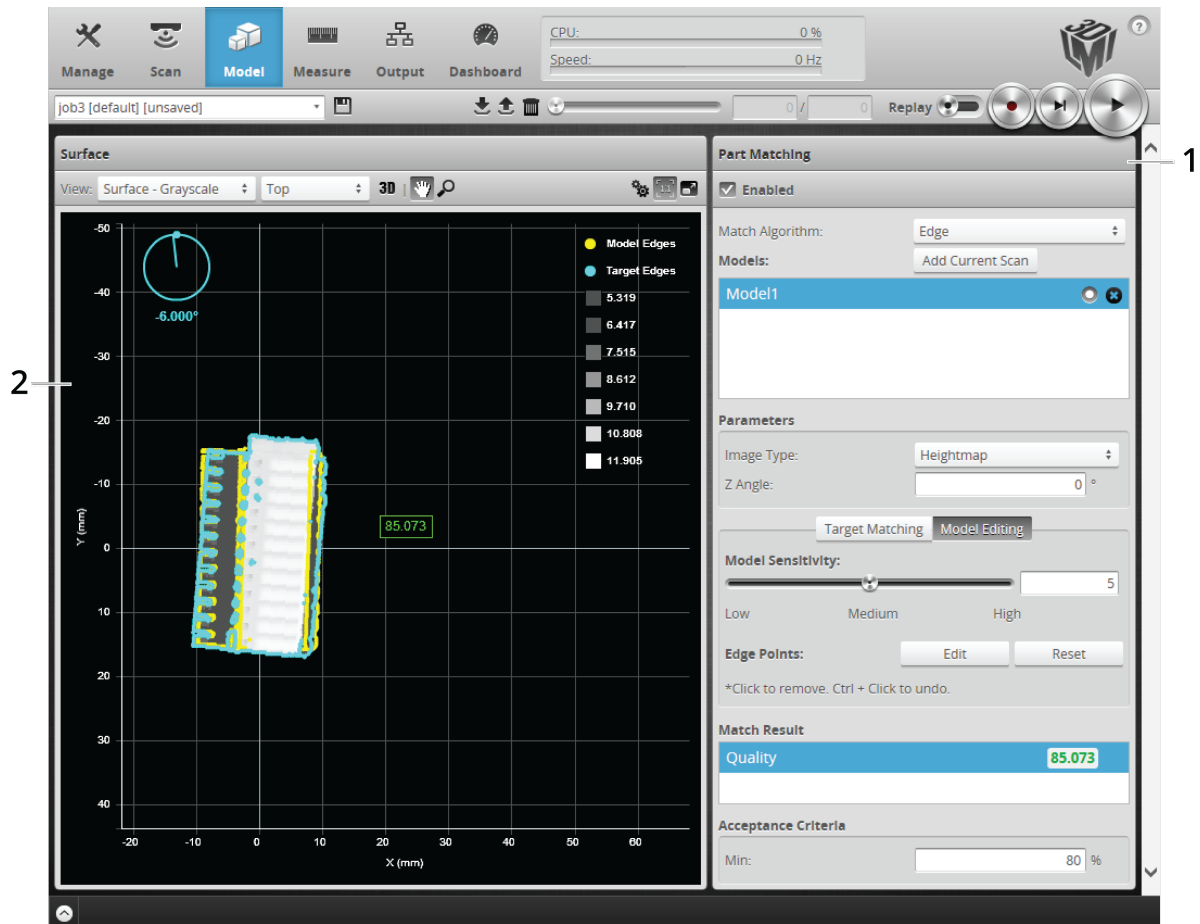
### Model Page Overview

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



The **Model** page is only displayed when the sensor is in **Surface** mode. See *Scan Modes* (page 65) for more information.





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

## Part Matching

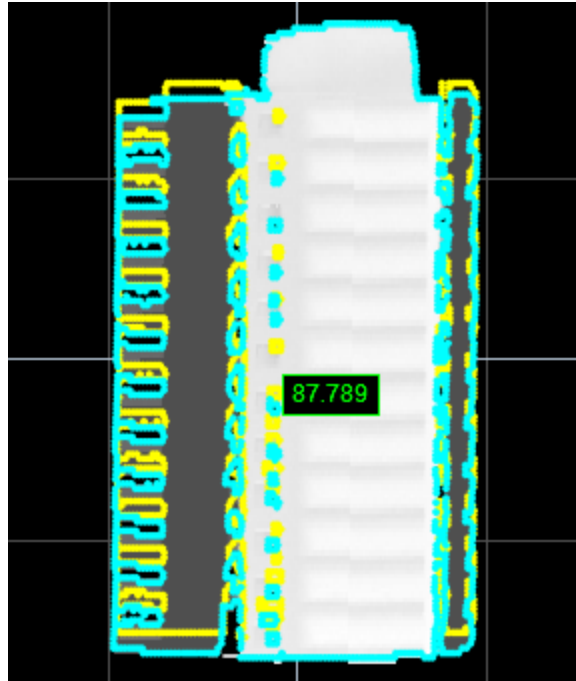
You can use Gocator to match parts to a previously saved model (see *Using Edge Detection* on page 110) or to the dimensions of a fitted bounding box or ellipse (see *Using Bounding Box and Ellipse* on page 119), regardless of the orientation of the part you are trying to match.

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, provided that 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 page 123.

## 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.

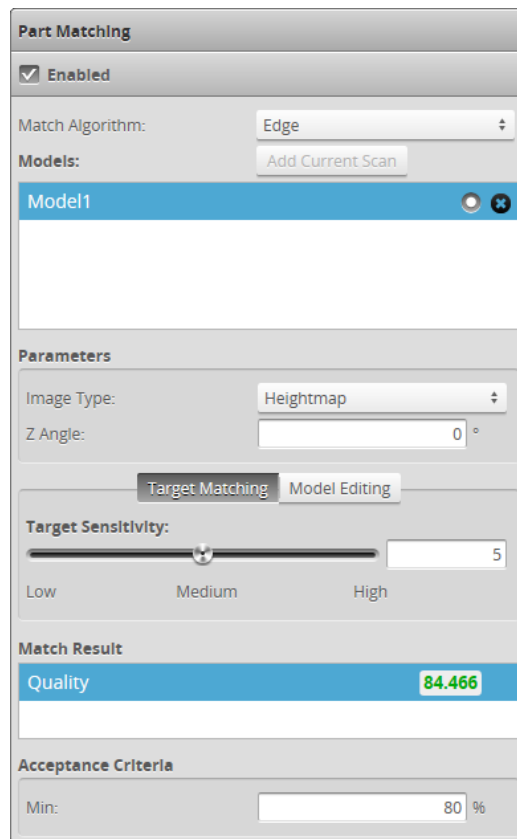


Models are saved as part of a job.

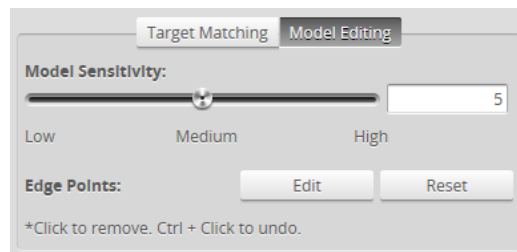
Once you have finished modifying the model, you can also modify target sensitivity, which controls how many edge points are detected on the subsequently scanned targets that will be compared to the model; the same edge detection algorithm used for creating models is used to compare a model to a part.

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> (page 110) 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> (page 110) 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

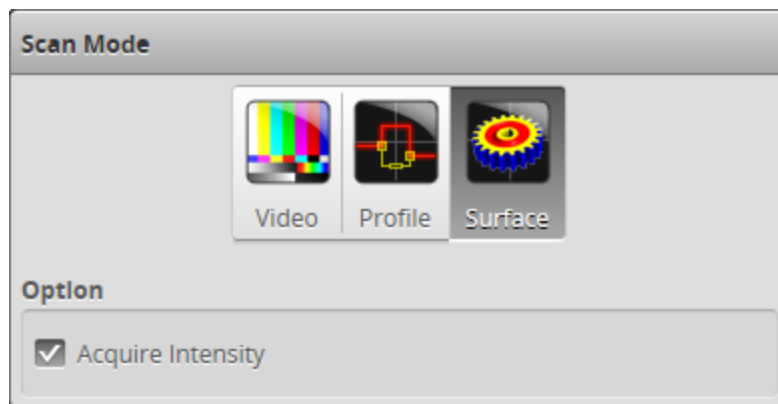
successfully matched part is rotated to match orientation of the model), returning a value and decision (as long as the part is in range, etc.). If a part match is rejected, measurements will return an Invalid value.

### 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.

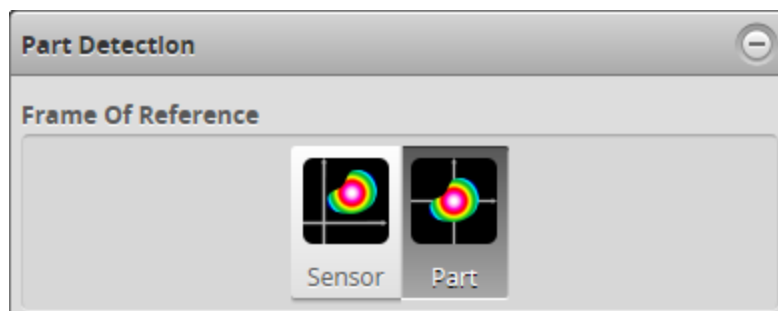
*To create a model:*

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.

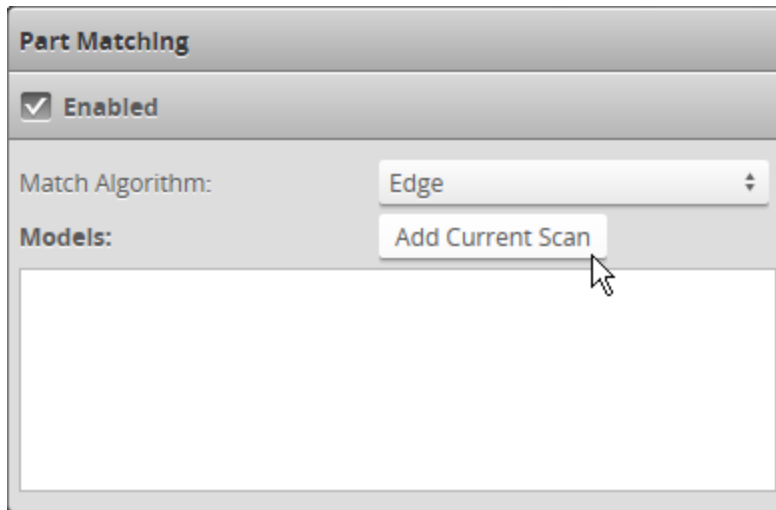
- b. If you want to use intensity data to create the model, make sure **Acquire Intensity** is checked.
  - c. In the **Part Detection** panel, choose **Part** for the **Frame of Reference**.



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* (page 64) for more information on setting up and aligning Gocator. See *Running a Standalone Sensor System* (page 32) or *Running a Dual-Sensor System* (page 33) 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* (page 45) and *Downloading, Exporting, and Uploading Recorded Data* (page 46) for more information on replay data.

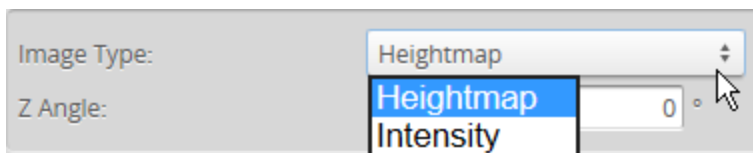
3. Go to the **Model** page.
  - a. Make sure the **Enabled** option is checked in the **Part Matching** panel.
  - b. In the **Match Algorithm** drop-down, choose **Edge**.



4. Click **Stop** on the toolbar if the sensor is running.
5. 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.

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



7. 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.
8. Save the job by clicking the **Save** button .

Models are saved in job files.

See *Saving and Loading Settings* (page 44) 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* (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 .

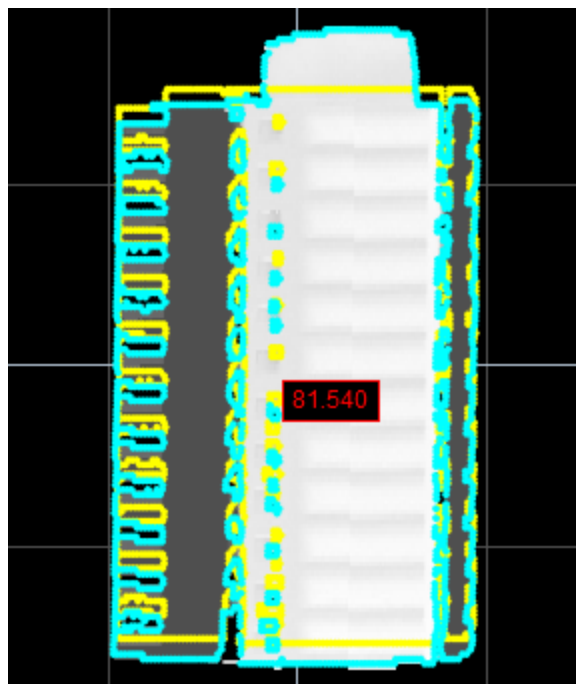
To delete a model, click the  button.

### Modifying a Model's Edge Points

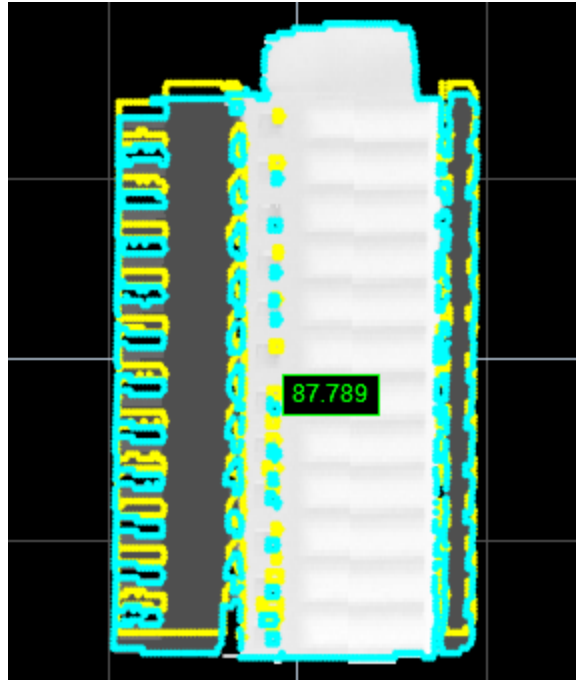
Modifying a model's edge points is useful to exclude noise in the detected edge points and to make sure distinguishing features are properly detected, which can improve matching. You can modify edge points in two ways.

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%.)*

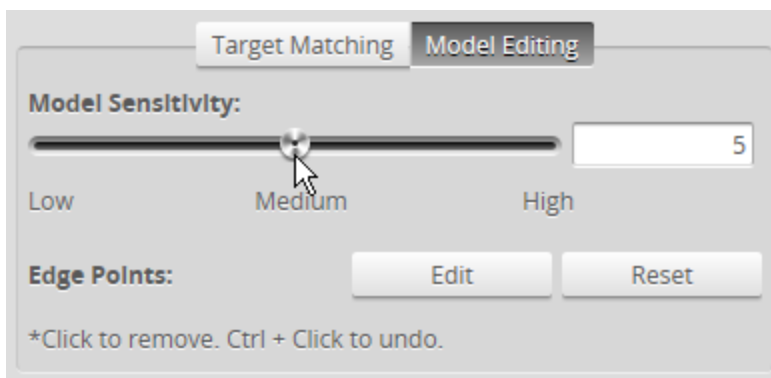
Removing edge points does not cause the edge detection algorithm to run again.

*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 .

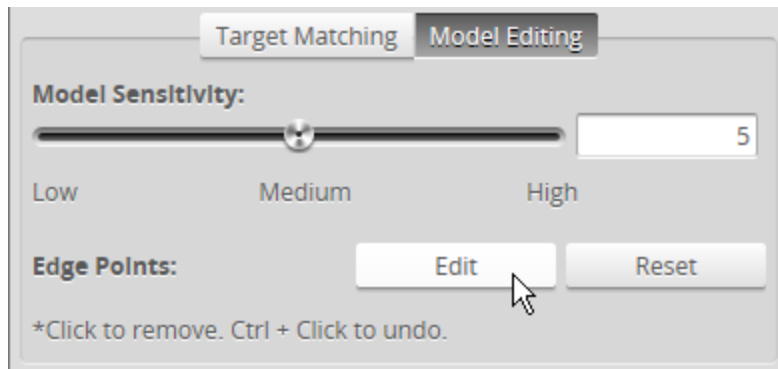


*To manually remove model edge points:*

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



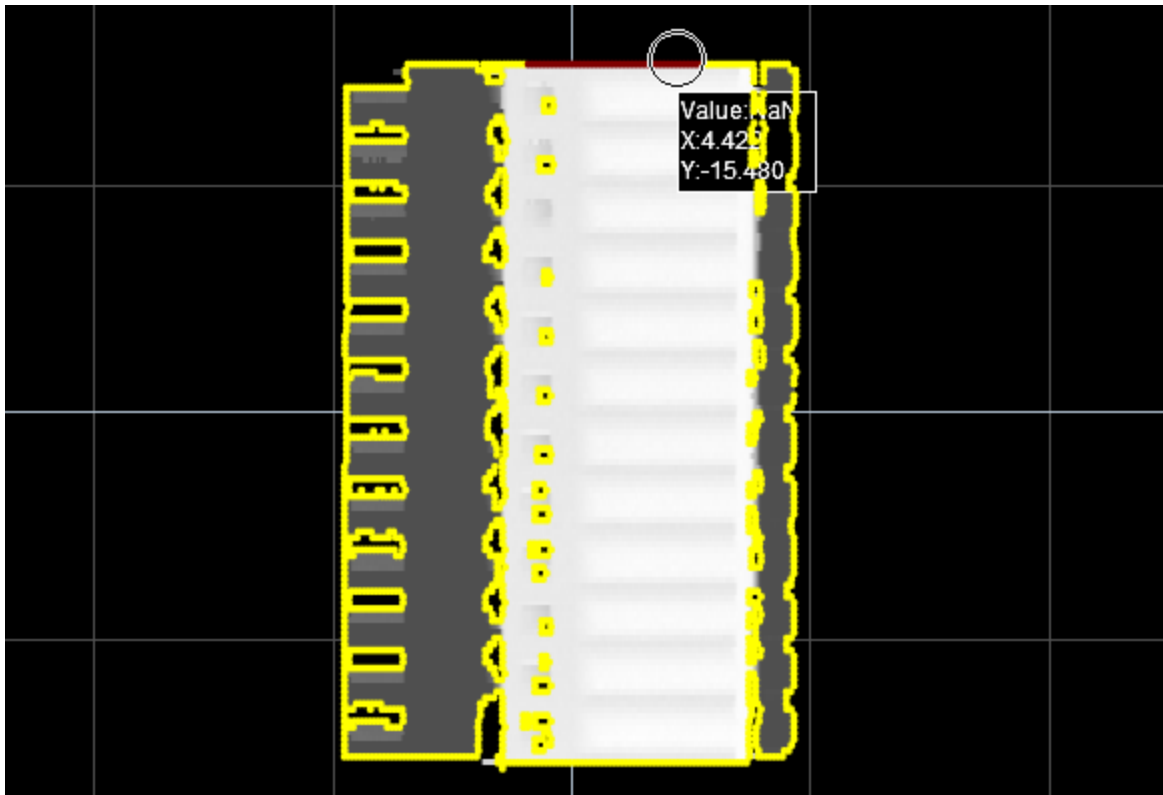
2. In the **Model Editing** tab, click on the **Edit** button.



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.

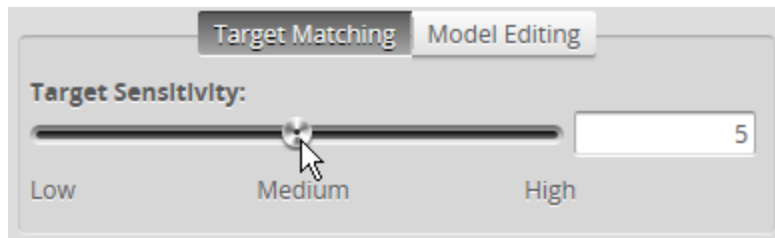
### Adjusting Target Sensitivity

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:*

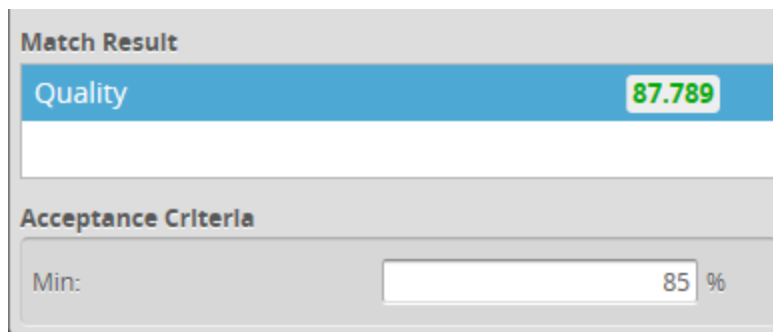
1. Click the **Target Matching** tab.
2. Adjust the **Target Sensitivity** setting to exclude noise in order to properly detect the distinguishing features that will allow parts to match.



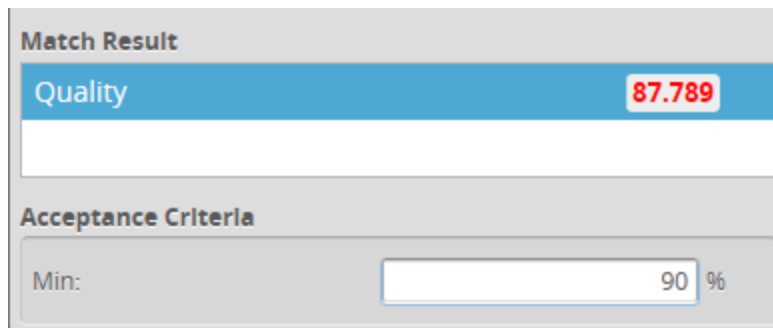
You can also set the sensitivity value manually in the provided text box.

### 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.



*Part accepted: Quality result is greater than Min*



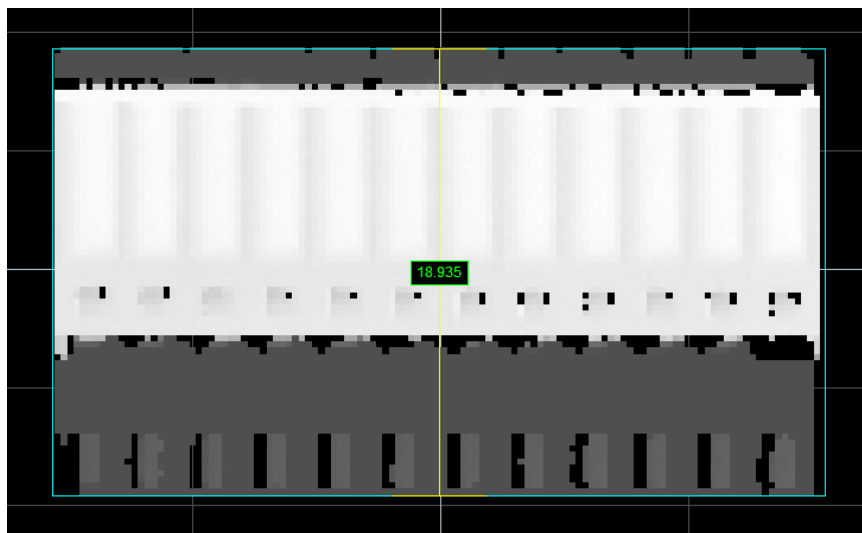
### Running Part Matching

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).

 A screenshot of the 'Part Matching' panel in a software interface. The panel has a title bar 'Part Matching' and a checked 'Enabled' checkbox. Below this is a 'Match Algorithm:' dropdown menu set to 'Bounding Box'. Under the 'Parameters' section, there is a 'Z Angle:' input field set to '0 °'. The 'Match Result' section displays two values: 'Width' as '18.935' and 'Length' as '31.134', both in green text. The 'Acceptance Criteria' section has 'Min:' and 'Max:' input fields, with '18 mm' and '19 mm' respectively.

*Part Matching panel (Bounding Box 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 <b>Bounding Box</b> or <b>Ellipse</b> . |

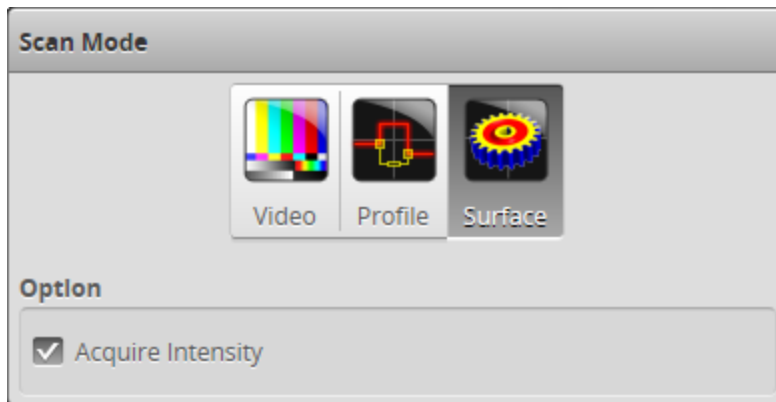
| Setting             | Description                                                                                                                                                              |
|---------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Z Angle             | Corrects the orientation of the bounding box or ellipse to accurately match typical orientation and simplify measurements.                                               |
| Acceptance Criteria | 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> . |

### 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:*

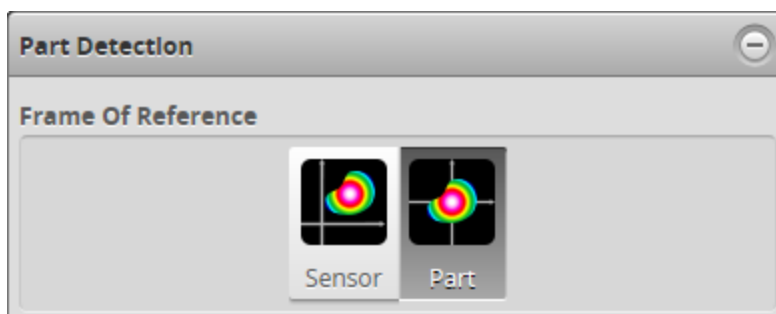
1. Go to the **Scan** page.
  - a. In the **Scan Mode** panel, choose **Surface**.



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**.

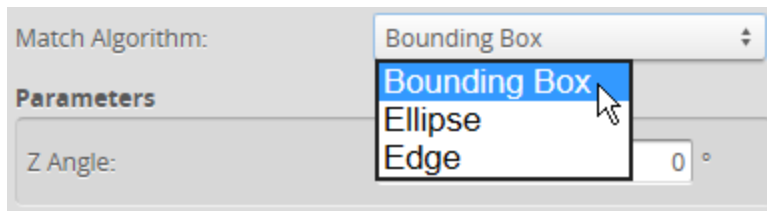


Part matching is only available when **Part** has been selected.

2. Do one of the following:
  - Scan a reference part. See *Scan Setup and Alignment* (page 64) for more information on setting up and aligning Gocator. See *Running a Standalone Sensor System* (page 32) or *Running a Dual-Sensor System*

(page 33) 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* (page 45) and *Downloading, Exporting, and Uploading Recorded Data* (page 46) 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 *Saving and Loading Settings* (page 44) 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.

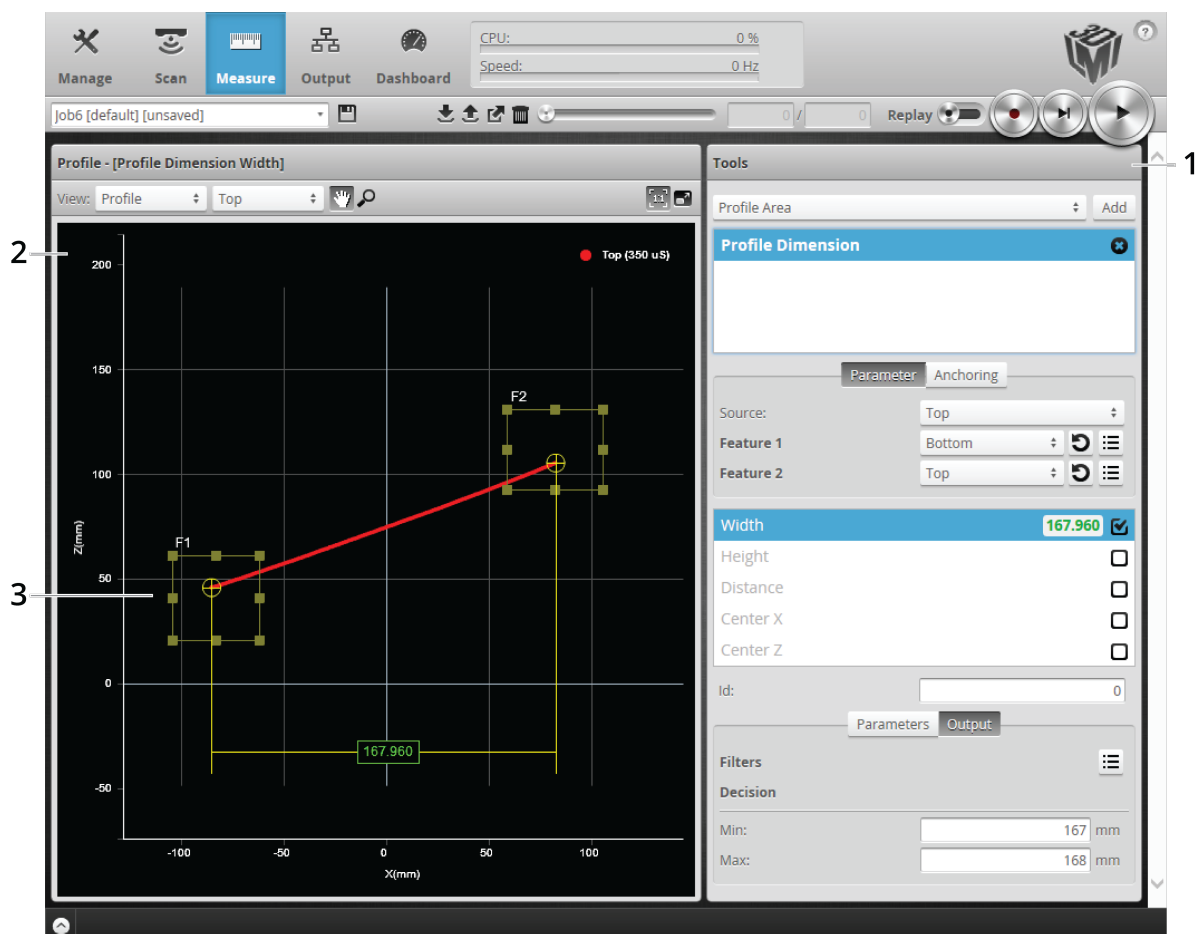
# Measurement

The following sections describe the Gocator's tools and measurements.

## Measure Page Overview

Measurement tools are added and configured using 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. In Video mode, tools are not accessible.



| Element       | Description                                                                                                                                                                                                                                                                   |
|---------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 1 Tools panel | Used to add, manage, and configure tools and measurements (see next page) and to choose anchors (see page 132).                                                                                                                                                               |
| 2 Data Viewer | Displays profile or surface data, sets up tools, and displays result calipers related to the selected measurement.<br>Parts are displayed using a height map, which is a top-down view of the XY plane, where color represents height.<br>See <i>Data Viewer</i> (next page). |

| Element        | Description                                                                                                                                                                                                                         |
|----------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 3 Feature Area | 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. |

## Data Viewer

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

When the **Measure** page is active, the data viewer can be used to graphically configure measurement regions. Measurement regions can also be configured manually in measurements by entering values into the provided fields (see page 129).

For instructions on how to set up measurement regions graphically, see page 106.

## Tools Panel

The **Tools** panel lets you add, configure, and manage 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, whereas some settings apply to specific measurements. See *Profile Measurement* (page 134) and *Surface Measurement* (page 158) for information on the measurement tools and their settings.

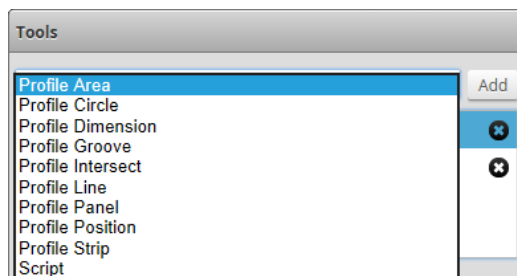


Tool names in the user interface include the scan mode, but not in the manual. So for example, you will see "Profile Area" or "Surface Bounding Box" in the user interface, but simply "Area" or "Bounding Box" in the manual.

## Measurement Tool Management

### Adding and Removing Tools

Adding a tool adds all of the tool's measurements to the **Tools** panel, which can then be enabled and configured selectively.



*To add 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 will be added to the tool list. The tool parameters will be listed in the configuration area below the tool list.

*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 "x" button of the tool you want to delete.  
The tool will be removed from the tool list.



If the drop-down list contains only the Distance measurement, the sensor is not equipped with profile tools. The Distance measurement is provided in all sensors to demonstrate the measurement capability.

### 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.

**Tools**

Profile Area ⌵ Add

**Profile Dimension** ✕

**Parameter** **Anchoring**

Source: Top ⌵

Feature 1 Bottom ⌵ ↺ ⋮

Feature 2 Top ⌵ ↺ ⋮

**Width** 167.960 ☒

Height ☐

Distance ☐

Center X ☐

Center Z ☐

Id: 0

**Parameters** **Output**

**Filters** ⋮

**Decision**

Min: 167 mm

Max: 168 mm

#### *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 assign a name to each tool and measurement. 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 edit a tool 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. In the tool list, double-click on the tool name you want to change.
5. Type a new name in the ID field.
6. Press the Tab or Enter key, or click outside the name edit field.  
The name will be changed.

*To change a 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 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, double-click on the measurement name you want to change.
5. Type a new name in the ID field.
6. Press the Tab or Enter key, or Click outside of the name edit field.  
The name change 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* (page 125) for instructions on how to enable a measurement.

5. Click in the ID field.
6. Enter 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.

## Common Measurement Settings

All tools provide region settings under the **Parameter** tab, and all measurements provide decision and filter settings under the **Output** tab.

Many tools and measurements also have tool- and measurement-specific parameters. See the individual measurement tools for details.

### Source

For dual-sensor systems, you must specify a profile source for tools. The source determines which sensor provides data for the measurement.

Depending on the layout you have selected, the **Source** drop-down will display a combination of the following. See *Dual-Sensor System Layout* (page 52) for more information on layouts.

| Setting   | Description                                                                                                                                                 |
|-----------|-------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Top       | Refers to the Main sensor in a standalone or dual-sensor system, the Main sensor in Opposite layout, or the combined data from both Main and Buddy sensors. |
| Bottom    | Refers to a Buddy sensor in a dual-sensor system position in Opposite layout.                                                                               |
| Top Left  | Refers to a Main sensor in Wide layout or to a Buddy sensor in Reverse layout in a dual-sensor system position.                                             |
| Top Right | Refers to a Buddy sensor in Wide layout or to a Main sensor in Reverse layout in a dual-sensor system position .                                            |

*To select the source:*

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. Go to the **Measure** page by clicking on the **Measure** icon.
4. In the **Tools** panel, click on a tool in the tool list.
5. Click on the **Parameter** tab in the tool configuration area.
6. Select the profile source in the **Source** drop-down list.

## Regions

Region parameters are used by many tools to limit the region in which a measurement will occur or to help in the identification of a feature (see page 134), a fit line (see page 136), or left or right side of the Panel measurements (Gap and Flush; see *Panel* on page 149).

See the individual tools for details on using this parameter with each tool.



The screenshot shows a 'Region' configuration panel. It has a title bar with a refresh icon and a list icon. Below the title bar, there are four input fields with labels on the left and units on the right. The values are: X: -54.122 mm, Z: -36.593 mm, Width: 109.67 mm, and Height: 109.67 mm.

| Parameter | Value   | Unit |
|-----------|---------|------|
| X:        | -54.122 | mm   |
| Z:        | -36.593 | mm   |
| Width:    | 109.67  | mm   |
| Height:   | 109.67  | mm   |

This parameter is also referred to as a measurement region.



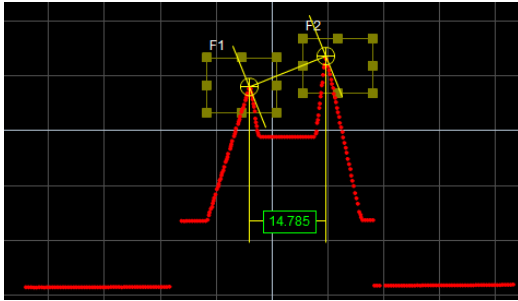
In 2D mode, the tool region defaults to the center of the current data view, not the global field of view. In 3D mode, the region defaults to the global field of view.

*To configure regions:*

1. Go to the **Scan** page by clicking on the **Scan** icon.
2. Choose Profile or Surface mode in the **Scan Mode** panel, depending on the type of measurement whose regions you need to configure.  
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, click on a tool in the tool list.
5. Expand the region area by clicking on the expand button .  
Some region settings are found within other settings in this area.
6. Configure the region using the fields or graphically using the mouse in the data viewer.

## 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 user interface, these values are displayed in green. Otherwise, the decision state is fail. In the user interface, these values are displayed in red.



|          |                                            |
|----------|--------------------------------------------|
| Width    | <input type="checkbox"/>                   |
| Height   | <input type="checkbox"/>                   |
| Distance | 14.785 <input checked="" type="checkbox"/> |
| Center X | <input type="checkbox"/>                   |
| Center Z | <input type="checkbox"/>                   |

Id:

Output

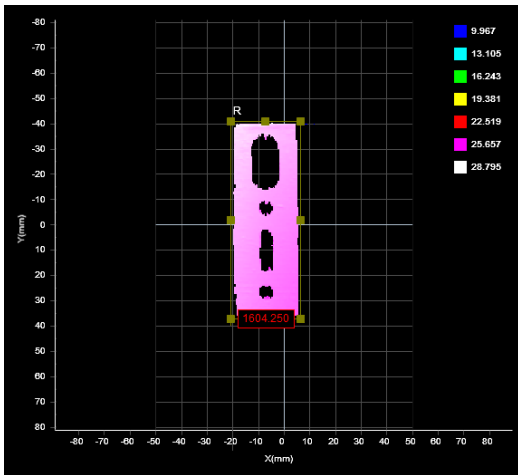
Filters

Decision

Min:  mm

Max:  mm

*Value (14.786) within decision thresholds (Min: 14, Max: 15). Decision: Pass*



Parameter Anchoring

Source:

☒ Region

Volume ☐

Area 1604.250 ☒

Thickness ☐

Id:

Output

Filters

Decision

Min:  mm<sup>2</sup>

Max:  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* (page 195) for more information on transmitting values and decisions.

*To configure decisions:*

1. Go to the **Scan** page by clicking on the **Scan** icon.
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. Go to the **Measure** page by clicking on the **Measure** icon.
4. In the **Tools** panel, click on a tool in the tool list.

- In the measurement list, select a measurement.  
To select a measurement, it must be enabled. See *Enabling and Disabling Measurements* (page 125) for instructions on how to enable a measurement.
- Click on the **Output** tab.  
For some measurements, only the **Output** tab is displayed.
- Enter values in the **Min** and **Max** fields.

## Filters

Filters can be applied to measurement values before they are output from the Gocator sensors.

| 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>                                                                                                                                                                                             |



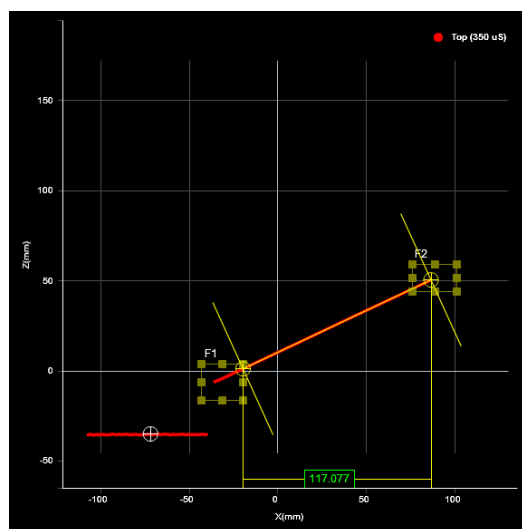
*To configure the filters:*

- Go to the **Scan** page by clicking on the **Scan** icon.
- Choose Profile or Surface mode in the **Scan Mode** panel, depending on the type of measurement whose filters you need to configure.  
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, click on a tool in the tool list.
5. In the measurement list, select a measurement.  
To select a measurement, it must be enabled. See *Enabling and Disabling Measurements* (page 125) for instructions on how to enable a measurement.
6. Click on the **Output** tab.  
For some measurements, only the **Output** tab is displayed.
7. Expand the **Filters** panel by clicking on the panel header or the  button.
8. Configure the filters.  
Refer to the table above for a list of the filters.

## Measurement Anchoring

Measurement anchoring is used to track the movement of parts within the field of view of the sensor, compensating for variations in the height and position of parts. The movement is calculated as an offset from the position of a measured feature, where the offset is then used to correct the positions of measurement regions of other measurement tools. This ensures that the regions used to measure features are correctly positioned for every part.



Parameter

Anchoring

X: #3 - Profile Position X
Z: Disabled

Width ☐
Height ☐
Distance 117.077 ☒
Center X ☐
Center Z ☐

Id: 2

Output

Filters

Decision

Min: 110 mm
Max: 125 mm

Anchoring is not required in order to use measurement tools. This is an optional feature that helps make measurements more robust when the position and the height of the target varies from target to target.

Any X, Y, or Z measurement can be used as an anchor for a tool.

Several anchors can be created to run in parallel. For example, you could anchor some measurements relative to the left edge of a target at the same time as some other measurements are anchored relative to the right edge of a target.



*To anchor a profile or surface tool to a measurement:*

1. Put a representative target object in the field of view.

The target should be similar to the objects that will be measured later.

*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 (see page 90) and adjust Part Detection settings (see page 93) if applicable.
  - b. Start the sensor, scan the target and then stop the sensor.
2. Add a suitable tool to act as an anchor.  
A suitable tool is one that returns an X, Y, or Z position as a measurement value.
  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. Go to the **Measure** page and adjust the settings of the tool and measurements you want to use as anchor.
  5. Adjust the anchor tool's 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 anchor tool's measurement regions define the zone within which movement will be tracked.  
See *Feature Points* (next page) for more information on feature types.
  6. Add the tool that will be anchored.  
Any tool can be anchored.
  7. Adjust the tool and measurement settings, as well as the measurement regions.
  8. Click on the tool's **Anchoring** tab.
  9. Choose an anchor from the X, Y, or Z drop-down box.  
When you choose an anchor, a white "bulls-eye" indicator shows the position of the anchor in the data viewer.  
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 under the sensor, as long as the anchor measurement produces a valid measurement value. If the anchor measurement is invalid, for example, if there is no target under the sensor, the anchored tool will not show the measurement regions at all and an "Invalid-Anchor" message will be displayed in the tool panel.

*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.

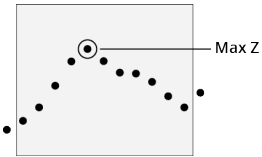
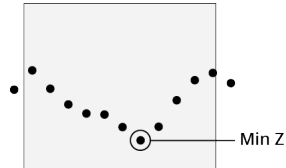
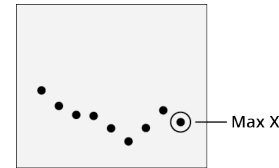
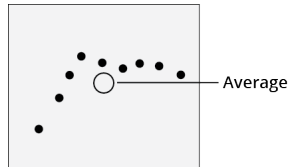
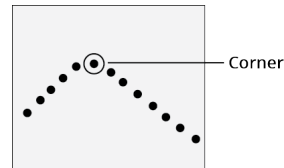
## Profile Measurement

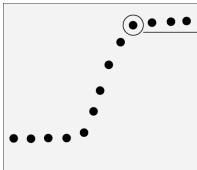
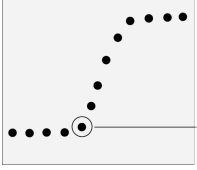
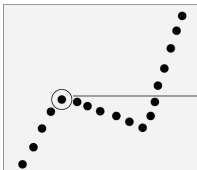
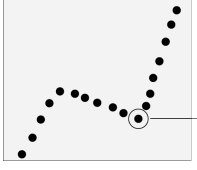
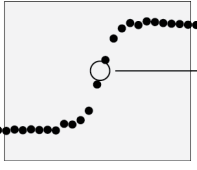
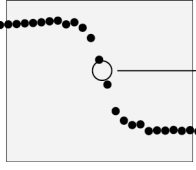
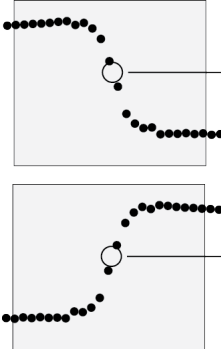
This section describes the profile measurement tools available in Gocator sensors that are equipped with these tools.

Most measurement functions detect and compare *feature points* or *lines* found within laser profile data. Measurement *values* are compared against minimum and maximum thresholds to yield *decisions*.

### Feature Points

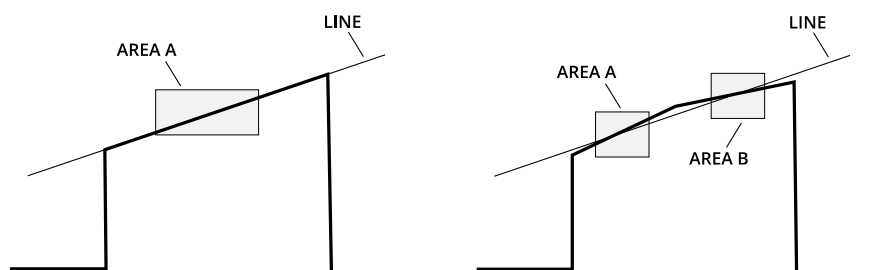
Many profile measurements involve estimating the locations of feature points and then making comparisons between the feature points. The following types of points can be identified.

| 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. |  |

| Point Type                                                                                                                            | Examples                                                                             |
|---------------------------------------------------------------------------------------------------------------------------------------|--------------------------------------------------------------------------------------|
| <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. |    |
| <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.



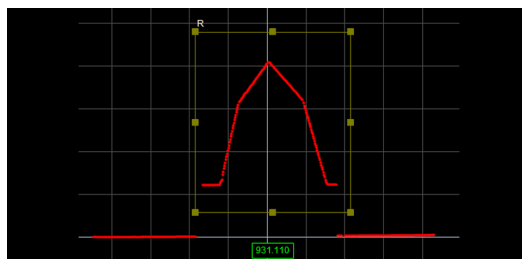
A line can be defined using one or two areas. Two areas can be used to bypass discontinuity in a line segment.

## Measurement Tools

### Area

The Area tool determines the cross-sectional area within a region. The measurement value can be compared with minimum and maximum constraints to yield a decision.

See *Adding and Removing Tools* (page 124) for instructions on how to add measurement tools.



| Parameter  |          | Anchoring       |                                     |
|------------|----------|-----------------|-------------------------------------|
| Source:    | Top      |                 |                                     |
| Type:      | Object   |                 |                                     |
| Baseline:  | X-Axis   |                 |                                     |
| Region     |          |                 |                                     |
| Line       | 1 Region |                 |                                     |
| Area       |          | 931.110         | <input checked="" type="checkbox"/> |
| Centroid X |          |                 | <input type="checkbox"/>            |
| Centroid Z |          |                 | <input type="checkbox"/>            |
| Id:        |          |                 | 0                                   |
| Output     |          |                 |                                     |
| Filters    |          |                 |                                     |
| Decision   |          |                 |                                     |
| Min:       | 930      | mm <sup>2</sup> |                                     |
| Max:       | 950      | 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.

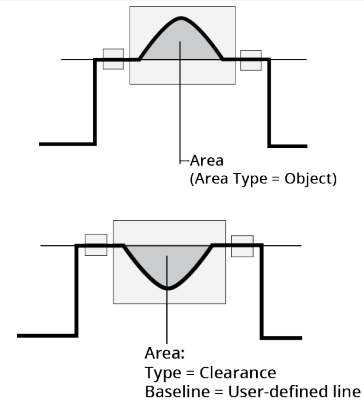
## Measurements

### Measurement

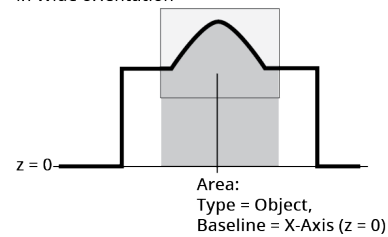
#### Area

Measures the cross-sectional area within a region that is above or below a fitted baseline.

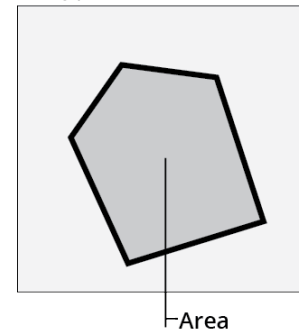
### Illustration



Standalone,  
or dual-sensor setup  
in Wide orientation



Dual-sensor setup  
in Opposite orientation

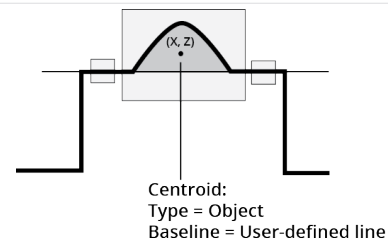


#### Centroid X

Determines the X position of the centroid of the area.

#### Centroid Z

Determines the Z position of the centroid of the area.



## Parameters

### Parameter

Type

### Description

**Object** area type is for convex shapes above the baseline. Regions below the baseline are ignored.

| Parameter | Description                                                                                                                                                                                                                                                                                                                                                                                                                               |
|-----------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
|           | <b>Clearance</b> area type is for concave shapes below the baseline. Regions above the baseline are ignored.                                                                                                                                                                                                                                                                                                                              |
| 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> (page 136) 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      | When Baseline is set to <b>Line</b> , you must set this parameter. See <i>Fit Lines</i> (page 136) for more information on fit lines.                                                                                                                                                                                                                                                                                                     |
| Decision  | See <i>Decisions</i> (page 129).                                                                                                                                                                                                                                                                                                                                                                                                          |
| Region    | See <i>Regions</i> (page 129).                                                                                                                                                                                                                                                                                                                                                                                                            |
| Filters   | See <i>Filters</i> (page 131).                                                                                                                                                                                                                                                                                                                                                                                                            |

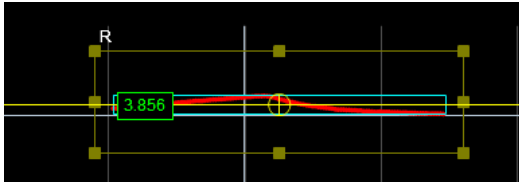
### Bounding Box

The Bounding Box tool provides measurements related to the smallest rectangle box that encapsulates the profile (for example, X position, Z position, width, etc.).

The measurement value can be compared with minimum and maximum constraints to yield a decision.

See *Adding and Removing Tools* (page 124) for instructions on how to add measurement tools.

The bounding box provides the absolute position from which the Position centroids tools are referenced.



ParametersAnchoring

Source: Top

☒ Region

X4.703

Z

Width

Height

Global X

ID: 1

Output

Filters

Decision

Min: 4 mm

Max: 5 mm

Measurement Panel

### Measurements

| Measurement                                                                                                                                                                      | Illustration |
|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--------------|
| <b>X</b><br>Determines the X position of the center of the smallest rectangle that encapsulates the profile.<br>The value returned is relative to the profile.                   |              |
| <b>Z</b><br>Determines the Z position of the center of the smallest rectangle that encapsulates the profile.<br>The value returned is relative to the profile.                   |              |
| <b>Width</b><br>Determines the width of the smallest rectangle box that encapsulates the profile. The width reports the dimension of the box in the direction of the minor axis. |              |
| <b>Height</b><br>Determines the height (thickness) of the smallest rectangle box that encapsulates the profile.                                                                  |              |

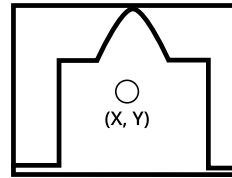
## Measurement

## Illustration

### Global X

Determines the X position of the center of the smallest rectangle that encapsulates the profile.

The value returned is relative to the global/sensor coordinates.



### Parameters

#### Parameter

#### Description

Decision

See *Decisions* (page 129).

Region

See *Regions* (page 129).

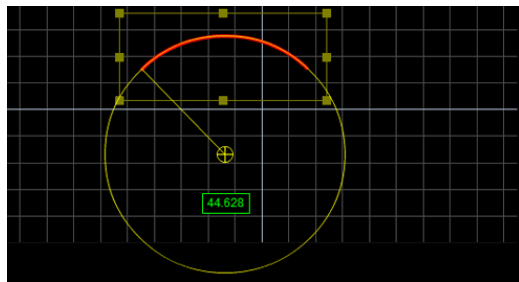
Output

See *Filters* (page 131).

## Circle

The Circle tool provides measurements that find the best-fitted circle to the live profile and measure various characteristics of the circle. The measurement value can be compared with minimum and maximum constraints to yield a decision.

See *Adding and Removing Tools* (page 124) for instructions on how to add measurement tools.



Parameter

Anchoring

Source: 

Top

Region

X

Z

Radius

44.628

Id: 

2

Output

Filters

Decision

Min:

44 mm

Max:

46 mm

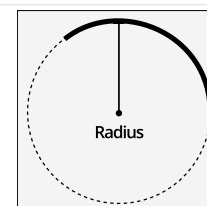
### Measurements

## Measurement

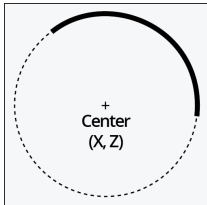
## Illustration

### Radius

Measures the radius of the circle.





| Measurement                                                 | Illustration                                                                       |
|-------------------------------------------------------------|------------------------------------------------------------------------------------|
| <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. |                                                                                    |

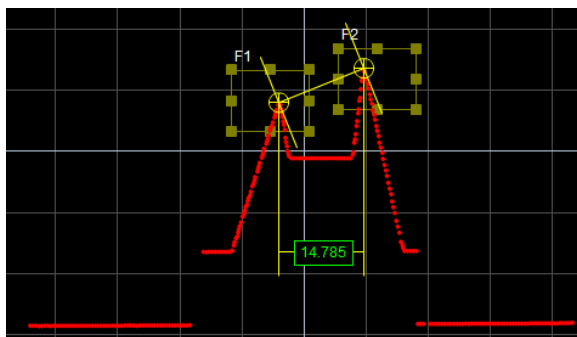
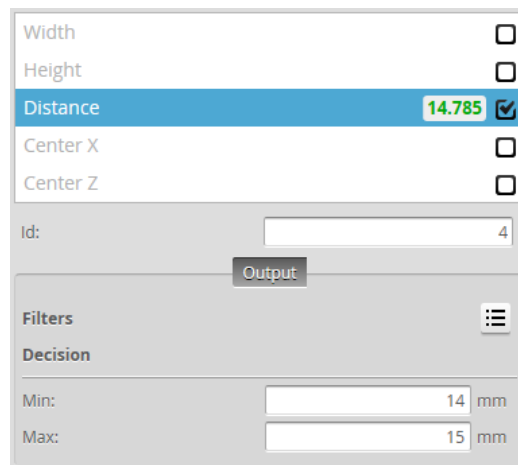
#### Parameters

| Parameter | Description                      |
|-----------|----------------------------------|
| Decision  | See <i>Decisions</i> (page 129). |
| Region    | See <i>Regions</i> (page 129).   |
| Output    | See <i>Filters</i> (page 131).   |

### Dimension

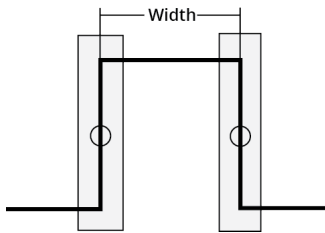
The Dimension tool provides Width, Height, Distance, Center X, and Center Z measurements.

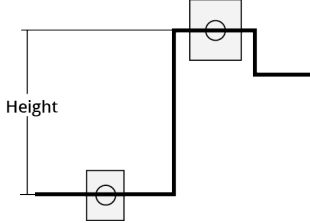
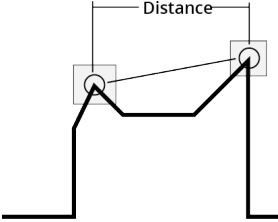
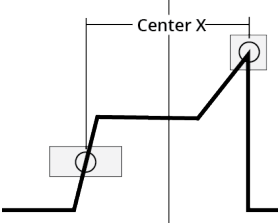
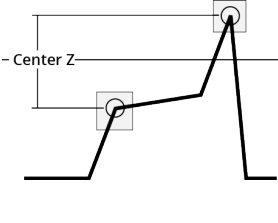
See *Adding and Removing Tools* (page 124) for instructions on how to add measurement tools.

The tool's measurements require two feature points. See *Feature Points* (page 134) for information on point types and how to configure them.

#### Measurements

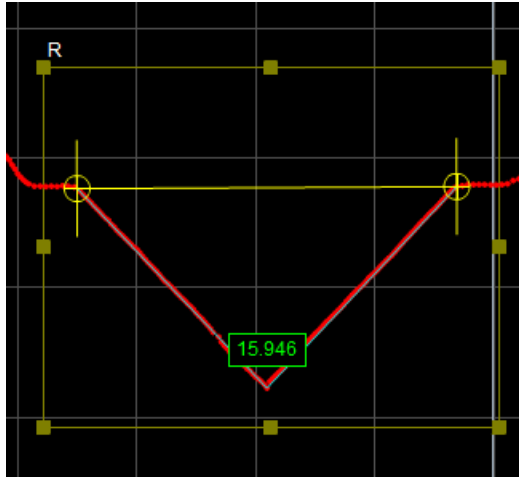
| Measurement                                                                                                                                                                                                                                                                                    | Illustration                                                                         |
|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--------------------------------------------------------------------------------------|
| <b>Width</b><br>Determines the difference along the X axis between two feature points.<br>The difference can be calculated as an absolute or signed result. The difference is calculated by:<br>$\text{Width} = \text{Feature 2}_{X \text{ position}} - \text{Feature 1}_{X \text{ position}}$ |  |

| Measurement                                                                                                                                                                                                                                                                                                 | Illustration                                                                         |
|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--------------------------------------------------------------------------------------|
| <p><b>Height</b></p> <p>Determines the difference along the Z axis between two feature points.</p> <p>The difference can be expressed as an absolute or signed result. The difference is calculated by:</p> $\text{Height} = \text{Feature 2}_{Z \text{ position}} - \text{Feature 1}_{Z \text{ position}}$ |    |
| <p><b>Distance</b></p> <p>Determines the Euclidean distance between two feature points.</p>                                                                                                                                                                                                                 |    |
| <p><b>Center X</b></p> <p>Finds the average location of two features and measures the X axis position of the average location</p>                                                                                                                                                                           |   |
| <p><b>Center Z</b></p> <p>Finds the average location of two features and measures the Z axis position of the average location.</p>                                                                                                                                                                          |  |
| <b>Parameters</b>                                                                                                                                                                                                                                                                                           |                                                                                      |
| 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> (page 129).                                                     |
| Region                                                                                                                                                                                                                                                                                                      | See <i>Regions</i> (page 129).                                                       |
| Output                                                                                                                                                                                                                                                                                                      | See <i>Filters</i> (page 131).                                                       |

## Groove

The Groove tool provides measurements of V-shape, U-shape, or open-shape grooves. The measurement value can be compared with minimum and maximum constraints to yield a decision.

See *Adding and Removing Tools* (page 124) 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.

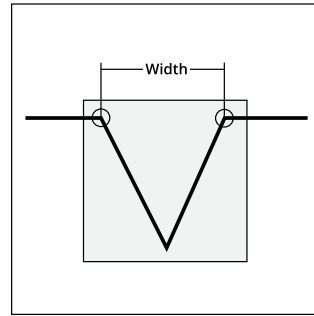
For example, if a target has three grooves, by adding two measurements, choosing **Index From The Left** in the **Select Type** setting of those measurements, and providing values of 0 and 2 in the **Index** setting of the measurements, respectively, the Groove tool will return measurements and decisions for the first and third grooves.

## Measurements

| Measurement                                     | Illustration |
|-------------------------------------------------|--------------|
| <b>Width</b><br>Measures the width of a groove. |              |

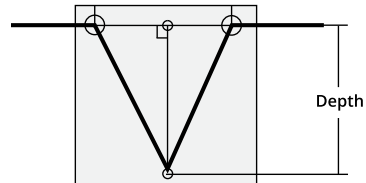
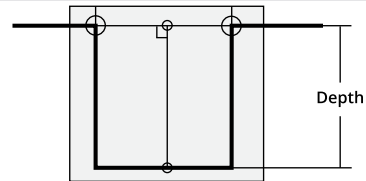
## Measurement

## Illustration



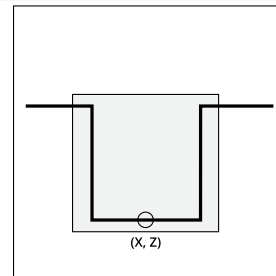
### Depth

Measures the depth of a groove as the maximum perpendicular distance from a line connecting the edge points of the groove.



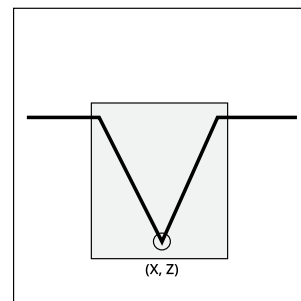
### X

Measures the X position of the bottom of a groove.



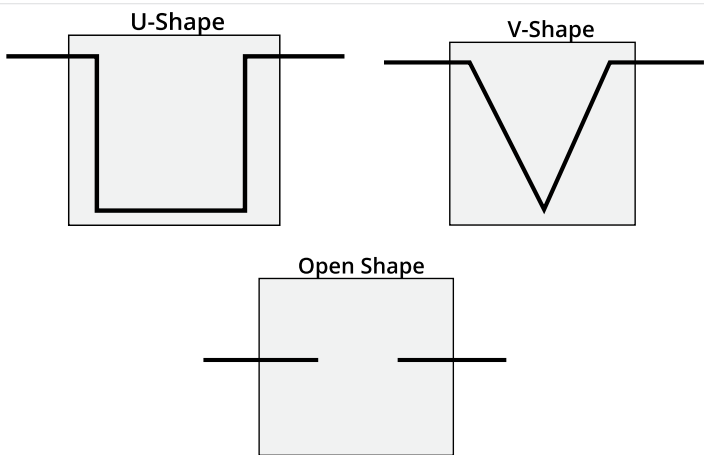
### Z

Measures the Z position of the bottom of a groove.

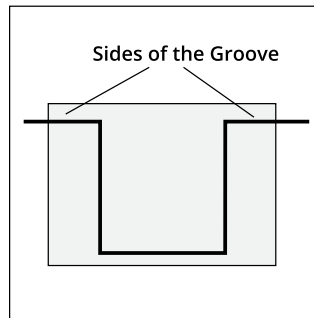


## Parameters

| Parameter | Description         |
|-----------|---------------------|
| Shape     | Shape of the groove |

| Parameter                                                                          | Description                                                                                                                                                                                                                                                                                                                                                                                                      |
|------------------------------------------------------------------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
|  |                                                                                                                                                                                                                                                                                                                                                                                                                  |
| Location<br>(Groove X and Groove Z measurements only)                              | <p>Specifies the location type to return</p> <p>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.</p> <p>Left - Groove's left corner.</p> <p>Right - Groove's right corner.</p> |
| 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> (page 129).                                                                                                                                                                                                                                                                                                                                                                                 |
| Region                                                                             | 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> (page 129).                                                                                                                                                     |

| Parameter | Description |
|-----------|-------------|
|-----------|-------------|



|        |                                |
|--------|--------------------------------|
| Output | See <i>Filters</i> (page 131). |
|--------|--------------------------------|

## Intersect

The Intersect tool determines intersect points and angles. The measurement value can be compared with minimum and maximum constraints to yield a decision.

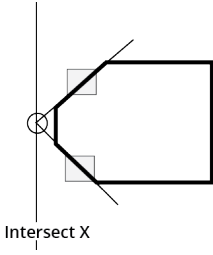
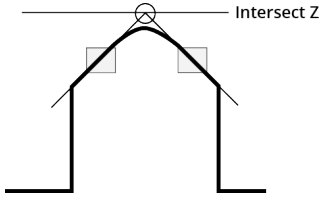
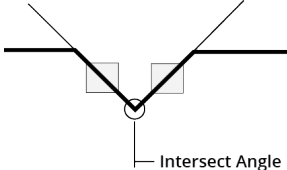
The Intersect tool's measurements require two fit lines, one of which is a reference line set to the X axis ( $z = 0$ ), the Z axis ( $x = 0$ ), or a user-defined line.

See *Adding and Removing Tools* (page 124) for instructions on how to add measurement tools.



| Parameter       | Anchoring |
|-----------------|-----------|
| Source:         | Top       |
| Reference Type: | Line      |
| Ref Line (RL)   | 2 Regions |
| Line (L)        | 2 Regions |
| X               | -0.291    |
| Z               |           |
| Angle           |           |
| Id:             | 7         |
| Output          |           |
| Filters         |           |
| Decision        |           |
| Min:            | -3 mm     |
| Max:            | -2 mm     |

## Measurements

| Measurement                                                                                                             | Illustration                                                                       |
|-------------------------------------------------------------------------------------------------------------------------|------------------------------------------------------------------------------------|
| <b>X</b><br>Finds the intersection between two fitted lines and measures the X axis position of the intersection point. |  |
| <b>Z</b><br>Finds the intersection between two fitted lines and measures the Z axis position of the intersection point. |  |
| <b>Angle</b><br>Finds the angle subtended by two fitted lines.                                                          |  |

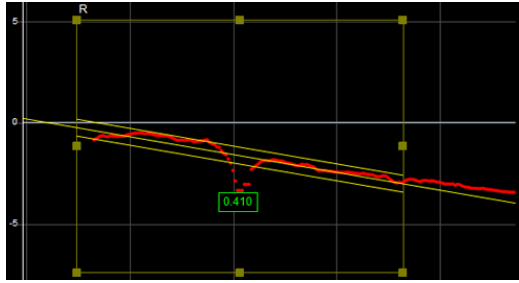
## Parameters

| 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. See <i>Fit Lines</i> (page 136) for more information.                                                                                                                                                                                                      |
| Absolute<br>(Angle measurement only) | Determines if the result will be expressed as an absolute or a signed value.                                                                                                                                                                                                                                   |
| Decision                             | See <i>Decisions</i> (page 129).                                                                                                                                                                                                                                                                               |
| Region                               | See <i>Regions</i> (page 129).                                                                                                                                                                                                                                                                                 |
| Output                               | See <i>Filters</i> (page 131).                                                                                                                                                                                                                                                                                 |

## Line

The Line tool fits a line to the live profile and measures the deviations from the best-fitted line. The measurement value can be compared with minimum and maximum constraints to yield a decision.

See *Adding and Removing Tools* (page 124) for instructions on how to add measurement tools.



Parameter

Anchoring

Source: Top

Region

Std Dev

0.410

☒

Max Error

☐

Min Error

☐

Percentile

☐

Id: 8

Output

Filters

Decision

Min: 0 mm

Max: 1 mm

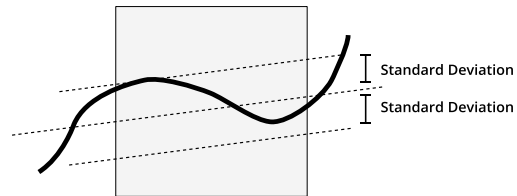
## Measurements

### Measurement

### Illustration

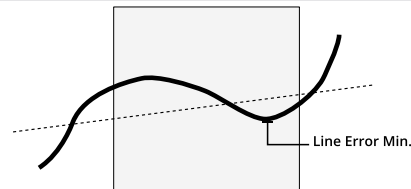
#### Std Dev

Finds the best-fitted line and measures the standard deviation of the laser points from the best-fitted line.



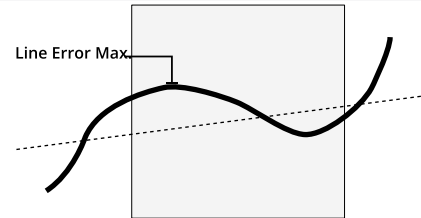
#### Min Error

Finds the best-fitted line and measures the minimum error from the best-fitted line (the maximum excursion below the fitted line).



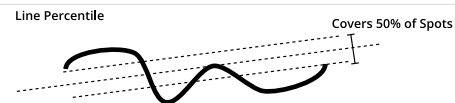
#### Max Error

Finds the best-fitted line and measures the maximum error from the best-fitted line (the maximum excursion above the fitted line).



#### Percentile

Finds the best-fitted line and measures the range (in Z) that covers a percentage of points around the best-fitted line.



## Parameters

### Parameter

### Description

Percent

The specified percentage of points around the best-



| Parameter                     | Description                      |
|-------------------------------|----------------------------------|
| (Percentile measurement only) | fitted line.                     |
| Decision                      | See <i>Decisions</i> (page 129). |
| Region                        | See <i>Regions</i> (page 129).   |
| Output                        | See <i>Filters</i> (page 131).   |

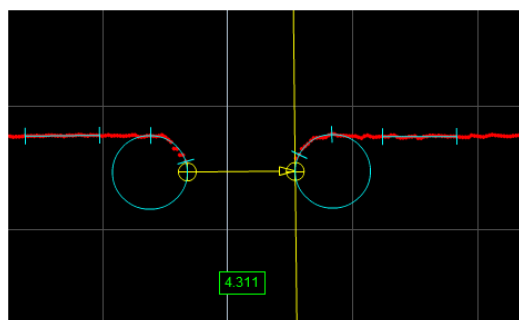
## Panel

This section describes the Panel tool's Gap and Flush measurements.

### Gap

The Gap measurement provides the distance between the edges of two surfaces. The measurement value can be compared with minimum and maximum constraints to yield a decision.

See *Adding and Removing Tools* (page 124) for instructions on how to add measurement tools.



Parameter

Anchoring

Source: 

Top

Reference Side: 

Left

Max Gap Width: 

0 mm

Left

Max Void Width: 0 mm

Min Depth: 0 mm

Surface Width: 5 mm

Surface Offset: 2 mm

Nominal Radius: 2 mm

Edge Angle: 90 °

Edge Type: Tangent

Region

Right

Gap

4.311

Flush

Id: 

1

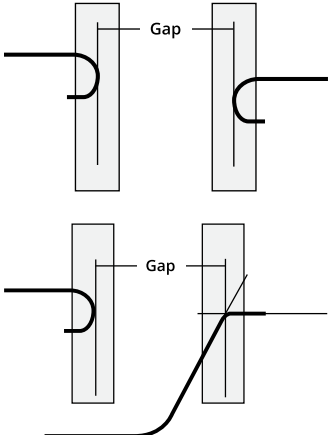
Parameters

Output

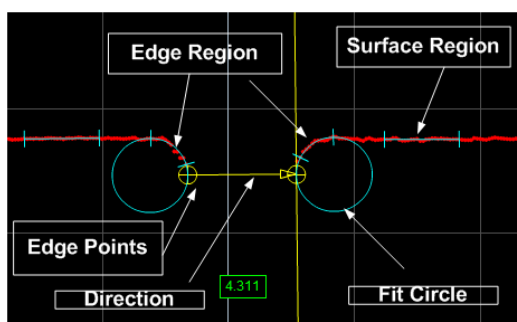
Measurement Axis: 

Edge

The Gap tool uses a complex feature-locating algorithm to find the gap and then 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 and the parameters.

| Measurement                                                                                         | Illustration                                                                       |
|-----------------------------------------------------------------------------------------------------|------------------------------------------------------------------------------------|
| <b>Gap</b><br>Measures the distance between two surfaces. The surface edges can be curved or sharp. |  |

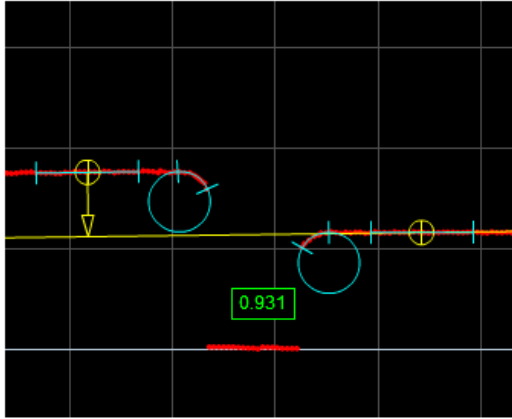
The Data Viewer displays the gap measurement in real time. It also displays the results from the intermediate steps in the algorithm.



### Flush

The Flush measurement provides the flushness between the edges of two surfaces. The measurement value can be compared with minimum and maximum constraints to yield a decision.

See *Adding and Removing Tools* (page 124) for instructions on how to add measurement tools.



ParameterAnchoring

Source:Top

Reference Side:Left

Max Gap Width:0 mm

Left

Max Void Width:0 mm

Min Depth:0 mm

Surface Width:5 mm

Surface Offset:2 mm

Nominal Radius:2 mm

Edge Angle:90 °

Edge Type:Tangent

Region

Right

Gap

Flush0.931

Id:2

ParametersOutput

Filters

Decision

Min:0 mm

Max:1 mm

The Flush tool uses a complex feature-locating algorithm to find the flushness of the object it is being used on and then 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.

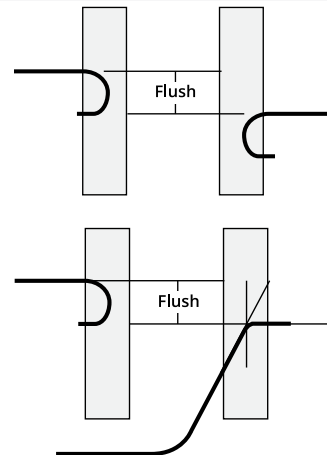
## Measurements

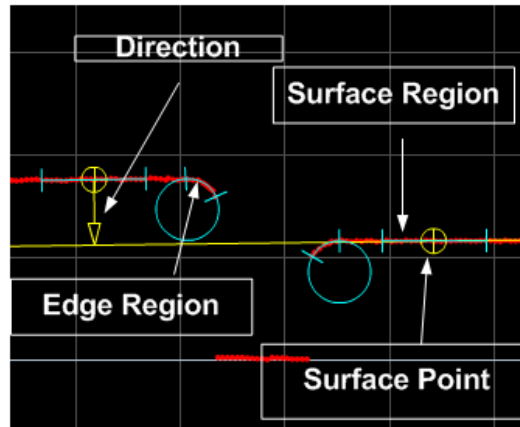
### Measurement

#### Flush

Measures the flushness between two surfaces. The surface edges can be curved or sharp.

### Illustration



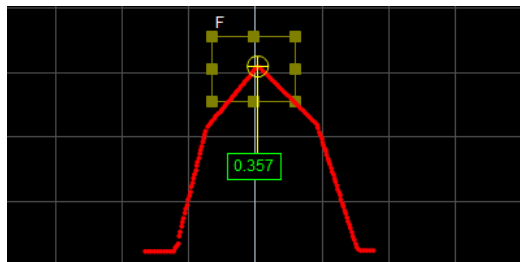


The Data Viewer displays the flush measurement in real time. It also displays the results from the intermediate steps in the algorithm.

### 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). The measurement value can be compared with minimum and maximum constraints to yield a decision.

See *Adding and Removing Tools* (page 124) for instructions on how to add measurement tools.



Parameter

Anchoring

Source:

Top

Feature

Max X

X

0.357

Z

ID:

0

Output

Filters

Decision

Min:

0

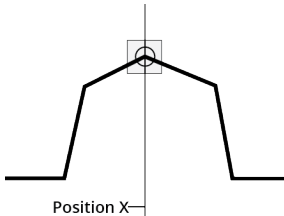
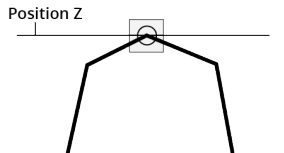
mm

Max:

1

mm

## Measurements

| Measurement                                                | Illustration                                                                                                                                                                                                                                                                                                               |
|------------------------------------------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <b>X</b><br>Finds the position of a feature on the X axis. |  A diagram showing a cross-section of a trapezoidal feature. A vertical line passes through the top center of the feature, with a small circle at the top. A horizontal line segment at the base of the feature is labeled 'Position X'. |
| <b>Z</b><br>Finds the position of a feature on the Z axis. |  A diagram showing a cross-section of a trapezoidal feature. A horizontal line passes through the top center of the feature, with a small circle at the top. A vertical line segment at the base of the feature is labeled 'Position Z'. |

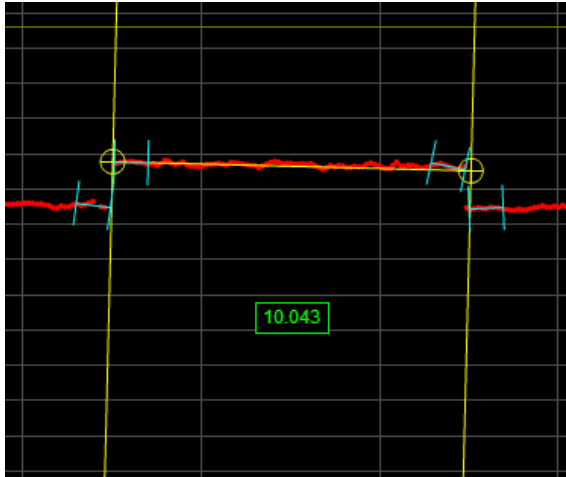
## Parameters

| 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 <i>Decisions</i> (page 129).                                                                                                                          |
| Region       | See <i>Regions</i> (page 129).                                                                                                                            |
| Output       | See <i>Filters</i> (page 131).                                                                                                                            |

## Strip

The Strip tool measures the width of a strip. The measurement value can be compared with minimum and maximum constraints to yield a decision.

See *Adding and Removing Tools* (page 124) for instructions on how to add measurement tools.



ParameterAnchoring

Source:Top
Base Type:Flat
Left Edge
Right Edge
Tilt Enabled:
Support Width:1 mm
Transition Width:0 mm
Min Width:0 mm
Min Height:1 mm
Max Void Width:1 mm
Region

X
Z
Width10.043
Height

Id:12
ParametersOutput
Select Type:Index Left
Index:0

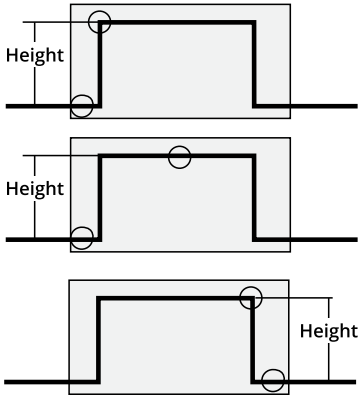
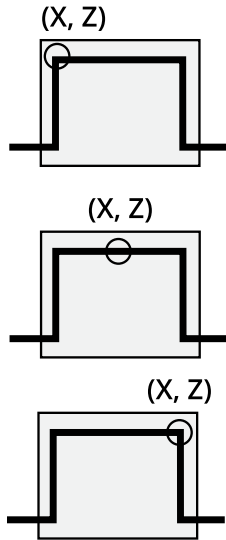
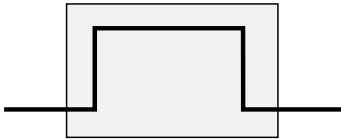
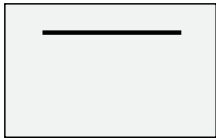
The Strip tool uses a complex feature-locating algorithm to find a strip and then return measurements. See "Strip Algorithm" in the *Gocator Measurement Tool Technical Manual* for a detailed explanation of the algorithm. The behavior of the algorithm can be adjusted by changing the parameters in the 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.

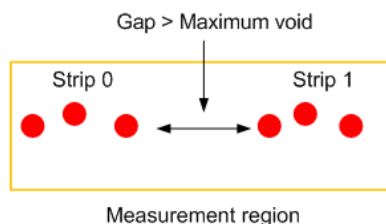
For example, if a target has three strips, by adding two measurements, choosing **Index From The Left** in the **Select Type** setting, and providing values of 1 and 3 in the **Index** of field of the measurements, respectively, the Strip tool will return measurements and decisions for the first and third strip.

## Measurements

| Measurement                                    | Illustration |
|------------------------------------------------|--------------|
| <b>Width</b><br>Measures the width of a strip. |              |

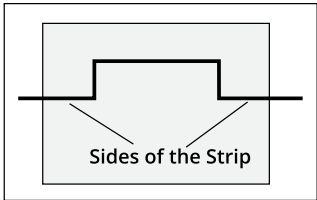
| Measurement                                                                                                                                                                                                                                                 | Illustration                                                                        |
|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------|
| <b>Height</b><br>Measures the height of a strip.                                                                                                                                                                                                            |   |
| <b>X</b><br>Measures the X position of a strip.                                                                                                                                                                                                             |  |
| <b>Z</b><br>Measures the Z position of a strip.                                                                                                                                                                                                             |                                                                                     |
| <i>Parameters</i>                                                                                                                                                                                                                                           |                                                                                     |
| Parameter                                                                                                                                                                                                                                                   | Description                                                                         |
| Base Type                                                                                                                                                                                                                                                   | Affects detection of rising and falling edges.                                      |
| <div> <div>Base Type = Flat</div>  </div> <div> <div>Base Type = None</div>  </div> |                                                                                     |
| 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.             |                                                                                     |

| Parameter                                                          | Description                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            |
|--------------------------------------------------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Location<br>(Strip Height, Strip X, and Strip Z measurements only) | Specifies the strip position from which the measurements are performed.<br><b>Left</b> - Left edge of the strip.<br><b>Right</b> - Right edge of the strip.<br><b>Center</b> - Center of the strip.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    |
| Left Edge<br>Right Edge                                            | Specifies the features that will be considered as the strip's left and right edges. You can select more than one condition.<br><b>Rising</b> - Rising edge detected based on the strip edge parameters.<br><b>Falling</b> - Falling edge detected based on the strip edge parameters.<br><b>Data end</b> - First valid profile data point in the measurement region.<br><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.<br>See "Strip Start and Terminate Conditions" in the <i>Gocator Measurement Tool Technical Manual</i> for the definitions of these conditions. |
| Select Type                                                        | Specifies how a strip is selected when there are multiple strips within the measurement area.<br><b>Best</b> - The widest strip.<br><b>Index Left</b> - 0-based strip index, counting from left to right.<br><b>Index Right</b> - 0-based strip index, counting from right to left.                                                                                                                                                                                                                                                                                                                                                                                                    |
| Index                                                              | 0-based strip index.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   |
| Min Height                                                         | 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.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 |
| 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                                                     | 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> .                                                                                                                                                                                                                                                                                                                                                                                                                                                  |



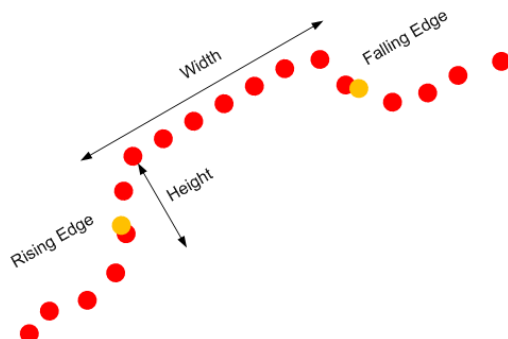
When occlusion and exposure causes data drops, users should use the gap filling function to fill the gaps. See *Gap Filling* (page 87) for information.



| Parameter    | Description                                                                                                                                                                                 |
|--------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Min Width    | Specifies the minimum width for a strip to be considered valid.                                                                                                                             |
| Tilt Enabled | Enables/disables tile correction.                                                                                                                                                           |
| Decision     | See <i>Decisions</i> (page 129).                                                                                                                                                            |
| Region       | 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. |
|              |                                                                                                           |
|              | See <i>Regions</i> (page 129) for more information.                                                                                                                                         |
| Output       | See <i>Filters</i> (page 131).                                                                                                                                                              |

### 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.

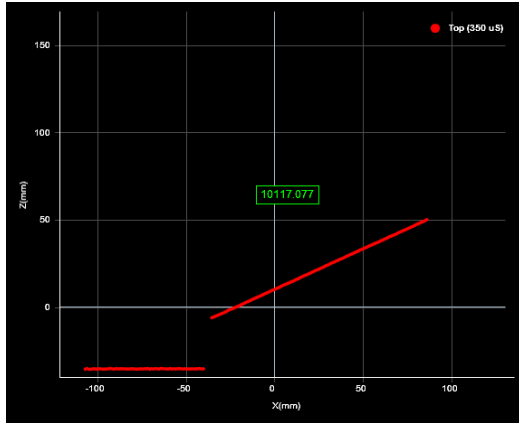


### Script

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.

See *Adding and Removing Tools* (page 124) for instructions on how to add measurement tools.

See *Script Measurement* (page 190) 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:

Output 0 10117.077

Id:

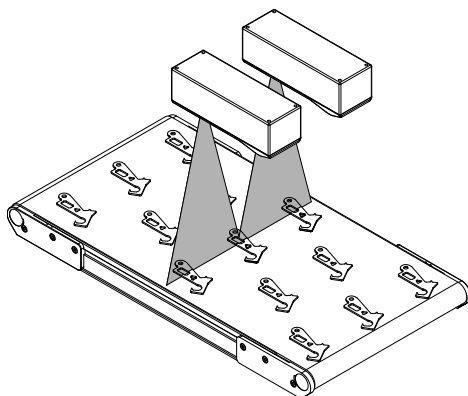
See *Script Measurement* (page 190) for more information on the script syntax.

*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 (see page 93). 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.

## Measurement Tools

### Bounding Box

The Bounding Box tool provides measurements related to the smallest rectangle box that encapsulates the part (for example, X position, Y position, width, length, etc.).

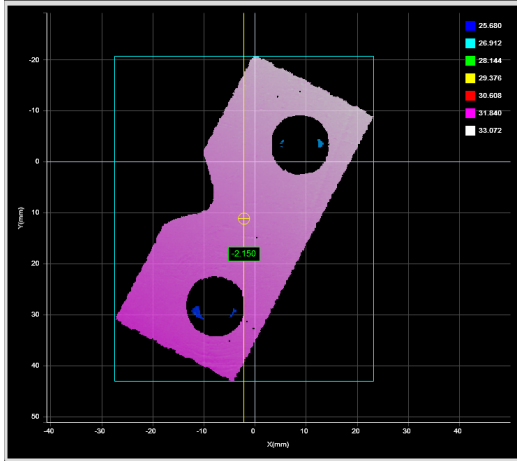
The measurement value can be compared with minimum and maximum constraints to yield a decision.

See *Adding and Removing Tools* (page 124) for instructions on how to add measurement tools.

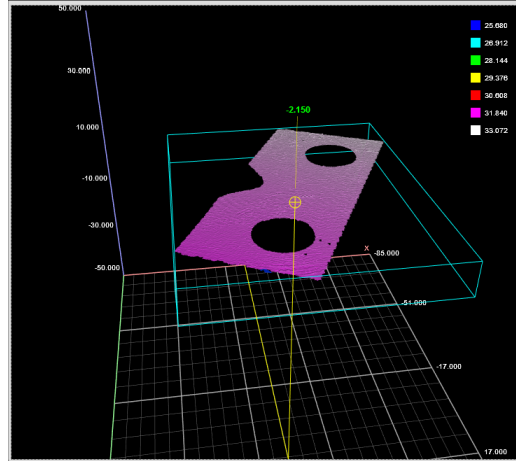
A bounding box can be vertical or rotated. A vertical bounding box provides the absolute position from which the Position centroids tools are referenced.



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 GlobalX and GlobalY) are referenced to this point when **Frame of Reference** on the **Part Detection** panel is set to **Part**. See *Part Detection* (page 93) for more information.



2D View



3D View

Parameter

Anchoring

Source:

Top

Rotation:

☒ Region

X

-2.150

☒

Y

☐

Z

☐

Width

☐

Length

☐

Height

☐

Z Angle

☐

Global X

☐

Global Y

☐

Id:

0

Output

Filters

Decision

Min:

0

mm

Max:

0

mm

Measurement Panel

## Measurements

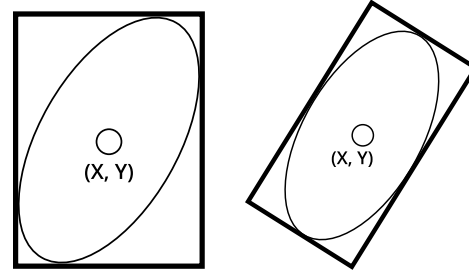
### Measurement

### Illustration

#### X

Determines the X position of the center of the smallest rectangle that encapsulates the part.

The value returned is relative to the part.



#### Y

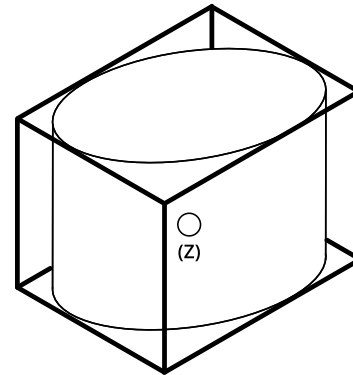
Determines the Y position of the center of the smallest rectangle that encapsulates the part.

The value returned is relative to the part.

#### Z

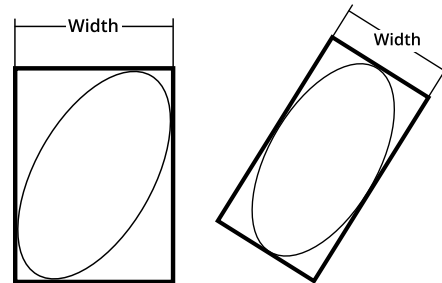
Determines the Z position of the center of the smallest rectangle that encapsulates the part.

The value returned is relative to the part.



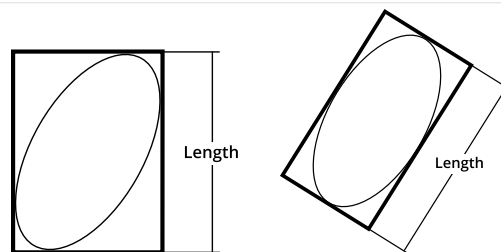
#### Width

Determines the width of the smallest rectangle box that encapsulates the part. The width reports the dimension of the box in the direction of the minor axis. When rotation is enabled, the bounding box is rotated by the angle of an ellipse fitted to the part data.



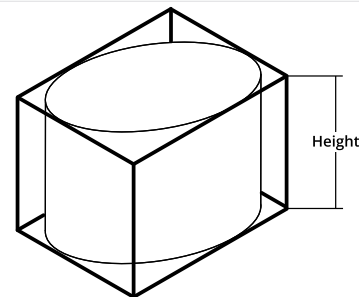
#### Length

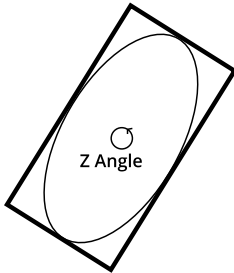
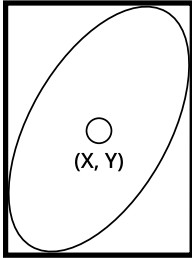
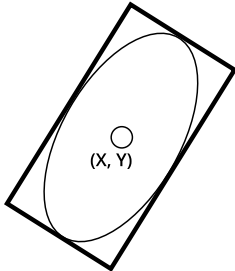
Determines the length of the smallest rectangle box that encapsulates the part. The length reports the dimension of the box in the direction of the major axis. When rotation is enabled, the bounding box is rotated by the angle of an ellipse fitted to the part data.



#### Height

Determines the height (thickness) of the smallest rectangle box that encapsulates the part.



| Measurement                                                                                                                                                                                  | Illustration                                                                        |
|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------|
| <p><b>Z Angle</b></p> <p>Determines the rotation about the Z axis and the angle of the bounding box relative to the X axis.</p>                                                              |   |
| <p><b>Global X</b></p> <p>Determines the X position of the center of the smallest rectangle that encapsulates the part. The value returned is relative to the global/sensor coordinates.</p> |   |
| <p><b>Global Y</b></p> <p>Determines the Y position of the center of the smallest rectangle that encapsulates the part. The value returned is relative to the global/sensor coordinates.</p> |  |

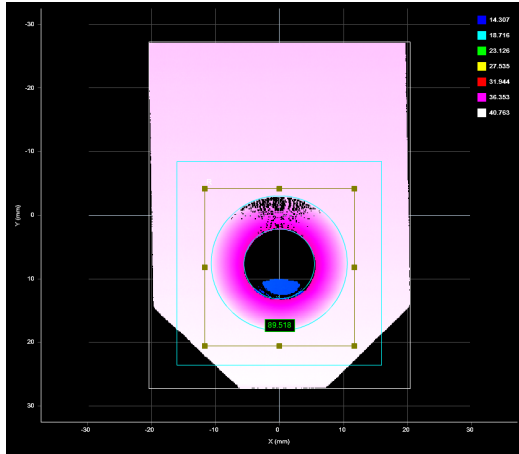
#### Parameters

| 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. Check the <b>Rotation</b> checkbox to select rotated bounding box. |
| Decision  | See <i>Decisions</i> (page 129).                                                                                                                                                                                                          |
| Region    | See <i>Regions</i> (page 129).                                                                                                                                                                                                            |
| Output    | See <i>Filters</i> (page 131).                                                                                                                                                                                                            |

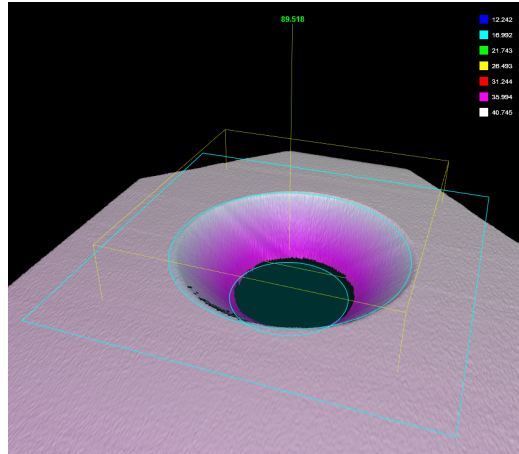
### Countersunk Hole

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.

See *Adding and Removing Tools* (page 124) for instructions on how to add measurement tools.



2D View



3D View

ParameterAdvancedAnchoring

Source:Top

Nominal Bevel Angle:100°

Bevel Angle Tolerance:5°

Nominal Outer Radius:10 mm

Outer Radius Tolerance:1 mm

Nominal Inner Radius:4 mm

Inner Radius Tolerance:1 mm

Bevel Radius Offset:4 mm

Partial Detection:

☒ Region

X89.518

Y

Z

Outer Radius

Depth

Bevel Radius

Bevel Angle

X Angle

Y Angle

ID:0

Output

Filters

Decision

Min:89 mm

Max:90 mm

ParameterAdvancedAnchoring

Curve Surface

Reference Region

Auto Set

Tilt Correction

Auto Set

X

Y

Z

Outer Radius

Depth

Bevel Radius

Bevel Angle

X Angle

Y Angle

ID:

0

Output

Filters

Decision

Min:

0 mm

Max:

0 mm

## Measurements

### Measurement

#### X

Determines the X position of the center of the countersunk hole.

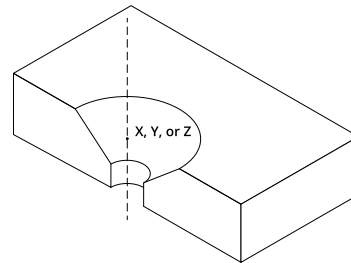
#### Y

Determines the Y position of the center of the countersunk hole.

#### Z

Determines the Z position of the center of the countersunk hole.

### Illustration





---

## Measurement

## Illustration

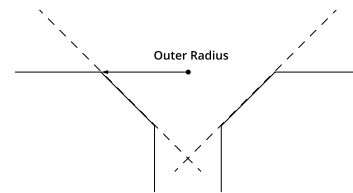
---

### Outer Radius

Determines the outer radius of the countersunk hole.

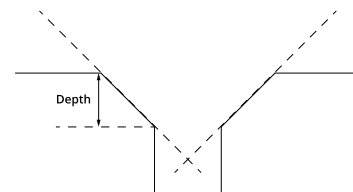


To convert the radius to a diameter, set the **Scale** setting in the **Output** panel (displayed after expanding the **Filters** section) to 2.



### Depth

Determines the depth of the countersunk hole relative to the surface that the countersunk hole is on.

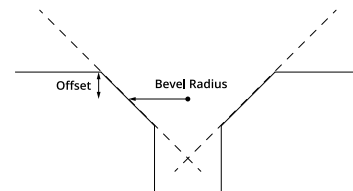


### Bevel Radius

Determines the radius at a user-defined offset (**Offset** setting) relative to the surface that the countersunk hole is on.

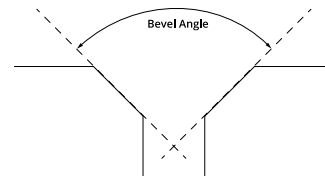


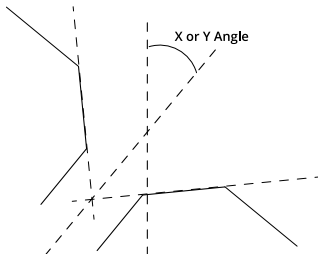
To convert the radius to a diameter, set the **Scale** setting in the **Output** panel (displayed after expanding the **Filters** section) to 2.

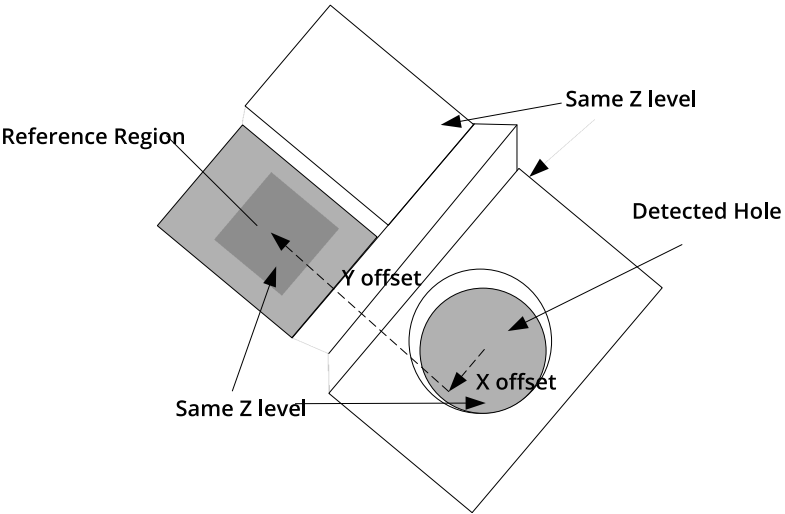


### Bevel Angle

Determines the angle of the hole's bevel.



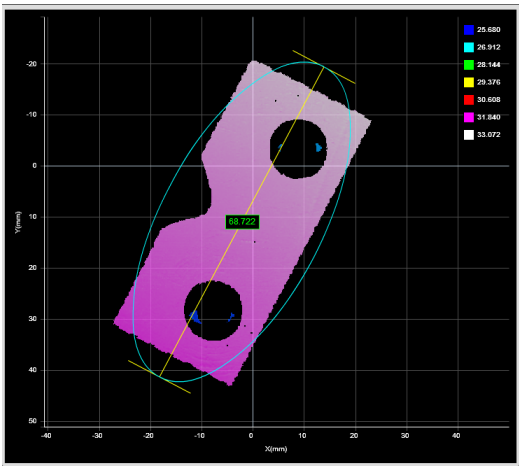
| Measurement                                                                                                                                                                                                   | Illustration                                                                                                                                                          |
|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <p><b>X Angle</b></p> <p>Determines the angle the hole relative to the X axis.</p> <p>The measurement assumes that the hole is perpendicular to the surface, even though the surface itself is tilted.</p>    |                                                                                     |
| <p><b>Y Angle</b></p> <p>Determines the angle of the hole relative to the Y axis.</p> <p>The measurement assumes that the hole is perpendicular to the surface, even though the surface itself is tilted.</p> |                                                                                                                                                                       |
| <i>Parameters</i>                                                                                                                                                                                             |                                                                                                                                                                       |
| Parameter                                                                                                                                                                                                     | Description                                                                                                                                                           |
| Nominal Bevel Angle                                                                                                                                                                                           | The expected bevel angle of the countersunk hole.                                                                                                                     |
| Bevel Angle Tolerance                                                                                                                                                                                         | The maximum variation from the nominal bevel angle (+/- from the nominal bevel angle).                                                                                |
| Nominal Outer Radius                                                                                                                                                                                          | The expected outer radius of the countersunk hole.                                                                                                                    |
| Outer Radius Tolerance                                                                                                                                                                                        | The maximum variation from the nominal outer radius (+/- from the nominal outer radius).                                                                              |
| Nominal Inner Radius                                                                                                                                                                                          | The expected outer radius of the countersunk hole.                                                                                                                    |
| Inner Radius Tolerance                                                                                                                                                                                        | The maximum variation from the nominal inner radius (+/- from the nominal inner radius).                                                                              |
| Bevel Radius Offset                                                                                                                                                                                           | The offset, relative to the surface that the countersunk hole is on, at which the bevel radius will be measured.                                                      |
| Curve Surface                                                                                                                                                                                                 | Whether the surface that the countersunk hole is on is curved. When enabled, specify the radius of the curvature in the <b>Curve Orientation</b> setting.             |
| 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. |

| Parameter         | Description                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         |
|-------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
|                   |  <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. 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.</p> <p>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>                                                                                                                                                                                                                                                                                                                                                                                                                                                |
| Decision          | See <i>Decisions</i> (page 129).                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    |
| Region            | See <i>Regions</i> (page 129).                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      |
| Output            | See <i>Filters</i> (page 131).                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      |

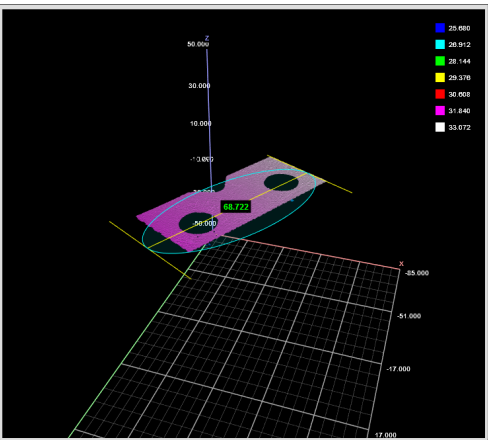
## Ellipse

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. The measurement value can be compared with minimum and maximum constraints to yield a decision.

See *Adding and Removing Tools* (page 124) for instructions on how to add measurement tools.



2D View



3D View

Parameter

Anchoring

Source: 

Top

☒ Region

Major

68.722

☒

Minor

☐

Ratio

☐

Z Angle

☐

Id:

2

Output

Filters

Decision

Min:

68

mm

Max:

69

mm

Measurement Panel

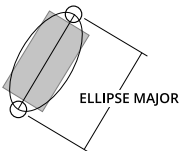
Measurements

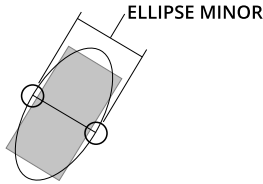
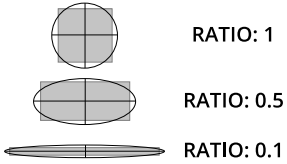
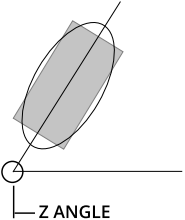
Measurement

Illustration

Major

Determines the major axis length of an ellipse fitted to the part's area in the XY plane.



| Measurement                                                                                                    | Illustration                                                                        |
|----------------------------------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------|
| <b>Minor</b><br>Determines the minor axis length of an ellipse fitted to the part's area in the XY plane.      |  |
| <b>Ratio</b><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>Determines the orientation angle of an ellipse fitted to the part's area in the XY plane.    |  |

#### Parameters

| Parameter | Description                      |
|-----------|----------------------------------|
| Decision  | See <i>Decisions</i> (page 129). |
| Region    | See <i>Regions</i> (page 129).   |
| Output    | See <i>Filters</i> (page 131).   |

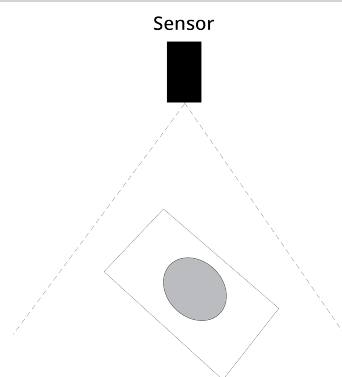
## Hole

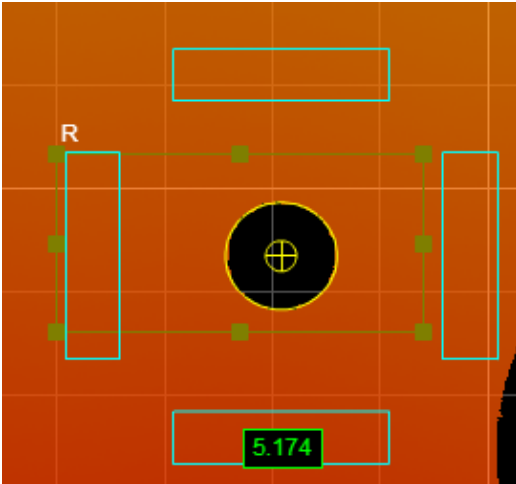
The Hole tool locates a circular opening within a region of interest on the surface and returns its position and radius.

See *Adding and Removing Tools* (page 124) for instructions on how to add measurement tools. The hole can be on a surface at an angle to the sensor.

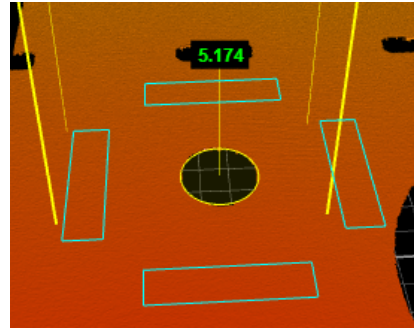
The tool uses a complex feature-locating algorithm to find a hold and then return measurements. See "Hole Algorithm" in the *Gocator Measurement Tool Technical Manual* for a detailed explanation of the algorithm. The behavior of the algorithm can be adjusted by changing the parameters in the measurement panel.

The measurement value can be compared with minimum and maximum constraints to yield a decision.





2D View



3D View

Parameter
Advanced
Anchoring

Source:
Top

Nominal Radius:
10
mm

Radius Tolerance:
5
mm

Partial Detection:
☐

☒ Region

X:
-40.062
mm

Y:
-3.225
mm

Z:
-50
mm

Width:
34.052
mm

Length:
17.152
mm

Height:
100
mm

X
☐

Y
☐

Z
☐

Radius
5.174
☒

Id:
10

Output

Filters

Decision

Min:
3
mm

Max:
8
mm

ParameterAdvancedAnchoring

☒ Reference Region

Auto Set

Tilt Correction

Auto Set

X

Y

Z

Radius

5.174

☒

Id:

10

Output

Filters

Decision

Min:

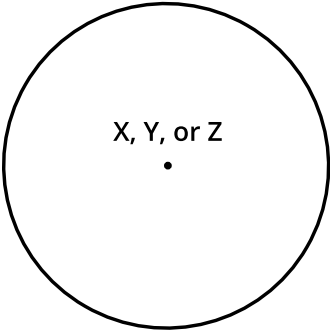
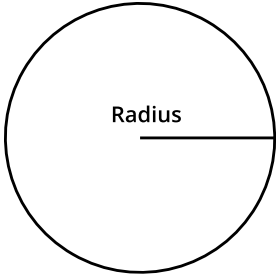
3 mm

Max:

8 mm

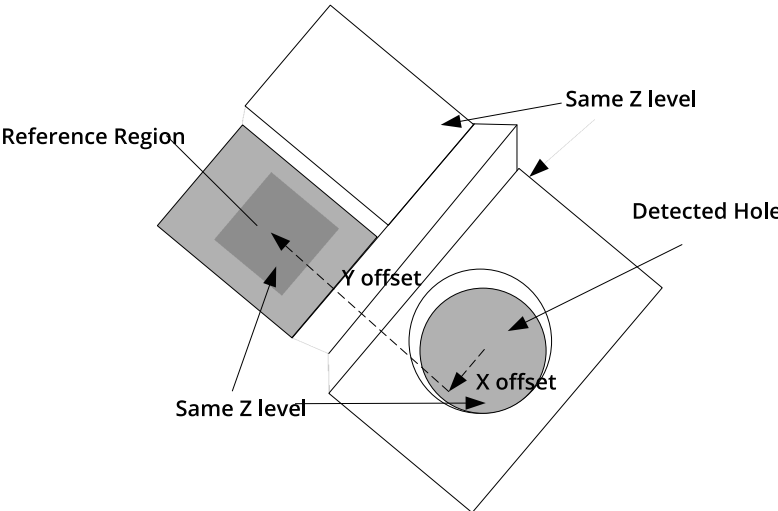
Measurement Panel

Measurements

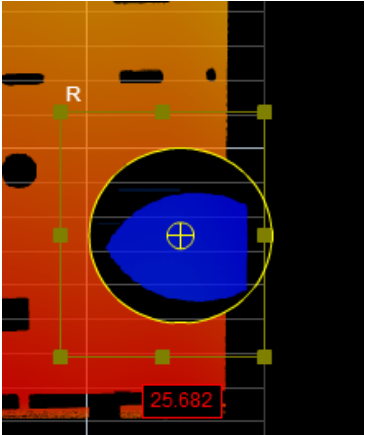
| Measurement                                               | Illustration                                                                         |
|-----------------------------------------------------------|--------------------------------------------------------------------------------------|
| <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.       |  |

Parameters

| Parameter        | Description                                                                  |
|------------------|------------------------------------------------------------------------------|
| Nominal Radius   | Expected radius of the hole.                                                 |
| Radius Tolerance | The maximum variation from the nominal radius (+/- from the nominal radius). |

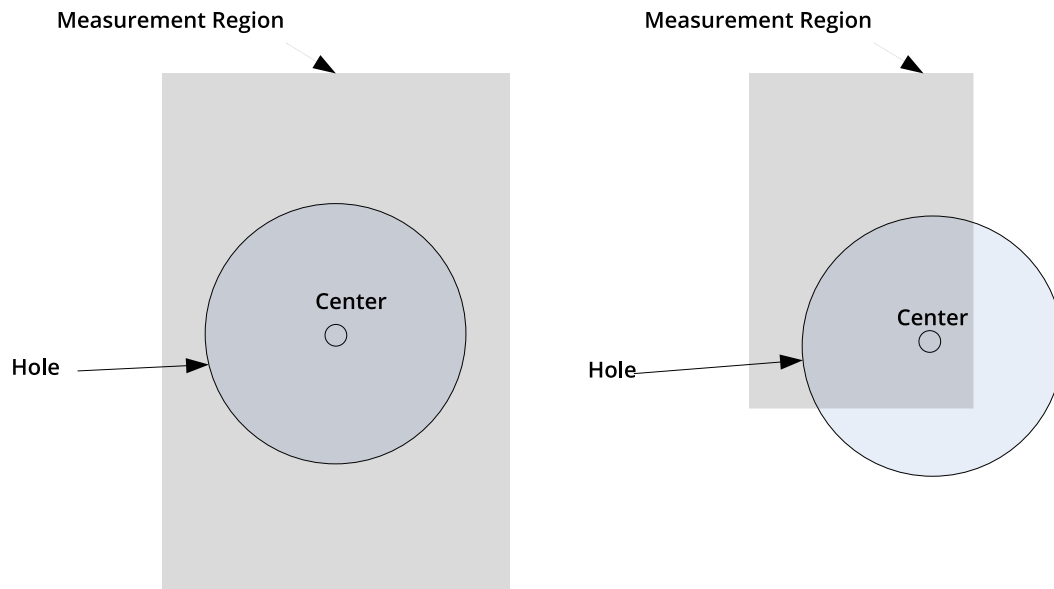
| Parameter         | Description                                                                                                                                                                                                                                                                                                                                                                                                 |
|-------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 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>                                                                                                                                              |
| 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.</p> <p>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>                                                                                                                                                                                                                                        |



| Parameter | Description                                                                        |
|-----------|------------------------------------------------------------------------------------|
|           |  |
| Decision  | See <i>Decisions</i> (page 129).                                                   |
| Region    | See <i>Regions</i> (page 129).                                                     |
| Output    | See <i>Filters</i> (page 131).                                                     |

### Measurement Region

The center of the hole must be inside the measurement region, even if the Partial Detection option is enabled.



## Opening

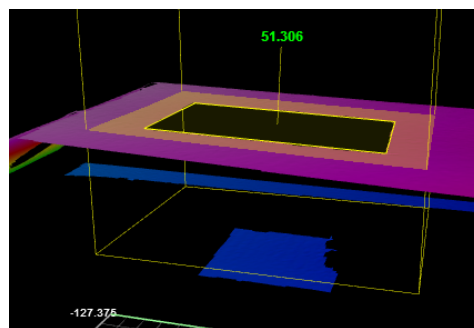
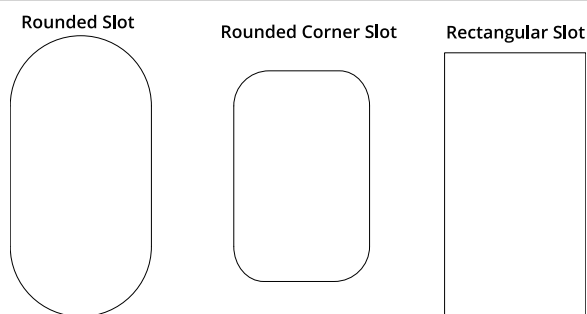
The Opening tool locates rounded, rectangular, and rounded corner openings. The opening can be on a surface at an angle to the sensor.

See *Adding and Removing Tools* (page 124) 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.

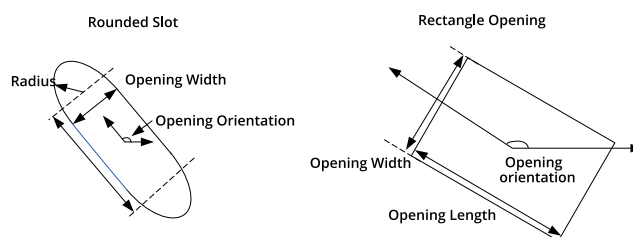
The measurement value can be compared with minimum and maximum constraints to yield a decision. You can select the measurement region in which the opening is expected to appear.

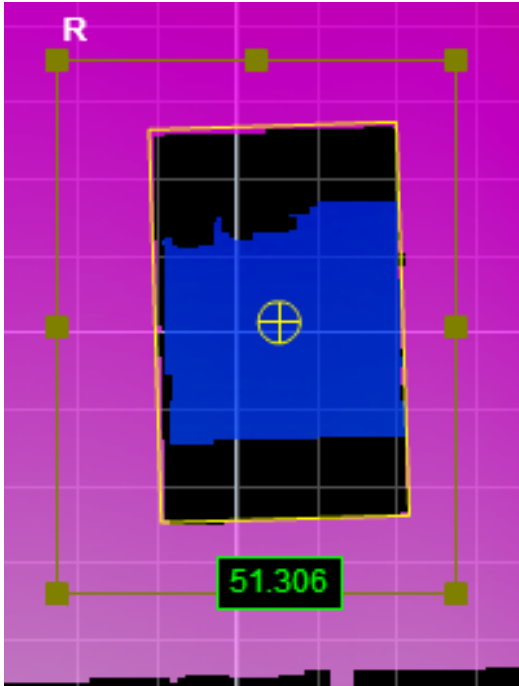
The algorithm can separate out background information that appears inside the opening. It can also detect a slot that only partially appears in the data.



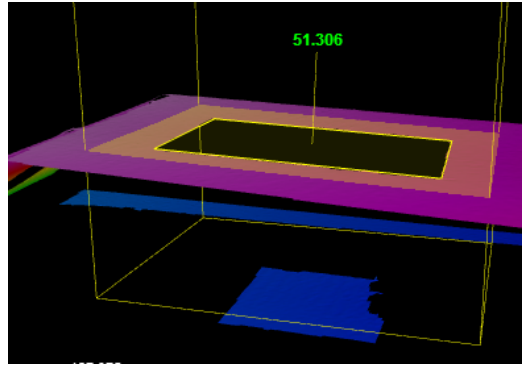
The shape of the opening is defined by its type and its nominal width, length, and radius.

The orientation defines the rotation around the normal of the alignment plane.





2D View



3D View

ParameterAdvancedAnchoring

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:

Region

X

Y

Z

Width

Length51.306

Angle

Id:11

Output

Filters

Decision

Min:50 mm

Max:60 mm

ParameterAdvancedAnchoring

Reference RegionAuto Set

Tilt CorrectionAuto Set

X

Y

Z

Width

Length51.306

Angle

Id:11

Output

Filters

Decision

Min:50 mm

Max:60 mm

**Measurements****Measurement****Illustration****X**

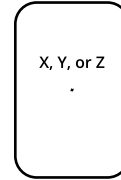
Determines the X position of the opening's center.

**Y**

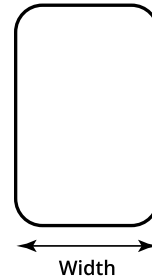
Determines the Y position of the opening's center.

**Z**

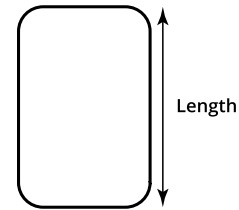
Determines the Z position of the opening's center.

**Width**

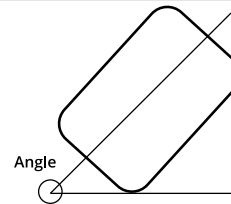
Determines the width of the opening.

**Length**

Determines the length of the opening.

**Angle**

Determines the angle (rotation) around the normal of the alignment plane.

**Parameters****Parameter****Description**

Type

Rounded Slot, Rectangle.

Nominal Width

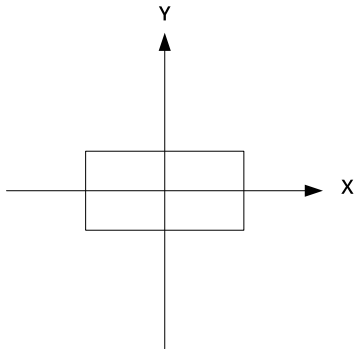
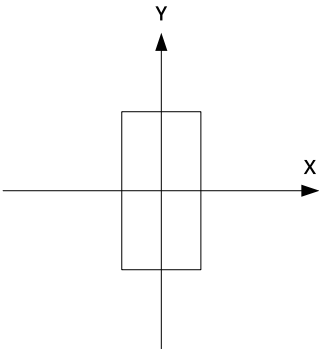
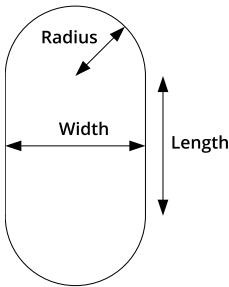
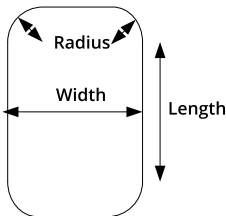
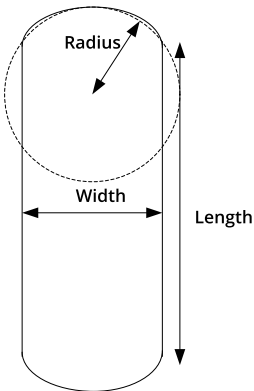
Nominal width of the opening.

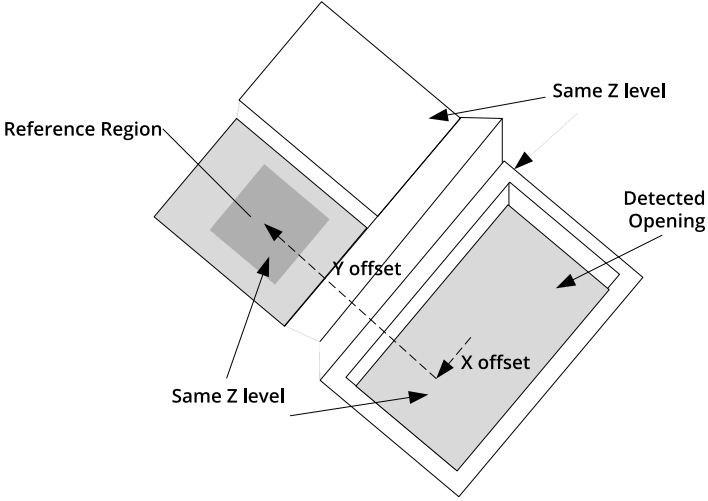
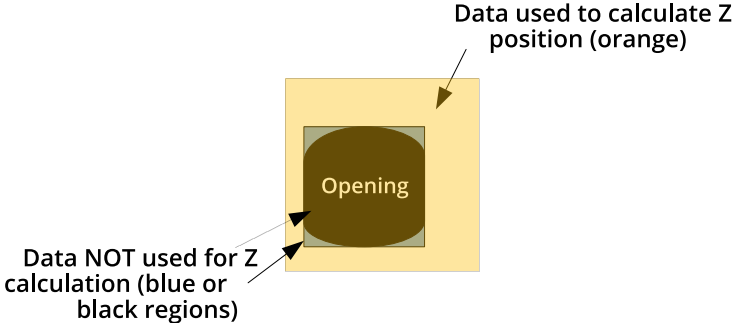
Nominal length

Nominal length of the opening.

Nominal Angle

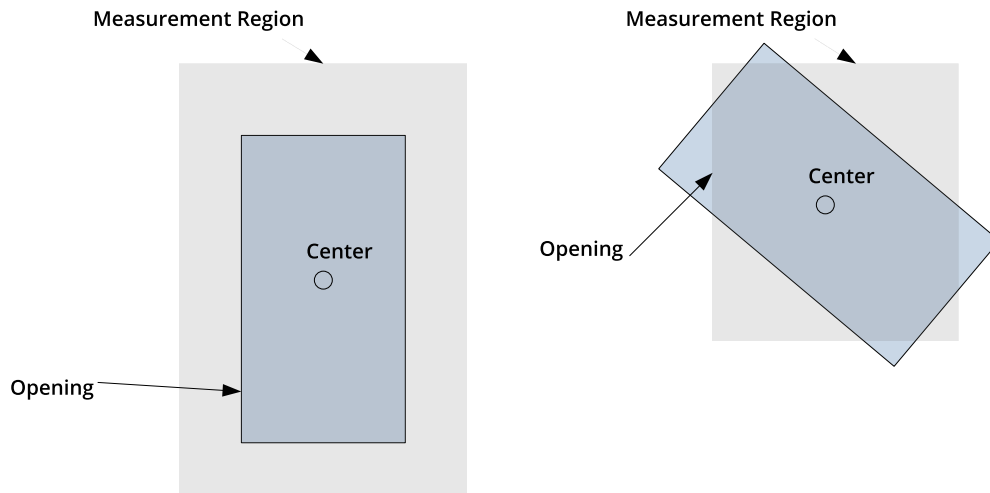
Nominal angle of the opening. The default orientation is the length of the opening along the X axis.

| Parameter             | Description                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       |
|-----------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
|                       | <div style="display: flex; justify-content: space-around; align-items: flex-start;"> <div style="text-align: center;"> <p>Orientation: 0 degrees</p>  </div> <div style="text-align: center;"> <p>Orientation: 90 degrees</p>  </div> </div> <p>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</p>                                                                                                                                                                                                                                                                                                                                |
| 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> <div style="display: flex; justify-content: space-around; align-items: flex-start;"> <div style="text-align: center;"> <p>Radius = <math>\frac{1}{2}</math> width</p>  </div> <div style="text-align: center;"> <p>Radius &lt; <math>\frac{1}{2}</math> width</p>  </div> <div style="text-align: center;"> <p>Radius &gt; <math>\frac{1}{2}</math> width</p>  </div> </div> |
| 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).                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       |
| Orientation Tolerance | The maximum variation from the nominal orientation (+/- from the nominal value).                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  |
| 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>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            |

| Parameter       | Description                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               |
|-----------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
|                 |  <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> (page 129).                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          |
| Region          | See <i>Regions</i> (page 129).                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            |
| Output          | See <i>Filters</i> (page 131).                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            |

## 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

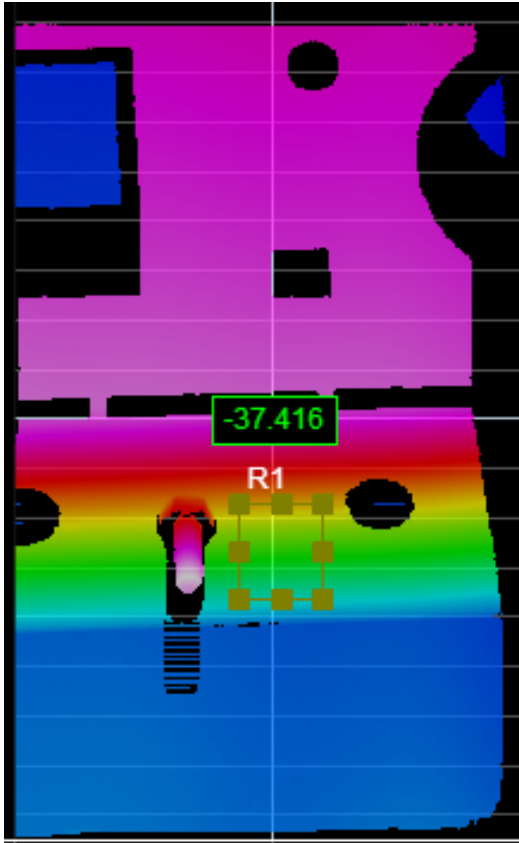
The Plane tool provides measurements that report angle X, angle Y, and offset Z of the surface with respect to the alignment target. The measurement value can be compared with minimum and maximum constraints to yield a decision.

See *Adding and Removing Tools* (page 124) for instructions on how to add measurement tools.

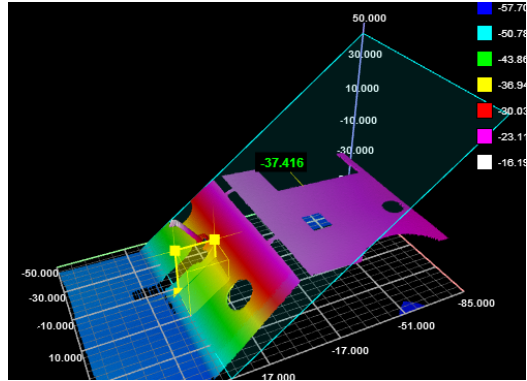
The Z offset reported is the Z position at zero position on the X axis and the Y axis.

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

Parameter

Anchoring

Source:

Top

Regions

1 Region

X Angle

-37.416

☒

Y Angle
☐

Z Offset
☐

Id:

5

Output

Filters

Decision

Min:

-38

mm

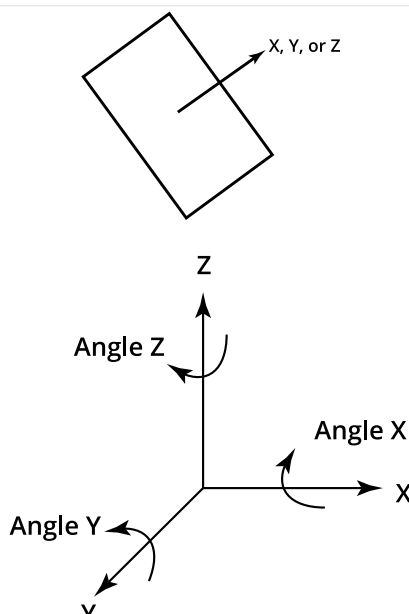
Max:

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. |                                                                                    |

## Parameters

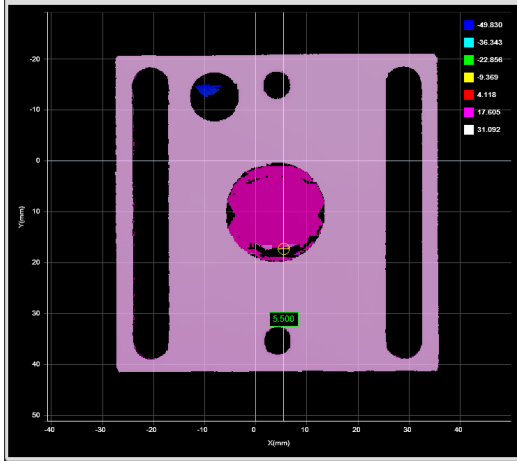
| Parameter | Description                      |
|-----------|----------------------------------|
| Decision  | See <i>Decisions</i> (page 129). |
| Region    | See <i>Regions</i> (page 129).   |
| Output    | See <i>Filters</i> (page 131).   |

## Position

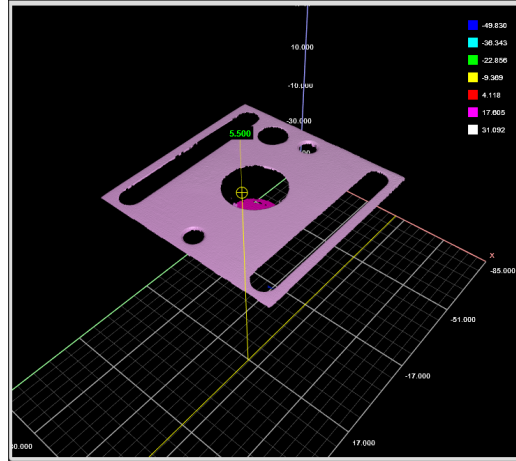
The Position tool reports the X, Y, or Z position of a part. The feature type must be specified and is one of the following: Average (the mean X, Y, and Z of the data points), Median (median X, Y, and Z of the data points), Centroid (the centroid of the data considered as a volume with respect to the  $z = 0$  plane), Min X, Max X, Min Y, Max Y, Min Z, or Max Z.

The measurement value can be compared with minimum and maximum constraints to yield a decision.

See *Adding and Removing Tools* (page 124) for instructions on how to add measurement tools.



2D View



3D View

ParameterAnchoring

Source:Top
Feature:Max Z

X5.500
Y
Z

Id:6

Output

Filters
Decision
Min:5 mm
Max:6 mm

Measurement Panel

## Measurements

### Measurement

#### X

Determines the X position of the selected feature type.

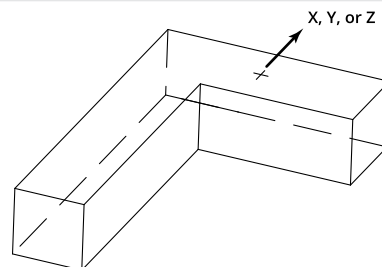
#### Y

Determines the Y position of the selected feature type.

#### Z

Determines the Z position of the selected feature type.

### Illustration



## 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> (page 129).                                                           |
| Region       | See <i>Regions</i> (page 129).                                                             |
| Output       | See <i>Filters</i> (page 131).                                                             |

## Stud

The Stud tool measures the location and radius of a stud.

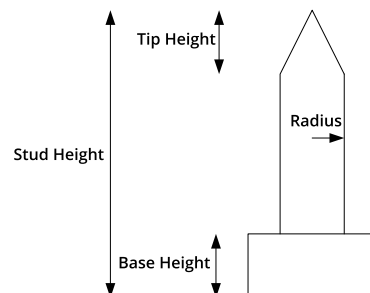
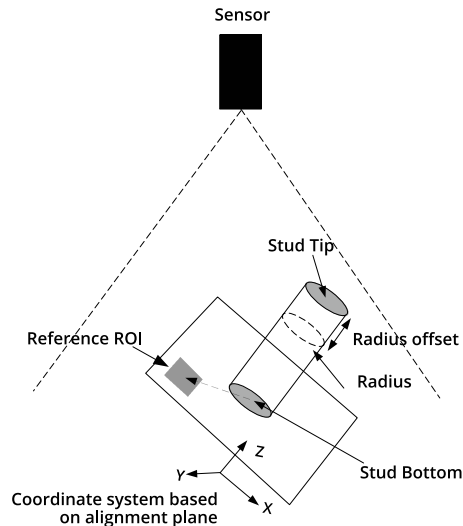
See *Adding and Removing Tools* (page 124) for instructions on how to add measurement tools.

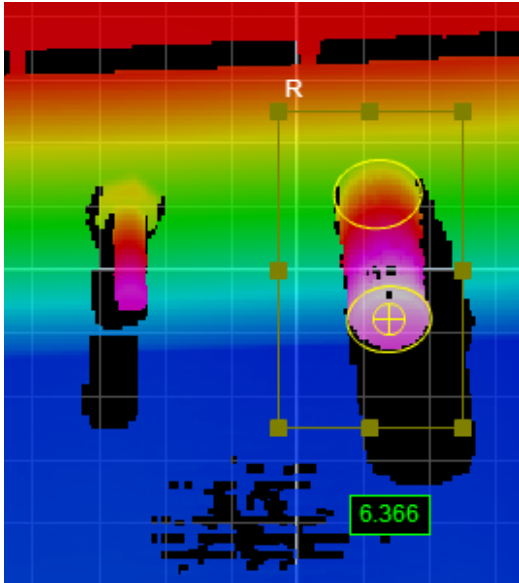
The tool uses a complex feature-locating algorithm to find a hold and then return measurements. See "Stud Algorithm" in the *Gocator Measurement Tool Technical Manual* for a detailed explanation of the algorithm. The behavior of the algorithm can be adjusted by changing the parameters in the measurement panel.

The measurement value can be compared with minimum and maximum constraints to yield a decision.

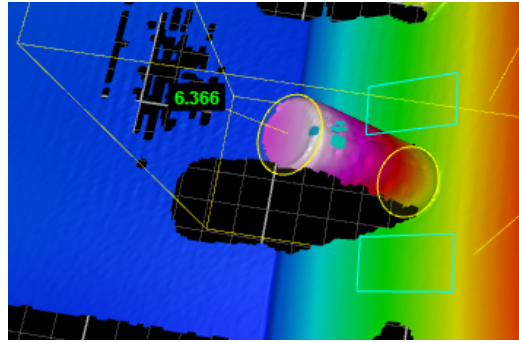
The location of the stud is defined at either the stud tip or the stud base. The tip is the intersection of the stud axis and the top of the stud; the base is the intersection of the stud axis and the surrounding plane.

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

Parameter
Advanced
Anchoring

Source:
Top

Stud Radius:
5 mm

Stud Height:
20 mm

Base Height:
0 mm

Tip Height:
0 mm

☒ Region

X:
-25 mm

Y:
-25 mm

Z:
-50 mm

Width:
50 mm

Length:
50 mm

Height:
100 mm

Base X
☐

Base Y
☐

Base Z
☐

Tip X
☐

Tip Y
☐

Tip Z
☐

Radius
6.366
☒

Id:
13

Parameters
Output

Radius Offset:
0 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

### Measurement

### Illustration

#### Tip X

Determines the X position of the stud tip.

#### Tip Y

Determines the Y position of the stud tip.

#### Tip Z

Determines the Z position of the stud tip.

#### Base X

Determines the X position of the stud base.

#### Base Y

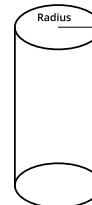
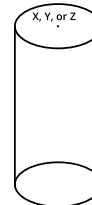
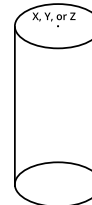
Determines the Y position of the stud base.

#### Base Z

Determines the Z position of the stud base.

#### Radius

Determines the radius of the stud.



## 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<br>(Radius measurement only) | The distance from the tip of the stud from which the radius is measured.                                                                                                                                                                                                                                                                      |
| 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. The results from the Plane X and Y tool can be used for angles X and Y parameters. |
| Decision                                   | See <i>Decisions</i> (page 129).                                                                                                                                                                                                                                                                                                              |
| Region                                     | See <i>Regions</i> (page 129).                                                                                                                                                                                                                                                                                                                |
| Output                                     | See <i>Filters</i> (page 131).                                                                                                                                                                                                                                                                                                                |

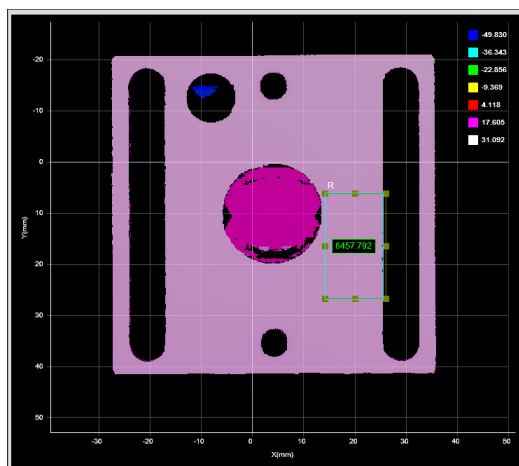
## Measurement Region

The tip and the side of the stud must be within the measurement region.

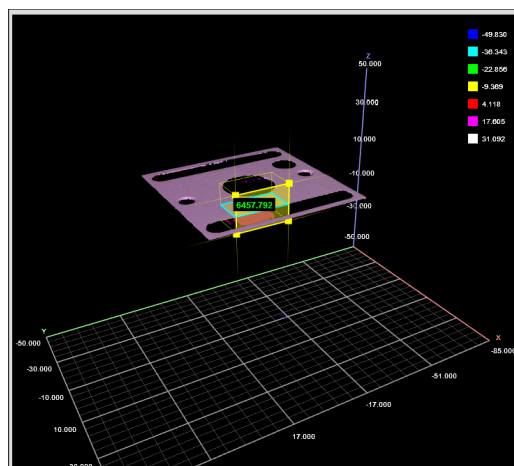
## Volume

The Volume tool determines the volume, area, and thickness of a part. The measurement value can be compared with minimum and maximum constraints to yield a decision.

See *Adding and Removing Tools* (page 124) for instructions on how to add measurement tools.



2D View



3D View

ParameterAnchoring

Source:Top

☒ Region

X:14.196mm

Y:6.121mm

Z:21.471mm

Width:11.847mm

Length:20.693mm

Height:14.326mm

Volume6457.792

Area

Thickness

Id:8

Output

Filters

Decision

Min:6540mm<sup>3</sup>

Max:6560mm<sup>3</sup>

Measurement Panel

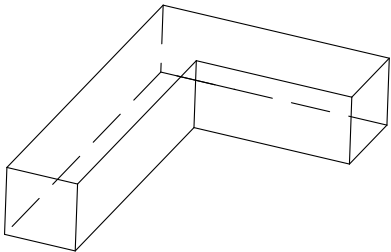
Measurements

Measurement

Illustration

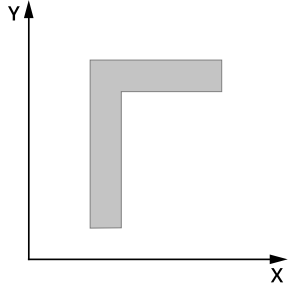
Volume

Measures volume in XYZ space.



Area

Measures area in the XY plane.



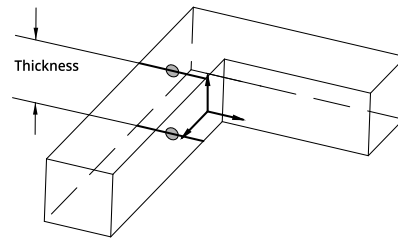


## Measurement

### Thickness

Measures thickness (height) of a part.

## Illustration



## Parameters

### Parameter

Location

(Thickness measurement only)

Decision

Region

Output

### Description

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.

See *Decisions* (page 129).

See *Regions* (page 129).

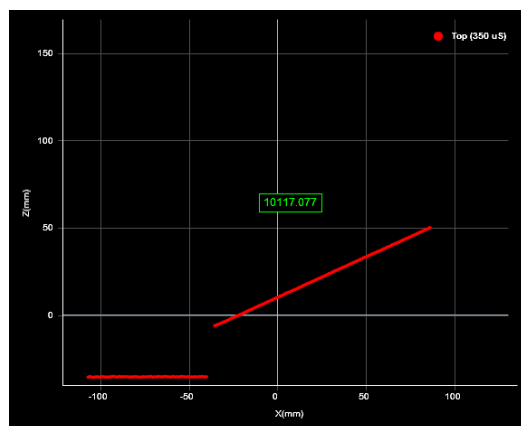
See *Filters* (page 131).

## 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 Removing Tools* (page 124) for instructions on how to add measurement tools.

See *Script Measurement* (next page) 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 *Script Measurement* (next page) 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.

## Script Measurement

A Script measurement can be used to program a custom measurement using a simplified C-based syntax. Similar to other measurement tools, a script measurement can produce multiple measurement values and decisions for the output.



Scripts must be less than 27000 characters long.

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) | Tests for the existence of a measurement by ID.<br>Parameters:<br>id – Measurement ID<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 |

| Function                                                          | Description                                                                                                                                                                                                                                                                                                                              |
|-------------------------------------------------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
|                                                                   | used (e.g., Output_SetAt(0, INVALID_VALUE, 0))<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>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>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>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>Parameters:<br>id - ID of the value<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>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>Parameters:<br>id - ID of the value<br>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                                         |

| Function                      | Description                                                                                                                                                                                                     |
|-------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 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                                                                                                                                                                        |

#### 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

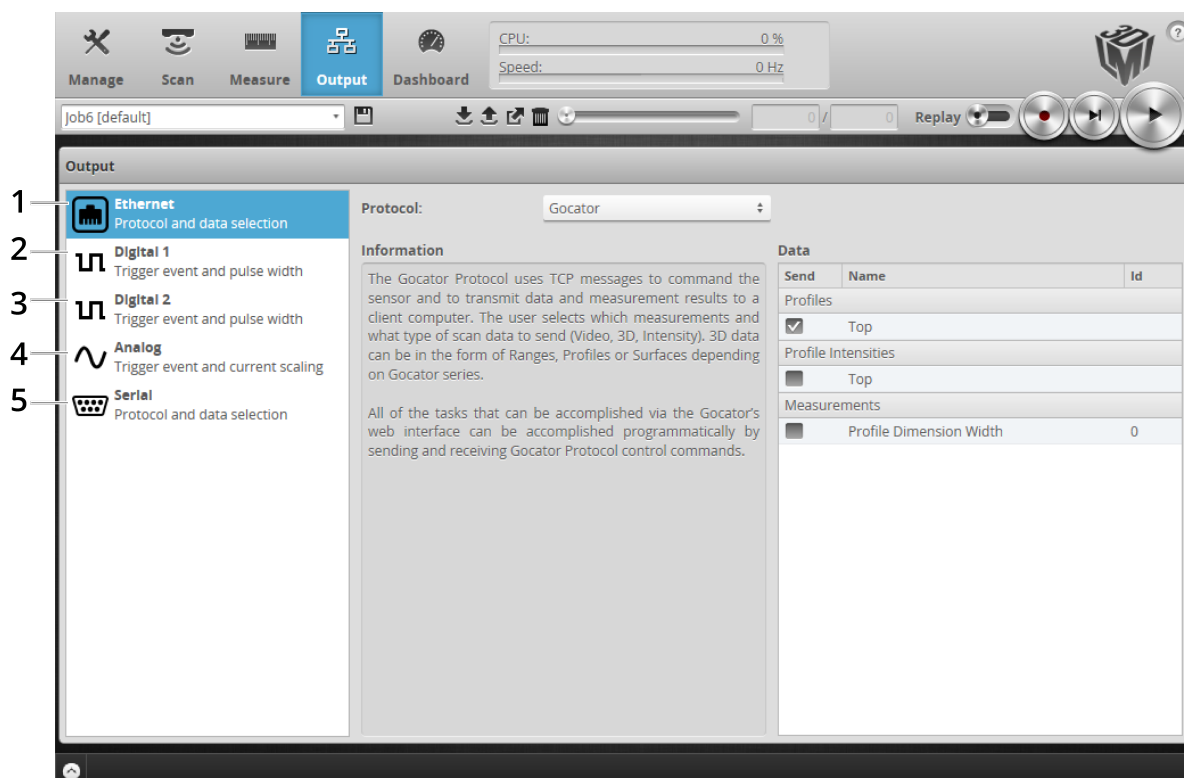
The following sections describe the **Output** page.

## 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> (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> (page 199). |
| 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> (page 199). |
| 4 | Analog Panel     | Used to convert a measurement value or decision into an analog output signal. See <i>Analog Output</i> (page 202).                         |
| 5 | Serial Panel     | Used to select the measurements that will be transmitted via RS-485 serial output. See <i>Serial Output</i> (page 204).                    |

## 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* (page 265) for the specification of these protocols.

The specific protocols used with Ethernet output are selected and configured within the panel.

**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**  
Gocator

**Information**

The Gocator Protocol uses TCP messages to command the sensor and to transmit data and measurement results to a client computer. The user selects which measurements and what type of scan data to send (Video, 3D, Intensity). 3D data can be in the form of Ranges, Profiles or Surfaces depending on Gocator series.

All of the tasks that can be accomplished via the Gocator's web interface can be accomplished programmatically by sending and receiving Gocator Protocol control commands.

**Data**

| Send                                | Name                       | Id |
|-------------------------------------|----------------------------|----|
| Profiles                            |                            |    |
| <input checked="" type="checkbox"/> | Top                        |    |
| Profile Intensities                 |                            |    |
| <input type="checkbox"/>            | Top                        |    |
| Measurements                        |                            |    |
| <input checked="" type="checkbox"/> | Profile Dimension Distance | 2  |
| <input checked="" type="checkbox"/> | Profile Groove X           | 1  |

*To receive commands and send results using Gocator Protocol messages:*

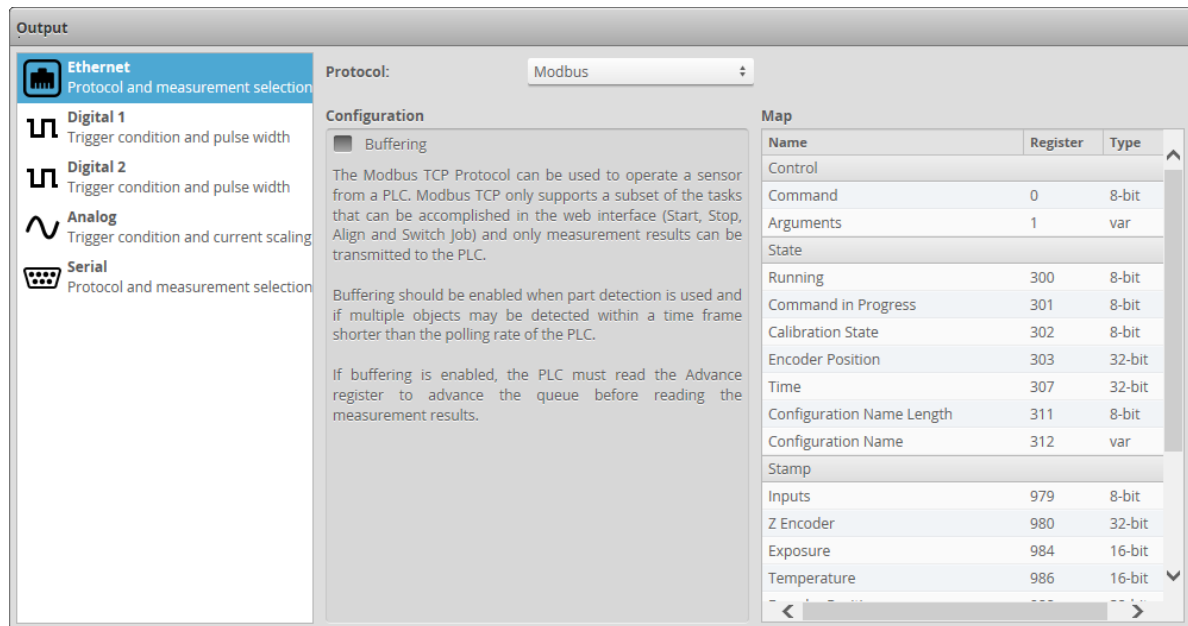
1. Go to the **Output** page.
2. Click on the **Ethernet** category in the **Output** panel.
3. Select **Gocator** as the protocol in the **Protocol** drop-down.
4. Check the video, profile, intensity, or measurement items to send.



Measurements shown here correspond to measurements that have been added using the **Measure** page (see page 123).

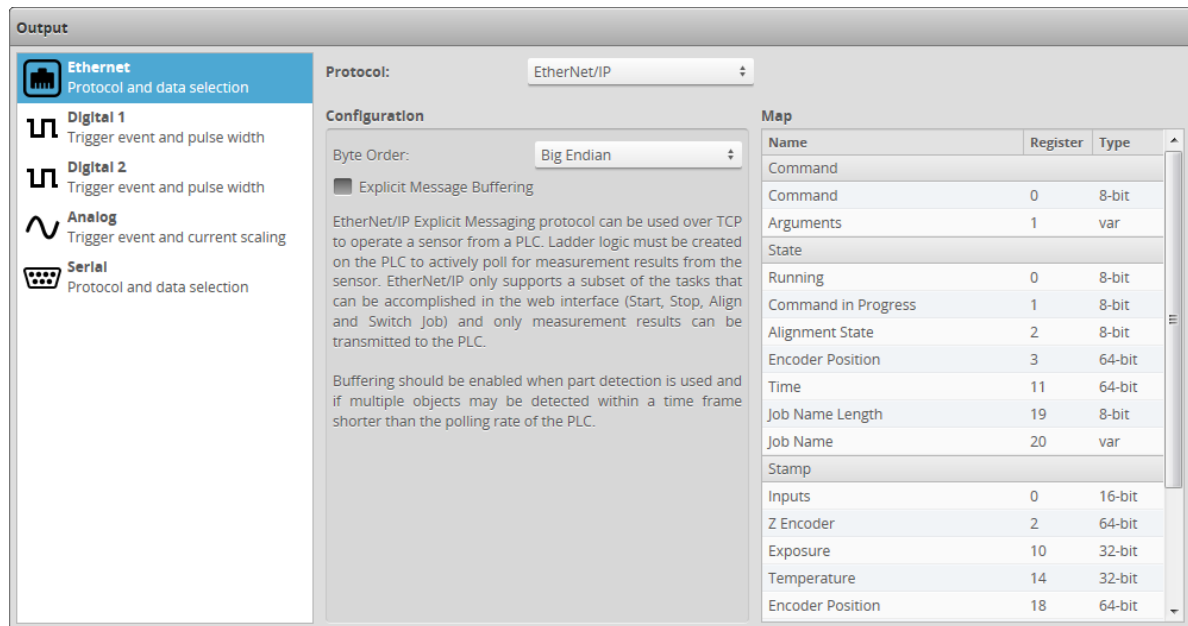
All of the tasks that can be accomplished with the Gocator's web interface (creating jobs, performing alignment, sending data and health information, and software triggering, etc.) can be accomplished programmatically by sending Gocator protocol control commands.





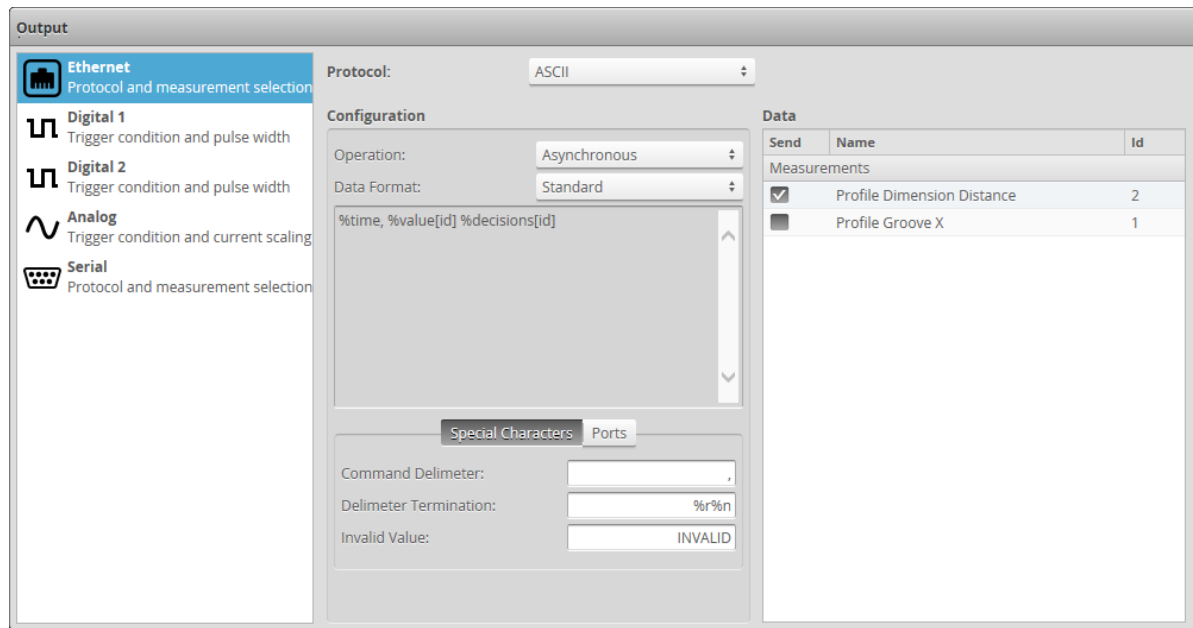
To receive commands and send results using Modbus TCP messages:

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** 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 EtherNet/IP protocol, the buffer is automatically advanced when the Sample State Assembly Object (see page 315) is read.
5. 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 *Asynchronous and Polling Operation* (page 318) for an explanation of the operation modes.
5. Select the data format from the **Data Format** drop-down.  
Select **Standard** to use 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* (page 319) for an explanation of the standard result mode.  
Select **Custom** to enable the custom format editor, and then 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

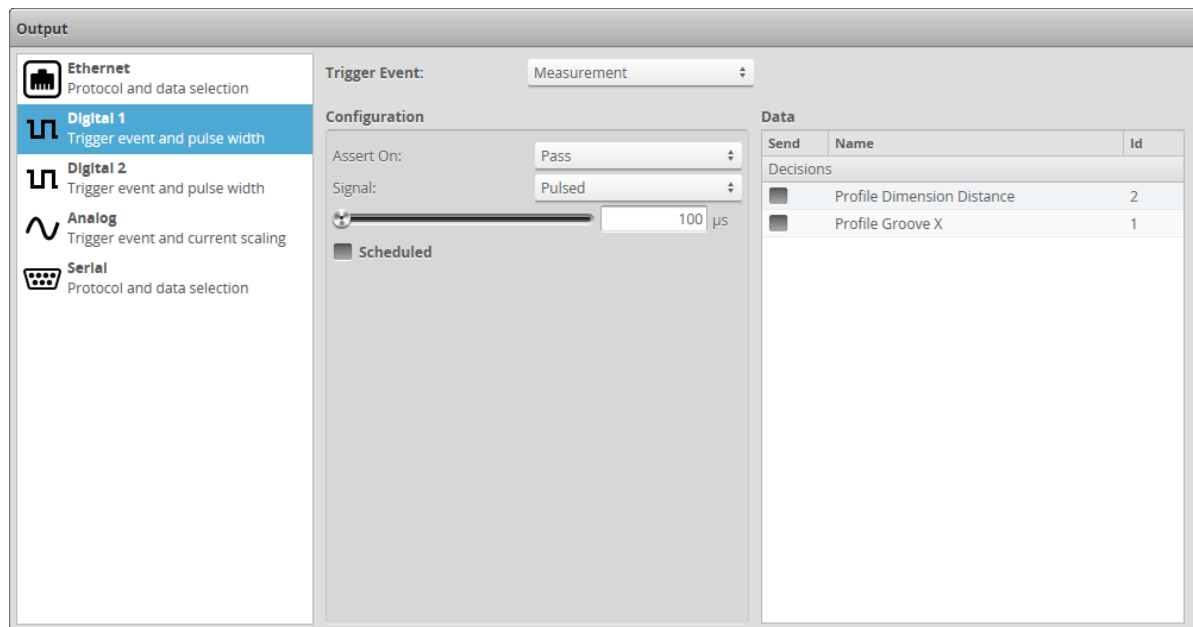
ejectors.

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* (page 367) for information on wiring digital outputs to external devices.

Trigger conditions and pulse width are then configured within the panel.



To output measurement decisions:

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** 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 is **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. Specify whether the output is immediate 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** 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. Specify a delay.  
The delay specifies the time or spatial location 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.

*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 on **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 scheduled. Continuous signal always becomes active immediately.

Immediate output becomes active as soon as a scheduled digital output (see page 282) is received.

Scheduled output becomes active at a specific target time or position, given by the Scheduled Digital Output command. Commands that schedule 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 on **Digital 1** or **Digital 2** in the **Output** panel.

3. Set **Trigger Event** to **Exposure**.

4. Set the **Pulse Width** option.

The pulse width determines the duration of the digital output pulse, in microseconds.

## 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* (page 372) for information on wiring analog output to an external device.

The screenshot shows the 'Output' configuration page in the Gocator Web Interface. The left sidebar contains a tree view with the following items: '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, which is currently selected), and 'Serial' (Protocol and data selection). The main content area is divided into three sections. The top section, 'Trigger Event:', has a dropdown menu set to 'Measurement'. The middle section, 'Configuration', is titled 'Analog Current' and contains the following controls: 'Data Scale:' with input fields for '0' and '10000'; 'Current Range:' with input fields for '0' and '20 mA'; a horizontal slider bar; a checkbox labeled 'Invalid' which is checked, with a value of '0 mA' next to it; and a checkbox labeled 'Scheduled' which is unchecked. The right section, 'Data', contains a table with columns 'Send', 'Name', and 'Id'. The table has two rows: 'Profile Dimension Distance' with 'Id' 2, and 'Profile Groove X' with 'Id' 1. The 'Profile Dimension Distance' row is highlighted in blue.

| Send                  | Name                       | Id |
|-----------------------|----------------------------|----|
| <input type="radio"/> | None                       |    |
| <input 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* (page 66) 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 page 282) 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.

The ASCII protocol outputs data asynchronously using a single serial port. See *ASCII Protocol* (page 318) for the ASCII Protocol parameters and data formats. See *Serial Output* (page 372) for information on wiring serial output to an external device.

The screenshot shows the 'Output' configuration page in the Gocator web interface. On the left, a sidebar lists output protocols: Ethernet, Digital 1, Digital 2, Analog, and Serial (which is highlighted). The main area is divided into 'Configuration' and 'Data' sections. Under 'Configuration', the 'Protocol' is set to 'ASCII' and the 'Data Format' is set to 'Standard'. A text box shows the default format: '%time, %value[id] %decisions[id]'. Below this, 'Special Characters' are configured: 'Command Delimeter' is empty, 'Delimiter Termination' is '%r%n', and 'Invalid Value' is 'INVALID'. On the right, the 'Data' section contains a table with columns 'Send', 'Name', and 'Id'. It lists two measurements: 'Profile Dimension Distance' with Id 2 and 'Profile Groove X' with Id 1.

| Send                     | Name                       | Id |
|--------------------------|----------------------------|----|
| <input type="checkbox"/> | Profile Dimension Distance | 2  |
| <input type="checkbox"/> | Profile Groove X           | 1  |

To exchange results using ASCII messages:

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* (page 319) 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* (page 320) for the supported format string syntax.

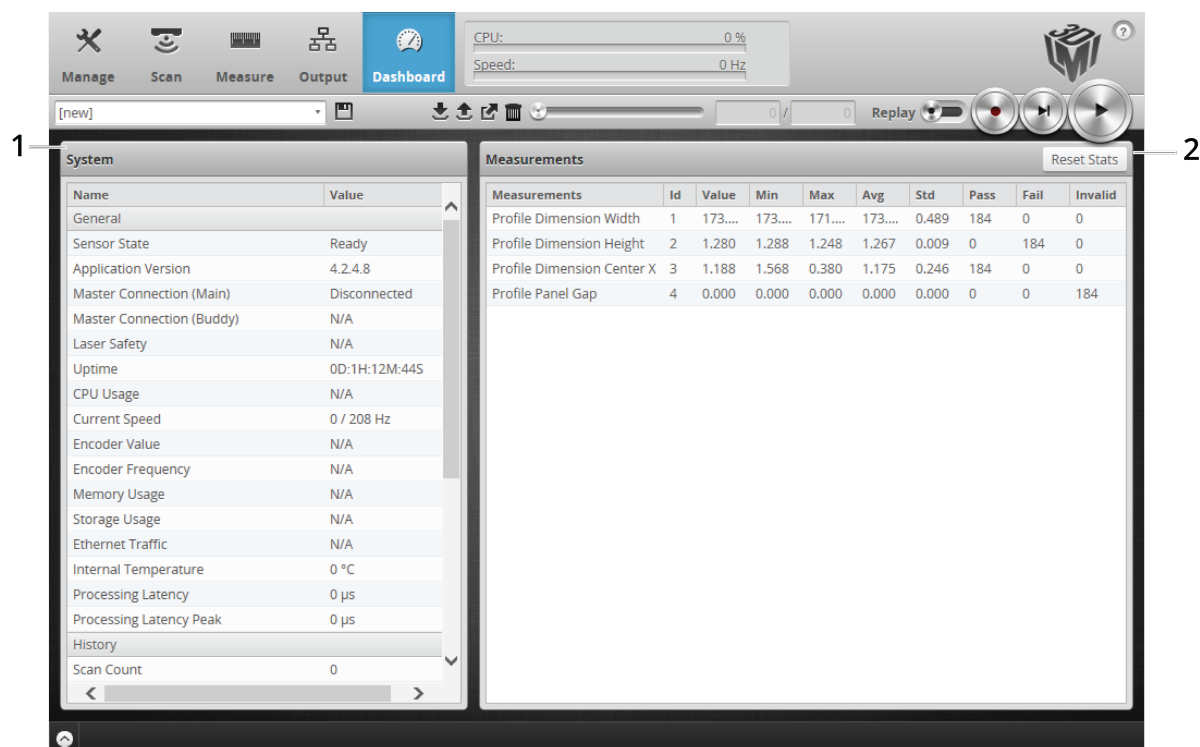
5. Select the measurements to send.  
Select measurements by placing a check in the corresponding check box.
6. Set the **Special Characters**.  
Select the delimiter, termination and invalid value characters. Special characters are used in commands and standard-format data results.

# Dashboard

The following sections describe the **Dashboard** page.

## Dashboard Page Overview

The **Dashboard** page summarizes sensor health information, and measurement statistics.



|   | Element      | Description                                                                    |
|---|--------------|--------------------------------------------------------------------------------|
| 1 | System       | Displays sensor state and health information. See <i>System Panel</i> (below). |
| 2 | Measurements | Displays measurement statistics. See <i>Measurements</i> (next page).          |

## System Panel

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 (Ready or Running).                   |
| Application Version | Gocator firmware version.                                  |
| Master Connection   | Whether Master is connected.                               |
| Laser Safety        | Whether Laser Safety is enabled.                           |
| Uptime              | Length of time since the sensor was power-cycled or reset. |

| Name                    | Description                                                                                           |
|-------------------------|-------------------------------------------------------------------------------------------------------|
| CPU Usage               | Sensor CPU utilization (%).                                                                           |
| Encoder Value           | Current encoder value (ticks).                                                                        |
| Encoder Frequency       | Current encoder frequency (Hz).                                                                       |
| Memory Usage            | Sensor memory utilization (MB used / MB total available).                                             |
| Storage Usage           | Sensor flash storage utilization (MB used / MB total available).                                      |
| Temperature             | Sensor internal temperature (C).                                                                      |
| 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. |

#### *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.                                       |
| Analog Output Drop        | Count of analog output drops because last output has not been completed.                             |
| Digital Output Drop       | Count of digital output drops because last output has not been completed.                            |
| Serial Output Drop        | Count of serial output drops because last output has not been completed.                             |
| Processing Drop           | Count of frame drops due to excessive CPU utilization.                                               |
| Ethernet Drop             | Count of frame drops due to slow Ethernet link.                                                      |
| Digital Output High Count | Count of high states on digital outputs.                                                             |
| Digital Output Low Count  | Count of low states on digital outputs.                                                              |
| Range Valid Count         | Count of valid ranges.                                                                               |
| Range Invalid Count       | Count of invalid ranges.                                                                             |
| 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. |

## Measurements

Measurement statistics are displayed for each measurement that has been configured on the **Measure** page. Use the **Reset** button to reset the statistics.

The following information is available for each measurement:

#### *Dashboard Measurement Statistics*

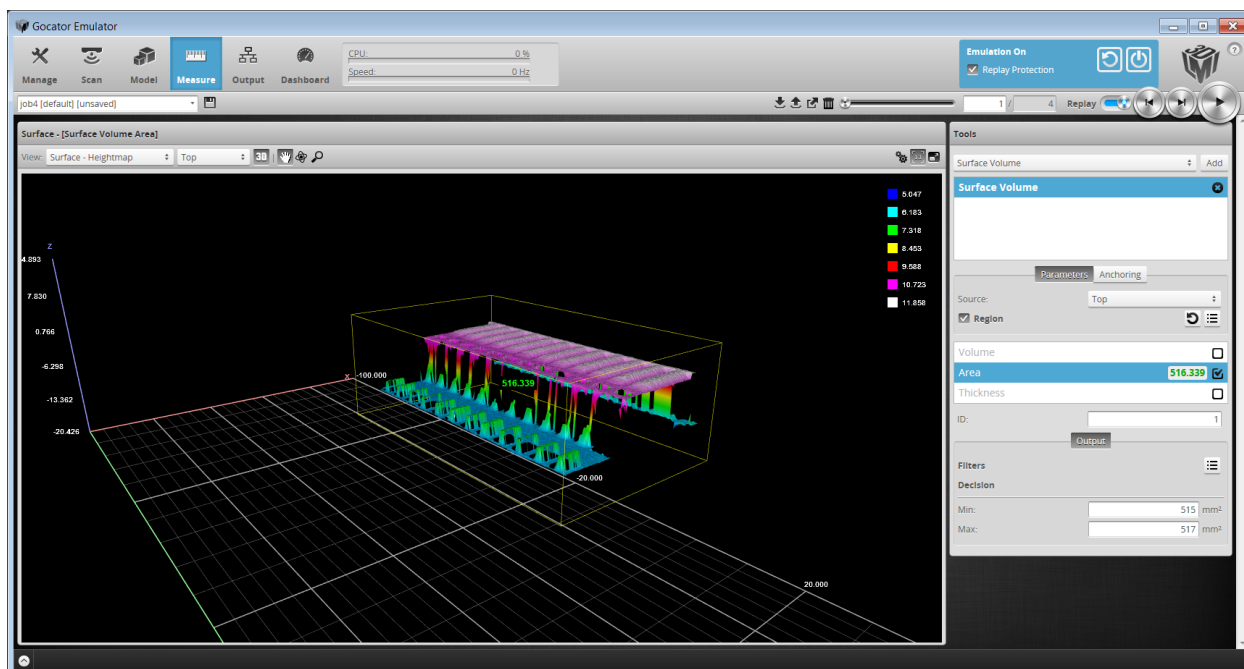
| Name         | Description                                                                               |
|--------------|-------------------------------------------------------------------------------------------|
| Measurements | The measurement ID and name.                                                              |
| Value        | The most recent measurement value.                                                        |
| Min/Max      | The minimum and maximum measurement values that have 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. |
| Pass/Fail    | The counts of pass or fail decisions that have been generated.                            |
| Invalid      | The count of frames from which no feature points could be extracted.                      |

# Gocator Emulator

The Gocator emulator is a stand-alone application that lets you run a "virtual" sensor. In a virtual sensor, you can test recordings and jobs, and even evaluate new features. You can also use a virtual sensor to familiarize yourself with the overall interface, rather than taking a physical device off of the production line to do this.



The Gocator emulator is only supported on Windows 7 and 8.



*Emulator showing a part in recorded data.  
A measurement is applied to the recorded data.*

The following are the limitations of the emulator:

- Job files saved in the emulator are not persistent (they are lost when you close the emulator). However, you can keep these jobs by downloading them from the **Jobs** list on the **Manage** page; see page 44 for more information on saving jobs. The job files can then be loaded into the emulator or even onto a physical sensor for final testing.
- Only one instance can be run at a time.

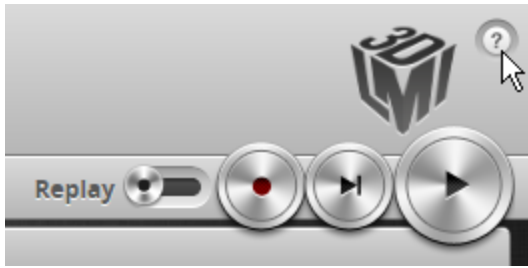
## Downloading a Support File

Virtual sensors are created using a support file (ending with a .gs extension) that is exported from a physical Gocator and then added to the emulator to create "scenarios."

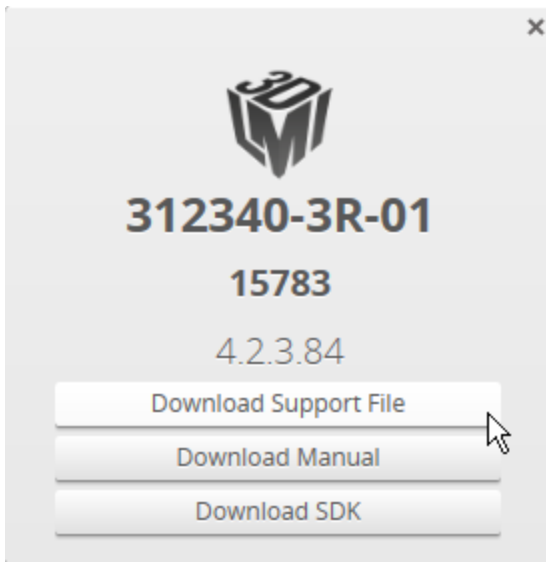
Support files can contain jobs, letting you configure systems and add measurements. They can also contain replay data, letting you test measurements on real data. Dual-sensor systems are supported.

To download a support file:

1. Click on the Help icon in the upper right corner of the Web interface.



2. Click on **Download Support File** in the dialog that opens.

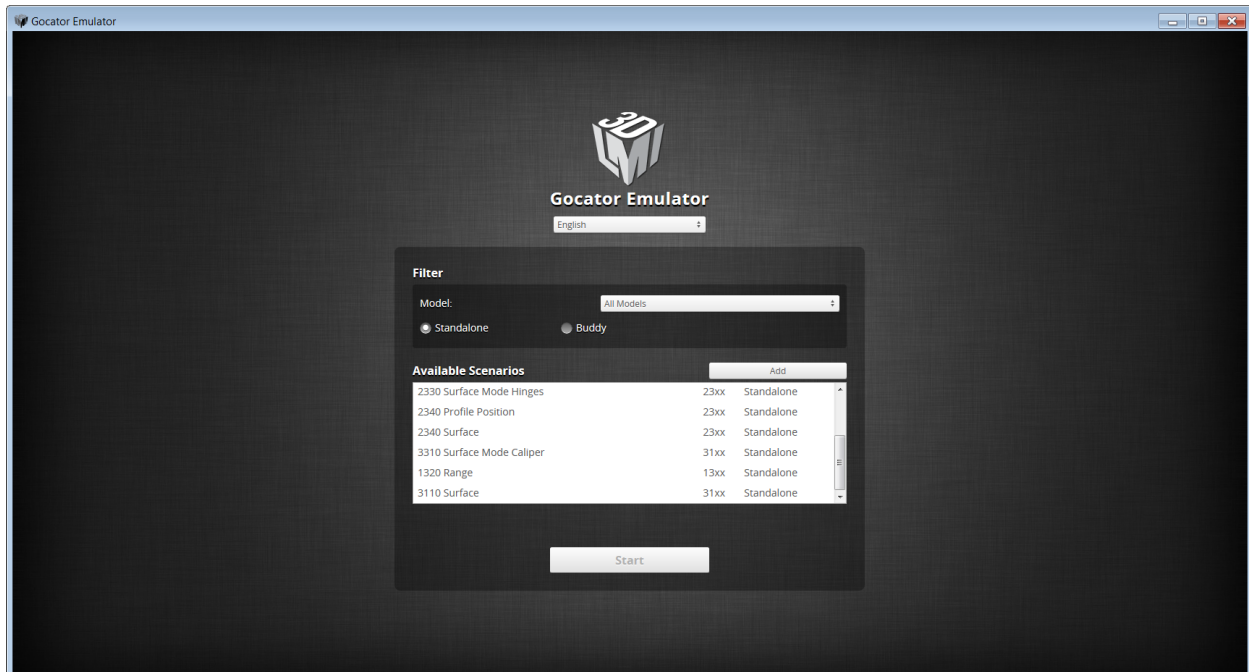


3. If you want, change the name from the default **support.gs**.  
The name of the .gs file is used in the **Available Scenarios** list in the emulator launch screen. See *Downloading a Support File* (previous page) for more information.
4. Save the file.

## Running the Emulator

The emulator is contained in the Gocator tools package (14405-x.x.x.x\_SOFTWARE\_GO\_Tools.zip). You can download the package by going to <http://lmi3d.com/support/downloads/>, selecting a product type, and clicking on the *Product User Area* link.

To run the emulator, double-click on `\Emulator\bin\win32\GoEmulator.exe`.



*Emulator launch screen*

Virtual sensors are called "scenarios" in the emulator, which are created by importing a previously created support file. See *Running the Emulator* (previous page) for information on downloading support files.

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

After you have downloaded a support file, you must add it as a scenario in the emulator.

*To add a scenario:*

1. Launch the emulator if it isn't running already.
2. Click the **Add** button and choose the previously saved support file (.gs extension) in the **Choose File to Upload** dialog.

| Available Scenarios   |      | Add        |
|-----------------------|------|------------|
| 2340 Profile Position | 23xx | Standalone |
| 2340 Surface          | 23xx | Standalone |

## Running a Scenario

After you have added a scenario by uploading a support file in the emulator, you can run the scenario from the emulator launch screen. Various scenarios are also included in the installation.

*To run a scenario:*

- 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-sensor scenarios, respectively.
- Select a scenario in the **Available Scenarios** list and click **Start**.

## Removing a Scenario from the Emulator

To remove a scenario from the emulator, you must remove it manually from the computer's file system.

 The following procedure applies to Windows 7.

*To remove a scenario:*

- Close the Gocator emulator.
- Click the Windows **Start** button.
- In the **Search programs and files** field, type **%LOCALAPPDATA%\LMI\GoEmulate\datasets** and press Enter.

Windows will open Windows Explorer showing the folder containing the scenarios.

 You must select **Show hidden files, folders, and drives** in the Windows Explorer **Folder Options** dialog (**View** tab) to see this folder.

- Delete the folder of the scenario you want to remove.

## Using Replay Protection

Because making changes to certain sensor settings on the **Scan** page causes replay data to be flushed, you can use the **Replay Protection** option in the **Emulation On** message to protect replay data. (The **Emulation On** message is displayed whenever the emulator is running a virtual sensor).



When **Replay Protection** is on, you cannot switch from Replay mode. Settings that do not affect replay data can be changed.

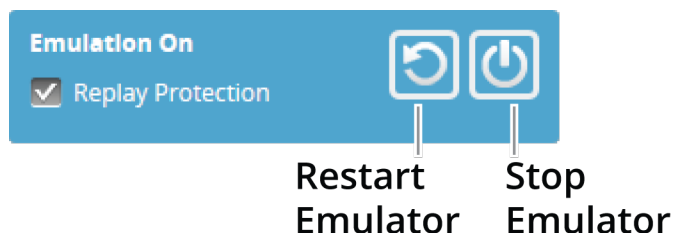


**Replay Protection** is on by default.

## Stopping and Restarting the Emulator

To stop the emulator, click on the **Stop Emulator** button in the **Emulation On** message. Stopping the emulator returns you to the launch screen. (To close the application, click on the Close button in the upper right corner of the application.)

To restart the emulator, click the **Restart Emulator** button. Restarting the emulator restarts the currently running simulation.



*Stop and Restart buttons*

## 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 of the emulated Gocator sensor. (See *Active Area* (page 71) 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* (page 74) for more information on exposure.)



To adjust active area in the emulator, **Replay Protection** must be turned off. See *Using Replay Protection* (previous page) for more information.



Saving changes to active area causes replay data to be flushed.

# Gocator Device Files

This section describes the device files found on a Gocator.

## Job Files

Job files, which reside in a Gocator's internal storage, contain settings that control system behavior when a sensor is running. If **Alignment Reference** is set to **Dynamic**, a job file will also contain transformation settings.

Elements in job files 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.



The following sections correspond to the XML structure used in job files.

## Configuration (Root)

### *Configuration Child Elements*

| Element       | Type         | Description                                                                                                                                                         |
|---------------|--------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| @version      | 32u          | Configuration version (101).                                                                                                                                        |
| Setup         | Section      | See <i>Setup</i> (below) for a description of the Setup elements.                                                                                                   |
| ToolOptions   | Section      | List of available tool types and their information. See <i>ToolOptions</i> (page 227) for more information.                                                         |
| Tools         | Collection   | Collection of sections. Each section is an instance of a tool and is named by the type of the tool it describes. See the topics for each tool for more information. |
| Tools.options | String (CSV) | List of available tool types.                                                                                                                                       |
| Output        | Section      | See <i>Output</i> (page 257) for a description of the Outputs elements.                                                                                             |

## 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.                                     |
| 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.                               |
| IntensityEnabled.used         | Bool         | Whether or not property is used.                                 |
| IntensityEnabled.value        | Bool         | Actual value used if not configurable.                           |
| ExternalInputZPulseEnabled    | Bool         | Enables the External Input based encoder Z Pulse feature.        |
| Filters                       | Section      | See <i>Filters</i> (below).                                      |
| Trigger                       | Section      | See <i>Triggers</i> (page 226).                                  |
| Layout                        | Section      | See <i>Layout</i> (page 217).                                    |
| Alignment                     | Section      | See <i>Alignment</i> (page 218).                                 |
| Devices                       | Collection   | A collection of two Device sections (with roles main and buddy). |
| SurfaceGeneration             | Section      | See <i>SurfaceGeneration</i> (page 222).                         |
| PartDetection                 | Section      | See <i>PartDetection</i> (page 223).                             |
| Custom                        | Custom       | Used by specialized sensors.                                     |

## Filters

The Filters element contains the settings related to post-processing the profiles before they are output or used by measurement tools.

### XSmoothing

#### XSmoothing Child Elements

| Element    | Type | Description               |
|------------|------|---------------------------|
| 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               |
|------------|------|---------------------------|
| Enabled    | Bool | Enables filtering.        |
| 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               |
|------------|------|---------------------------|
| 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               |
|------------|------|---------------------------|
| 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               |
|------------|------|---------------------------|
| 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               |
|------------|------|---------------------------|
| 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               |
|------------|------|---------------------------|
| 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               |
|------------|------|---------------------------|
| Enabled    | Bool | Enables filtering.        |
| Window     | 64f  | Window size (mm).         |
| Window.min | 64f  | Minimum window size (mm). |
| Window.max | 64f  | Maximum window size (mm). |

## 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 |
| TransformedDataRegion           | Region3D  | Transformed data region of the layout output.                                                           |
| Orientation                     | 32s       | Sensor orientation:<br>0 – Wide<br>1 – Opposite<br>2 – Reverse                                          |
| 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 us (currently rounded to integer when read by the sensor)                          |
| MultiplexSingleDelay            | 32u       | Delay in $\mu$ s. (Currently gets rounded up when read by the sensor.)                                  |
| MultiplexSinglePeriod           | 32u       | Period in $\mu$ s. (Currently gets rounded up when read by the sensor.)                                 |
| XSpacingCount                   | 32u       | Number of points along X when data is resampled.                                                        |
| YSpacingCount                   | 32u       | Number of points along Y when data is resampled.                                                        |
| MultiplexSinglePeriod min       | 64f       | Minimum period in $\mu$ s.                                                                              |

## Alignment

The Alignment element contains settings related to alignment and encoder calibration.

### *Alignment Child Elements*

| Element                  | Type      | Description                                                                  |
|--------------------------|-----------|------------------------------------------------------------------------------|
| InputTriggerEnabled      | Bool      | Enables digital input-triggered alignment operation.                         |
| 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.                                  |
| 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> (next page).                                                |

## 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. |

| Element      | Type | Description                  |
|--------------|------|------------------------------|
| HoleDistance | 64f  | Distance between holes (mm). |
| HoleDiameter | 64f  | Diameter of holes (mm).      |

## 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                                                               |
| DataSource                  | 32s       | Data source of device output (read-only):<br>0 – Top<br>1 – Bottom<br>2 – Top Left<br>3 – Top Right |
| ActiveArea                  | Region3D  | Active area. (Contains min and max attributes for each element.)                                    |
| TransformedDataRegion       | Region3D  | Active area after transformation (read-only).                                                       |
| PatternSequenceType         | 32s       | G3 projection sequence for video mode.<br>0 – Normal<br>100 – Nine Lines                            |
| PatternSequenceType.options | 32s (CSV) | List of available projection sequences.                                                             |
| PatternSequenceType.used    | Bool      | Whether or not the type can be selected.                                                            |
| PatternSequenceCount        | 32u       | Number of frames in the active sequence (read-only)..                                               |
| FrontCamera                 | Window    | Front camera window (read-only).                                                                    |
| BackCamera                  | Window    | Back camera window (read-only).                                                                     |
| ExposureMode                | 32s       | Exposure mode:<br>0 – Single exposure<br>1 – Multiple exposures<br>2 – Dynamic exposure             |

| Element                  | Type      | Description                                                                                         |
|--------------------------|-----------|-----------------------------------------------------------------------------------------------------|
| 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).                                                                              |
| DynamicExposureMin       | 64f       | Dynamic exposure range minimum (μs).                                                                |
| DynamicExposureMax       | 64f       | Dynamic exposure range maximum (μs).                                                                |
| ExposureSteps            | 64f (CSV) | Mutiple exposure list (μs).                                                                         |
| ExposureSteps.countMin   | 32u       | Minimum number of exposure steps.                                                                   |
| ExposureSteps.countMax   | 32u       | Maximum number of exposure steps.                                                                   |
| IntensityStepIndex       | 32u       | Index of exposure step to use for intensity when using multiple exposures.                          |
| XSubsampling             | 32u       | Subsampling factor in X.                                                                            |
| XSubsampling.options     | 32u (CSV) | List of available subsampling factors in X.                                                         |
| 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 field is used.                                                                       |
| Tracking                 | Section   | Described below.                                                                                    |
| Material                 | Section   | Described below.                                                                                    |
| Custom                   | Custom    | Used by specialized sensors.                                                                        |
| XSpacingCount            | 32u       | Number of resampled points along X (read-only).                                                     |
| YSpacingCount            | 32u       | Number of resampled points along Y (read-only).                                                     |

## Tracking

### *Tracking Child Elements*

| Element         | Type | Description                                                |
|-----------------|------|------------------------------------------------------------|
| Enabled         | Bool | Enables tracking.                                          |
| SearchThreshold | 64f  | Percentage of spots that must be found to remain in track. |



| Element    | Type | Description                          |
|------------|------|--------------------------------------|
| 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.<br>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 |
| 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.                                                                                                                                        |
| 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                                                                                                                                               |

| Element                  | Type | Description                                                                                                                    |
|--------------------------|------|--------------------------------------------------------------------------------------------------------------------------------|
|                          |      | false.                                                                                                                         |
| 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.                                                                                                                 |
| GammaType                | 32s  | Gamma type.                                                                                                                    |
| GammaType used           | Bool | Value in use by the sensor, useful for determining value when used is false.                                                   |
| GammaType value          | 32s  | Determines if the setting's value is currently used.                                                                           |

## SurfaceGeneration

### SurfaceGeneration Child Elements

| Element        | Type    | Description                                                                                           |
|----------------|---------|-------------------------------------------------------------------------------------------------------|
| Type           | 32s     | Surface generation type:<br>0 – Continuous<br>1 – Fixed length<br>2 – Variable length<br>3 – Rotation |
| FixedLength    | Section | See <i>FixedLength</i> (next page)                                                                    |
| VariableLength | Section | See <i>VariableLength</i> (next page).                                                                |
| Rotational     | Section | See <i>Rotational</i> (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). |

## 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).                 |
| ThresholdDirection | 64f  | Threshold direction:<br>0 – Above<br>1 – Below |
| GapWidth           | 64f  | Gap width (mm).                                |
| GapWidth.min       | 64f  | Minimum gap width (mm).                        |
| GapWidth.max       | 64f  | Maximum gap width (mm).                        |

| Element                | Type    | Description                                                    |
|------------------------|---------|----------------------------------------------------------------|
| 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.                             |
| FrameOfReference.value | 32s     | Actual value.                                                  |
| EdgeFiltering          | Section | See <i>EdgeFiltering</i> (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.                             |

## EdgeFiltering

### *EdgeFiltering Child Elements*

| Element | Type | Description                          |
|---------|------|--------------------------------------|
| @used   | Bool | Whether or not this section is used. |

| Element                 | Type | Description                       |
|-------------------------|------|-----------------------------------|
| 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

### *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

### *Edge Child Elements*

| Element                | Type   | Description                                                       |
|------------------------|--------|-------------------------------------------------------------------|
| ModelName              | String | Name of the part model to use. Do 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). |
| 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). |
| 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).                |

## Edge

### *Edge Child Elements*

| Element                | Type   | Description                                                       |
|------------------------|--------|-------------------------------------------------------------------|
| ModelName              | String | Name of the part model to use. Do not include the ,mdl extension. |
| Acceptance/Quality/Min | 64f    | Minimum quality value for a match.                                |

## Triggers

The Triggers element contains settings related trigger source, speed, and encoder resolution.

### *Triggers 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:                                                      |

| Element            | Type | Description                                                                                   |
|--------------------|------|-----------------------------------------------------------------------------------------------|
|                    |      | 0 – Resolution<br>1 – Surface generation                                                      |
| EncoderTriggerMode | 32s  | Encoder triggering mode:<br>0 – Tracking backward<br>1 – Bidirectional<br>2 – Ignore backward |
| Delay              | 64f  | Trigger delay (µs or mm).                                                                     |
| Delay.min          | 64f  | Minimum trigger delay (µs or mm).                                                             |
| Delay.max          | 64f  | Maximum trigger delay (µs 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.                                           |

## ToolOptions

The ToolOptions element contains a list of available tool types, their measurements, and settings for related information.

### ToolOptions Child Elements

| Element      | Type    | Description                                                               |
|--------------|---------|---------------------------------------------------------------------------|
| <ToolOption> | Section | A collection of ToolOption elements. An element for each tool is present. |

### ToolOption Child Elements

| Element            | Type       | Description                            |
|--------------------|------------|----------------------------------------|
| @displayName       | String     | Display name of the tool.              |
| @isCustom          | Bool       | Reserved for future use.               |
| MeasurementOptions | Collection | See <i>MeasurementOptions</i> (below). |



ToolOption elements are named by tool type.

## MeasurementOptions

The MeasurementOptions element contains a list of available measurement types.

### MeasurementOptions Child Elements

| Element             | Type       | Description                                                                             |
|---------------------|------------|-----------------------------------------------------------------------------------------|
| <MeasurementOption> | Collection | A collection of MeasurementOption elements. An element for each measurement is present. |

### MeasurementOption 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. |



MeasurementOption elements are named by measurement type.

## 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.

### **ProfileRegion2D**

A ProfileRegion2D element 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 position (mm).  |
| Height  | 64f  | Setting for profile region height position (mm). |

### **ProfileFeature**

A ProfileFeature element defines the settings for detecting a feature within an area of interest.

### *ProfileFeature Child Elements*

| Element | Type | Description                                                                                                                                                                                                                                                                                |
|---------|------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Type    | 32s  | Setting to determine how the feature is detected within the area:<br>0 – Max Z<br>1 – Min Z<br>2 – Min X<br>3 – Max 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 |



| Element | Type            | Description                         |
|---------|-----------------|-------------------------------------|
|         |                 | 13 – Median                         |
| Region  | ProfileRegion2D | Element for feature detection area. |

### ProfileLine

A ProfileLine element 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 1 or 2 ProfileRegion2D elements. |

## Surface Types

The following types are used by the various measurement tools.

### Region3D

A Region3D element defines a rectangular area of interest in 3D.

#### Region3D Child Elements

| Element | Type | Description                         |
|---------|------|-------------------------------------|
| X       | 64f  | Setting for volume x position (mm). |
| Y       | 64f  | Setting for volume y position (mm). |
| Z       | 64f  | Setting for volume z position (mm). |
| Width   | 64f  | Setting for volume width (mm).      |
| Length  | 64f  | Setting for volume length (mm).     |
| Height  | 64f  | Setting for volume height (mm).     |

### SurfaceRegion2D

A SurfaceRegion2D element defines a rectangular area of interest on the X-Y plane.

#### SurfaceRegion2D Child Elements

| Element | Type | Description                       |
|---------|------|-----------------------------------|
| X       | 64f  | Setting for area x position (mm). |
| Y       | 64f  | Setting for area y position (mm). |
| Width   | 64f  | Setting for region width (mm).    |
| Height  | 64f  | Setting for region height (mm).   |

### SurfaceFeature

A SurfaceFeature element 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 Min<br>3 – X Max<br>4 – Y Min<br>5 – Y Max<br>6 – Z Min<br>7 – Z Max<br>8 – Median |
| RegionEnabled | 32s      | Setting to enable/disable region:<br>0 – Disable<br>1 – Enable                                                                                                                                                                             |
| Region        | Region3D | Element for feature detection volume.                                                                                                                                                                                                      |

### **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          | Setting for measurement name.                                                                                       |
| Source                 | 32s             | Setting for 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.                                                                   |
| 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.                                                                                       |
| Region                 | ProfileRegion2d | Measurement region                                                                                                  |
| Line                   | ProfileLine     | Baseline definition when baseline type is set to Line                                                               |
| Measurements\Area      | AreaMeasuerment | Area measurement                                                                                                    |
| Measurements\CentroidX | AreaMeasurement | CentroidX measurement                                                                                               |
| Measurements\CentroidZ | AreaMeasurement | CentroidZ measurement                                                                                               |

### *AreaMeasurement*

| 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        |
| SmoothingWindow  | 32s     | 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          | Setting for measurement name.                                                    |
| Source               | 32s             | Setting for 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.                                |
| RegionEnabled        | Bool            | Whether or not to use region. If region is disabled, all available data is used. |
| Region               | ProfileRegion2d | Measurement region                                                               |
| Measurements\X       | BoxMeasurement  | X measurement                                                                    |
| Measurements\Z       | BoxMeasurement  | Z measurement                                                                    |
| Measurements\Width   | BoxMeasurement  | Width measurement                                                                |
| Measurements\Height  | BoxMeasurement  | Height measurement                                                               |
| Measurements\GlobalX | BoxMeasurement  | GlobalX measurement                                                              |

### *BoxMeasurement*

| 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        |
| SmoothingWindow  | 32s     | 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            | Setting for measurement name.                     |
| Source              | 32s               | Setting for 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. |
| Region              | ProfileRegion2d   | Measurement region                                |
| Measurements\X      | CircleMeasurement | X measurement                                     |
| Measurements\Z      | CircleMeasurement | Z measurement                                     |
| Measurements\Radius | CircleMeasurement | Radius measurement                                |

### *CircleMeasurement*

| 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   |
| SmoothingWindow  | 32s     | 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.

### ProfileCircle Child Elements

| Element               | Type                 | Description                                                |
|-----------------------|----------------------|------------------------------------------------------------|
| id (attribute)        | 32s                  | Measurement ID. Optional (measurement disabled if not set) |
| Name                  | String               | Setting for measurement name.                              |
| Source                | 32s                  | Setting for 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.          |
| RefFeature            | ProfileFeature       | Reference measurement region                               |
| Feature               | ProfileFeature       | Measurement region                                         |
| Measurements\Width    | DimensionMeasurement | Width measurement                                          |
| Measurements\Height   | DimensionMeasurement | Height measurement                                         |
| Measurements\Distance | DimensionMeasurement | Distance measurement                                       |
| Measurements\CenterX  | DimensionMeasurement | CenterX measurement                                        |
| Measurements\CenterZ  | DimensionMeasurement | CenterZ measurement                                        |

### *DimensionMeasurement*

| Element                                             | Type    | Description                                                                    |
|-----------------------------------------------------|---------|--------------------------------------------------------------------------------|
| 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                            |
| SmoothingWindow                                     | 32s     | 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.

#### *ProfileGroove Child Elements*

| Element          | Type         | Description                                                |
|------------------|--------------|------------------------------------------------------------|
| id (attribute)   | 32s          | Measurement ID. Optional (measurement disabled if not set) |
| Name             | String       | Setting for measurement name.                              |
| Source           | 32s          | Setting for 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.          |
| Shape            | 32s          | Shape<br>0 – U-shape<br>1 – V-shape<br>2 – Open            |
| MinDepth         | 64f          | Minimum depth                                              |
| MinWidth         | 64f          | Minimum width                                              |

| Element            | Type              | Description        |
|--------------------|-------------------|--------------------|
| MaxWidth           | 64f               | Maximum width      |
| Region             | ProfileRegion2d   | Measurement region |
| Measurements\X     | GrooveMeasurement | X measurement      |
| Measurements\Z     | GrooveMeasurement | Z measurement      |
| Measurements\Width | GrooveMeasurement | Width measurement  |
| Measurements\Depth | GrooveMeasurement | Depth measurement  |

#### *GrooveMeasurement*

| Element                                 | Type    | Description                                                                                                                         |
|-----------------------------------------|---------|-------------------------------------------------------------------------------------------------------------------------------------|
| 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                                                                                 |
| SmoothingWindow                         | 32s     | 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                    | Setting for measurement name.                     |
| Source             | 32s                       | Setting for 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. |
| RefType            | 32s                       | Reference line type<br>0 – Fit<br>1 – X Axis      |
| RefLine            | ProfileLine               | Reference line. Ignored if RefType is not 0.      |
| Line               | ProfileLine               | Line                                              |
| Measurements\X     | ResultMeasurement         | X measurement                                     |
| Measurements\Z     | ResultMeasurement         | Z measurements                                    |
| Measurements\Angle | IntersectAngleMeasurement | Angle measurement                                 |

### *IntersectAngleMeasurement*

| 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                            |
| SmoothingWindow  | 32s     | Smoothing window                                                               |
| Scale            | 64f     | Output scaling factor                                                          |
| Offset           | 64f     | Output offset factor                                                           |
| DecisionMin      | 64f     | Minimum decision threshold                                                     |
| DecisionMax      | 64f     | Maximum decision threshold                                                     |
| Absolute         | Boolean | Setting for selecting absolute or signed result.<br>0 – Signed<br>1 – Absolute |



## 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                    | Setting for measurement name.                     |
| Source                  | 32s                       | Setting for 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. |
| Region                  | ProfileRegion2d           | Measurement region                                |
| Measurements\StdDev     | ResultMeasurement         | StdDev measurement                                |
| Measurements\MaxError   | ResultMeasurement         | MaxError measurement                              |
| Measurements\MinError   | ResultMeasurement         | MinError measurement                              |
| Measurements\Percentile | PercentileMeasureme<br>nt | Percentile measurement                            |

### PercentileMeasurement

| 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        |
| SmoothingWindow  | 32s     | 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                                           |

## ProfilePanel

A ProfilePanel element defines settings for a profile panel tool and one or more of its measurements.

### *ProfilePanel Child Elements*

| <b>Element</b>     | <b>Type</b>      | <b>Description</b>                                |
|--------------------|------------------|---------------------------------------------------|
| Name               | String           | Setting for measurement name.                     |
| Source             | 32s              | Setting for 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. |
| RefSide            | 32s              | Setting for reference side to use.                |
| MaxGapWidth        | 64f              | Setting for maximum gap width (mm).               |
| LeftEdge           | ProfilePanelEdge | Element for left edge configuration               |
| RightEdge          | ProfilePanelEdge | Element for right edge configuration              |
| Measurements\Gap   | GapMeasurement   | Gap measurement                                   |
| Measurements\Flush | FlushMeasurement | Flush measurement                                 |

### *ProfilePanelEdge*

| <b>Element</b> | <b>Type</b>     | <b>Description</b>                     |
|----------------|-----------------|----------------------------------------|
| 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                             |
| Region         | ProfileRegion2d | Edge region                            |

### *GapMeasurement*

| <b>Element</b>   | <b>Type</b> | <b>Description</b>                                         |
|------------------|-------------|------------------------------------------------------------|
| 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                                                   |
| SmoothingWindow | 32s  | Smoothing window                                             |
| Scale           | 64f  | Output scaling factor                                        |
| Offset          | 64f  | Output offset factor                                         |
| DecisionMin     | 64f  | Minimum decision threshold                                   |
| DecisionMax     | 64f  | Maximum decision threshold                                   |
| Axis            | 32s  | Measurement axis:<br>0 – Edge<br>1 – Surface<br>2 – Distance |

#### *FlushMeasurement*

| 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                            |
| SmoothingWindow  | 32s     | Smoothing window                                                               |
| Scale            | 64f     | Output scaling factor                                                          |
| Offset           | 64f     | Output offset factor                                                           |
| DecisionMin      | 64f     | Minimum decision threshold                                                     |
| DecisionMax      | 64f     | Maximum decision threshold                                                     |
| Absolute         | 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              | Setting for measurement name.                     |
| Source           | 32s                 | Setting for 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. |
| Feature          | ProfileFeature      | Element for feature detection                     |
| Measurements\X   | PositionMeasurement | X measurement                                     |
| Measurements\Z   | PositionMeasurement | Z measurement                                     |

#### *PositionMeasurement*

| 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        |
| SmoothingWindow  | 32s     | 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.

#### *ProfileStrip Child Elements*

| Element  | Type         | Description                                  |
|----------|--------------|----------------------------------------------|
| Name     | String       | Setting for measurement name.                |
| Source   | 32s          | Setting for profile source.                  |
| Anchor\X | String (CSV) | The X measurements (IDs) used for anchoring. |

| Element             | Type             | Description                                                                                    |
|---------------------|------------------|------------------------------------------------------------------------------------------------|
| 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.                                              |
| BaseType            | 32s              | Setting for the strip type:<br>0 – None<br>1 – Flat                                            |
| LeftEdge            | Bitmask          | Setting of the left edge conditions<br>1 – Raising<br>2 – Falling<br>4 – Data End<br>8 – Void  |
| RightEdge           | Bitmask          | Setting of 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              | ProfileRegion2d  | Region containing the strip                                                                    |
| Measurements\X      | StripMeasurement | X measurement                                                                                  |
| Measurements\Z      | StripMeasurement | Z measurement                                                                                  |
| Measurements\Width  | StripMeasurement | Width measurement                                                                              |
| Measurements\Height | StripMeasurement | Width measurement                                                                              |

#### *StripMeasurement*

| 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                                                                            |
| SmoothingWindow                                  | 32s     | 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       | Setting for measurement name.    |
| Code                | String       | Script code.                     |
| Measurements\Output | (Collection) | Dynamic list of Output elements. |

### Output

| Element        | Type   | Description                                         |
|----------------|--------|-----------------------------------------------------|
| id (attribute) | 32s    | Output ID. Optional (output disabled if set to -1). |
| Name           | String | Output 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 | Setting for measurement name. |

| Element              | Type                   | Description                                        |
|----------------------|------------------------|----------------------------------------------------|
| Source               | 32s                    | Setting for the 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.  |
| ZRotationEnabled     | Boolean                | Setting to enable/disable rotation of bounding box |
| RegionEnabled        | Boolean                | Setting to enable/disable region                   |
| Region               | Region3D               | Measurement region                                 |
| Measurements\GlobalX | BoundingBoxMeasurement | Global X measurement                               |
| Measurements\GlobalY | BoundingBoxMeasurement | Global Y measurement                               |
| Measurements\X       | BoundingBoxMeasurement | X measurement                                      |
| Measurements\Y       | BoundingBoxMeasurement | Y measurement                                      |
| Measurements\Z       | BoundingBoxMeasurement | Z measurement                                      |
| Measurements\Width   | BoundingBoxMeasurement | Width measurement                                  |
| Measurements\Height  | BoundingBoxMeasurement | Height measurement                                 |
| Measurements\ZAngle  | BoundingBoxMeasurement | ZAngle measurement                                 |

#### ***BoundingBoxMeasurement***

| 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                 |
| SmoothingWindow | 32s  | 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             | Setting for measurement name.                     |
| Source              | 32s                | Setting for 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. |
| RegionEnabled       | Boolean            | Setting to enable/disable region                  |
| Region              | Region3D           | Measurement region                                |
| Measurements\Major  | EllipseMeasurement | Major measurement                                 |
| Measurements\Minor  | EllipseMeasurement | Minor measurement                                 |
| Measurements\Ratio  | EllipseMeasurement | Ratio measurement                                 |
| Measurements\ZAngle | EllipseMeasurement | ZAngle measurement                                |

### EllipseMeasurement

| 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                                     |



| Element         | Type | Description                |
|-----------------|------|----------------------------|
|                 |      | 0 – Disable<br>1 – Enable  |
| SmoothingWindow | 32s  | 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       | Setting for measurement name.                                            |
| Source                  | 32s          | Setting for 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.                        |
| NominalRadius           | 64f          | Nominal radius (mm)                                                      |
| RadiusTolerance         | 64f          | Radius tolerance (mm)                                                    |
| 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                  | Region3D     | 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 2 SurfaceRegion2D elements                   |
| AutoTiltEnabled         | Boolean      | Setting to enable/disable tilt correction                                |

| Element             | Type            | Description                                |
|---------------------|-----------------|--------------------------------------------|
|                     |                 | 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      | HoleMeasurement | X measurement                              |
| Measurements\Y      | HoleMeasurement | Y measurement                              |
| Measurements\Z      | HoleMeasurement | Z measurement                              |
| Measurements\Radius | HoleMeasurement | Radius measurement                         |

#### *HoleMeasurement*

| 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        |
| SmoothingWindow  | 32s     | 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       | Setting for measurement name.                     |
| Source           | 32s          | Setting for source.                               |
| Anchor\X         | String (CSV) | The X measurements (IDs) used for anchoring.      |
| Anchor\X.options | String (CSV) | The X measurements (IDs) available for anchoring. |

| Element                  | Type              | Description                                                              |
|--------------------------|-------------------|--------------------------------------------------------------------------|
| 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.                        |
| NominalBevelAngle        | 64f               | Nominal bevel angle (mm)                                                 |
| BevelAngleTolerance      | 64f               | Bevel angle tolerance (mm)                                               |
| NominalOuterRadius       | 64f               | Nominal outer radius (mm)                                                |
| OuterRadiusTolerance     | 64f               | Outer radius tolerance (mm)                                              |
| NominalInnerRadius       | 64f               | Nominal inner radius (mm)                                                |
| InnerRadiusTolerance     | 64f               | Inner radius tolerance (mm)                                              |
| BevelRadiusOffset        | 64f               | Bevel radius offset (mm)                                                 |
| 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                   | Region3D          | 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 SurfaceRegion2D 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               | Setting for curve orientation angle                                      |
| Measurements\X           | CsHoleMeasurement | X measurement                                                            |
| Measurements\Y           | CsHoleMeasurement | Y measurement                                                            |
| Measurements\Z           | CsHoleMeasurement | Z measurement                                                            |
| Measurements\OuterRadius | CsHoleMeasurement | Outer Radius measurement                                                 |
| Measurements\Depth       | CsHoleMeasurement | Depth measurement                                                        |

| Element                  | Type              | Description              |
|--------------------------|-------------------|--------------------------|
| Measurements\BevelRadius | CsHoleMeasurement | Bevel Radius measurement |
| Measurements\BevelAngle  | CsHoleMeasurement | Bevel Angle measurement  |
| Measurements\XAngle      | CsHoleMeasurement | X Angle measurement      |
| Measurements\YAngle      | CsHoleMeasurement | Y Angle measurement      |
| Measurements\Radius      | CsHoleMeasurement | Radius measurement       |

#### *CsHoleMeasurement*

| 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        |
| SmoothingWindow  | 32s     | 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       | Setting for measurement name.                     |
| Source           | 32s          | Setting for 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.      |

| Element                 | Type               | Description                                                              |
|-------------------------|--------------------|--------------------------------------------------------------------------|
| Anchor\Z.options        | String (CSV)       | The Z measurements (IDs) available for anchoring.                        |
| 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 |
| RegionEnabled           | Boolean            | Setting to enable/disable region<br>0 – Disable<br>1 – Enable            |
|                         |                    |                                                                          |
| Region                  | Region3D           | 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 2 SurfaceRegion2D 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                               |
| Measurements\X          | OpeningMeasurement | X measurement                                                            |
| Measurements\Y          | OpeningMeasurement | Y measurement                                                            |
| Measurements\Z          | OpeningMeasurement | Z measurement                                                            |
| Measurements\Width      | OpeningMeasurement | Width measurement                                                        |
| Measurements\Length     | OpeningMeasurement | Length measurement                                                       |
| Measurements\Angle      | OpeningMeasurement | Angle measurement                                                        |

### *OpeningMeasurement*

| 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        |
| SmoothingWindow  | 32s     | 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           | Setting for measurement name.                                  |
| Source               | 32s              | Setting for 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.              |
| RegionsEnabled       | Boolean          | Setting to enable/disable regions<br>0 – Disable<br>1 – Enable |
| RegionCount          | 32s              | Count of the regions                                           |
| Regions              | Region3D         | Measurement region. Contains 1 or 2 Region3D elements.         |
| Measurements\XAngle  | PlaneMeasurement | XAngle measurement                                             |
| Measurements\YAngle  | PlaneMeasurement | YAngle measurement                                             |
| Measurements\ZOffset | PlaneMeasurement | ZOffset measurement                                            |

### *PlaneMeasurement*

| 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        |
| SmoothingWindow  | 32s     | 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              | Setting for measurement name.                     |
| Source           | 32s                 | Setting for 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. |
| Feature          | SurfaceFeature      | Measurement feature                               |
| Measurements\X   | PositionMeasurement | X measurement                                     |
| Measurements\Y   | PositionMeasurement | Y measurement                                     |
| Measurements\Z   | PositionMeasurement | Z measurement                                     |

### *PositionMeasurement*

| 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        |
| SmoothingWindow  | 32s     | 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       | Setting for measurement name.                     |
| Source            | 32s          | Setting for 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. |
| 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            | Region3D     | Measurement region                                |
| RefRegionsEnabled | Boolean      | Setting to enable/disable reference regions       |



| Element             | Type            | Description                                                            |
|---------------------|-----------------|------------------------------------------------------------------------|
|                     |                 | 0 – Disable<br>1 – Enable                                              |
| RefRegionCount      | 32s             | Count of the reference regions that are to be used.                    |
| RefRegions          | (Collection)    | Reference regions. Contains 2 SurfaceRegion2D 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                             |
| Measurements\BaseX  | StudMeasurement | BaseX measurement                                                      |
| Measurements\BaseY  | StudMeasurement | BaseY measurement                                                      |
| Measurements\BaseZ  | StudMeasurement | BaseZ measurement                                                      |
| Measurements\TipX   | StudMeasurement | TipX measurement                                                       |
| Measurements\TipY   | StudMeasurement | TipY measurement                                                       |
| Measurements\TipZ   | StudMeasurement | TipZ measurement                                                       |
| Measurements\Radius | StudMeasurement | Radius measurement                                                     |

#### *StudMeasurement*

| 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        |
| SmoothingWindow  | 32s     | 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)     |

## 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            | Setting for measurement name.                     |
| Source                 | 32s               | Setting for 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. |
| RegionEnabled          | Boolean           | Setting to enable/disable region                  |
| Region                 | Region3D          | Measurement region                                |
| Measurements\Volume    | VolumeMeasurement | Volume measurement                                |
| Measurements\Area      | VolumeMeasurement | Area measurement                                  |
| Measurements\Thickness | VolumeMeasurement | Thickness measurement                             |

### *VolumeMeasurement*

| 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        |
| SmoothingWindow                          | 32s     | 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                            |

| Element | Type | Description     |
|---------|------|-----------------|
|         |      | 1 – Minimum     |
|         |      | 2 – 2D Centroid |
|         |      | 3 – 3D Centroid |
|         |      | 4 – Average     |
|         |      | 5 – Median      |

## 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       | Setting for measurement name.                                            |
| Source                  | 32s          | Setting for 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.                        |
| NominalBevelAngle       | 64f          | Nominal bevel angle (mm)                                                 |
| BevelAngleTolerance     | 64f          | Bevel angle tolerance (mm)                                               |
| NominalOuterRadius      | 64f          | Nominal outer radius (mm)                                                |
| OuterRadiusTolerance    | 64f          | Outer radius tolerance (mm)                                              |
| NominalInnerRadius      | 64f          | Nominal inner radius (mm)                                                |
| InnerRadiusTolerance    | 64f          | Inner radius tolerance (mm)                                              |
| BevelRadiusOffset       | 64f          | Bevel radius offset (mm)                                                 |
| 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                  | Region3D     | 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 SurfaceRegion2D elements                   |

| Element                  | Type              | Description                                                            |
|--------------------------|-------------------|------------------------------------------------------------------------|
| 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               | Setting for curve orientation angle                                    |
| Measurements\X           | CsHoleMeasurement | X measurement                                                          |
| Measurements\Y           | CsHoleMeasurement | Y measurement                                                          |
| Measurements\Z           | CsHoleMeasurement | Z measurement                                                          |
| Measurements\OuterRadius | CsHoleMeasurement | Outer Radius measurement                                               |
| Measurements\Depth       | CsHoleMeasurement | Depth measurement                                                      |
| Measurements\BevelRadius | CsHoleMeasurement | Bevel Radius measurement                                               |
| Measurements\BevelAngle  | CsHoleMeasurement | Bevel Angle measurement                                                |
| Measurements\XAngle      | CsHoleMeasurement | X Angle measurement                                                    |
| Measurements\YAngle      | CsHoleMeasurement | Y Angle measurement                                                    |
| Measurements\Radius      | CsHoleMeasurement | Radius measurement                                                     |

#### *CsHoleMeasurement*

| 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        |
| SmoothingWindow  | 32s     | Smoothing window                                           |
| Scale            | 64f     | Output scaling factor                                      |
| Offset           | 64f     | Output offset factor                                       |
| DecisionMin      | 64f     | Minimum decision threshold                                 |
| DecisionMax      | 64f     | Maximum decision threshold                                 |

## 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 (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 of the Profiles element—0—indicates that only data from that source will be sent to output.

```
<ProfileDimension>    ...
  <Measurements>
    <Width id="2">    ...
    <Height id="3">   ...

<Output>
  <Ethernet>          ...
  <Profiles options="0,1">0</Profiles>    ...
  <ProfileIntensities options="0" />      ...
  <Measurements options="2,3">2</Measurements>
```

### Ethernet Child Elements

| Element  | Type | Description        |
|----------|------|--------------------|
| Protocol | 32s  | Ethernet protocol: |

| Element                    | Type      | Description                                                                                   |
|----------------------------|-----------|-----------------------------------------------------------------------------------------------|
|                            |           | 0 – Gocator<br>1 – Modbus<br>2 – EtherNet/IP<br>3 – ASCII                                     |
| Ascii                      |           | See <i>ASCII</i> (page 262).                                                                  |
| EIP                        |           | See EIP.                                                                                      |
| Modbus                     |           | See Modbus                                                                                    |
| 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).                                                  |
| 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).                                                |
| ProfileIntensities         | 32s (CSV) | Selected profile intensity sources.<br>0 – Top<br>1 – Bottom<br>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.                                                        |

## 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.                       |

## EIP

### *EIP Child Elements*

| Element               | Type | Description                                               |
|-----------------------|------|-----------------------------------------------------------|
| BufferEnabled         | Bool | Enables EIP output buffering                              |
| EndianOutputType      | 32s  | Endian Output Type<br>0 – Big endian<br>1 – Little endian |
| ImplicitOutputEnabled | Bool | Enables Implicit (I/O) Messaging.                         |

## Modbus

### *Modbus Child Elements*

| Element       | Type | Description                     |
|---------------|------|---------------------------------|
| BufferEnabled | Bool | Enables Modbus output buffering |

## Digital0 and Digital1

The Digital0 and Digital1 elements defines 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>3 – Alignment state |
| SignalType | 32s  | Signal type:                                                                                                               |

| Element              | Type      | Description                                                                                                             |
|----------------------|-----------|-------------------------------------------------------------------------------------------------------------------------|
|                      |           | 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<br>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)                                                               |
| 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.                 |



| Element             | Type      | Description                                                       |
|---------------------|-----------|-------------------------------------------------------------------|
| 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:<br>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   | Described below.                            |
| Ascii                | Section   | Described below.                            |
| 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 |

| Element        | Type      | Description                                            |
|----------------|-----------|--------------------------------------------------------|
| 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. |

## 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. |

# Transformation File

The transformation file 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

The transformation file exists as a separate file when **Alignment Reference (page 56)** is set to **Fixed**. When **Alignment Reference** is set to **Dynamic**, transformation information is included in each job file (see page 214) under the Transform element.

Use the Read File and Write File commands to modify the transformation file. See the following sections for the elements contained in the transformation file.

## Alignment 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>
      <Orientation>0</Orientation>
    </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>
      <Orientation>0</Orientation>
    </Device>
  </Devices>
</Transform>
```

## Transform

The Transform element contains the alignment record for both the Main and the Buddy sensor. The version attribute defines the version of the record format.

```
<Transform version="100">
```

### *Transform Child Elements*

| Element           | Type         | Description                   |
|-------------------|--------------|-------------------------------|
| EncoderResolution | 64f          | Encoder Resolution (mm/tick). |
| Speed             | 64f          | Travel Speed (mm/s).          |
| Devices           | (Collection) | Contains two Device 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 role="0">
```

### *Device Child Elements*

| Element | Type | Description                      |
|---------|------|----------------------------------|
| X       | 64f  | Translation in the X axis (mm).  |
| Y       | 64f  | Translation in the Y axis (mm).  |
| Z       | 64f  | Translation in the Z axis (mm).  |
| XAngle  | 64f  | Rotation about X axis (degrees). |
| YAngle  | 64f  | Rotation about Y axis (degrees). |
| ZAngle  | 64f  | Rotation about Z axis (degrees). |

The rotation (counter-clockwise in the X-Z plane) is performed before the translation.

# Protocols

The following sections describe the protocols that Gocator sensors support.

## Gocator Protocol

This section describes TCP and UDP commands and data formats used by a client computer to communicate with Gocator sensors. Network communication 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 Concepts section defines network connection types (Discovery, Control, Upgrade, Data, and Health), common data types, and other terminologies. Subsequent sections provide details about network commands and data formats.

The Gocator SDK provides open source C language libraries that implement the network commands and data formats defined in this section. See *Software Development Kit* (page 327) for more information.

## General

### Modes

A Gocator system can operate in the following modes.

#### System Modes

| Mode    | Description                                   |
|---------|-----------------------------------------------|
| Video   | Sends raw video.                              |
| Profile | Performs profile measurements (default mode). |
| Surface | Performs part detection and measurements.     |

### Buddy Communication Channels

The peer-to-peer control channels are used by Gocator sensors to communicate between sensors.

| Channel   | Port        | Description                                                             |
|-----------|-------------|-------------------------------------------------------------------------|
| Discovery | 2002, 2005, | Gocator peer discovery port. UDP broadcasts on the subnet are sent once |

| Channel | Port         | Description                                                                                                                                 |
|---------|--------------|---------------------------------------------------------------------------------------------------------------------------------------------|
|         | 2008         | every second.                                                                                                                               |
| Command | 2002 to 2015 | Gocator request and response ports. Gocator uses UDP communications on these ports for configuration and reporting.                         |
| Data    | 2500         | Main Gocator listens on this port for TCP traffic from the Buddy sensor. Buddy sensor communicates using a free port available at the time. |

## States

A Gocator system can be in one of three states: Conflict, Ready, or Running. The Start and Stop commands are sent by the client to change the current state. The sensor can be configured to boot in either the Ready or Running state.

In the Ready state, a sensor can be configured. In the Running state, a sensor will respond to input signals, perform measurements, drive its outputs, and send data messages to the client. Disconnecting to command channel will change the sensor from the Running state to the Ready state.

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 Change Buddy command is used to remove the configured Buddy.

## Data Types

The table below defines the data types and associated type identifiers used throughout this document. All values are transmitted in little endian format (least significant byte first) unless stated otherwise.

### Data Types

| Type     | Description                       | Null Value                                |
|----------|-----------------------------------|-------------------------------------------|
| char     | Character (8-bit, ASCII encoding) | -                                         |
| byte     | Byte.                             | -                                         |
| 8u       | 8-bit unsigned integer.           | -                                         |
| 8s       | 8-bit signed integer.             | -                                         |
| 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        | -                                         |



IP addresses are an exception to the little endian rule. The bytes in the address "a.b.c.d" will always be transmitted in the order a, b, c, d (big endian).

## Status Codes

Each reply on Discovery (page 267), Control (page 269), and Upgrade (page 292) 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.               |

## 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) |

The Get Address and Set Address discovery commands can be used to modify a sensor's network configuration. Discovery 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    | 64u  | 0      | Command length.                                                                          |
| type      | 64s  | 8      | Command type (0x1).                                                                      |
| signature | 64u  | 16     | Message signature (0x0000504455494D4C).                                                  |
| deviceld  | 64u  | 24     | Serial number of the device whose address information is queried. 0 selects all devices. |

### Reply

| Field         | Type | Offset | Description                                 |
|---------------|------|--------|---------------------------------------------|
| length        | 64u  | 0      | Reply length.                               |
| type          | 64s  | 8      | Reply type (0x1001).                        |
| status        | 64s  | 16     | Operation status.                           |
| signature     | 64u  | 24     | Message signature (0x0000504455494D4C).     |
| deviceld      | 64u  | 32     | Serial number.                              |
| dhcpEnabled   | 64u  | 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    | 64u  | 0      | Command length.                                                                          |
| type      | 64s  | 8      | Command type (0x2).                                                                      |
| status    | 64s  | 16     | 1 – OK<br>0 – Error                                                                      |
| signature | 64u  | 24     | Message signature (0x0000504455494D4C).                                                  |
| deviceld  | 64u  | 32     | Serial number of the device whose address information is queried. 0 selects all devices. |



| Field         | Type | Offset | Description                                 |
|---------------|------|--------|---------------------------------------------|
| dhcpEnabled   | 64u  | 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.                                   |

#### *Reply*

| Field     | Type | Offset | Description                             |
|-----------|------|--------|-----------------------------------------|
| length    | 64u  | 0      | Reply length.                           |
| type      | 64s  | 8      | Reply type (0x1002).                    |
| status    | 64s  | 16     | Operation status.                       |
| signature | 64u  | 24     | Message signature (0x0000504455494D4C). |
| deviceId  | 64u  | 32     | Serial number.                          |

## Control Commands

A client can send commands and receive responses over the Control and Upgrade TCP channels.

#### *Command Channels*

| Channel | Port | Description                                    |
|---------|------|------------------------------------------------|
| Control | 3190 | Sensor accepts commands for most operations.   |
| Upgrade | 3192 | Sensor accepts commands for firmware upgrades. |

The Control and Upgrade channels can be connected simultaneously, but the sensor will accept only a single connection on each port. If an additional connection is attempted on a port that is already connected, the previous connection will be closed and the new connection will be accepted.

## Protocol Version

The Protocol Version command reports the Control 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.                              |
| majorVersion | 8u   | 10     | Major version.                             |
| minorVersion | 8u   | 11     | Minor version.                             |

## Get Address

The Get Address command is used to discover Gocator sensors across subnets.

### *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.                              |
| dhcpEnabled   | byte | 10     | 0 – DHCP not used<br>1 – DHCP used         |
| 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  | 8      | Reply status.                              |

## Get System Info

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 page 293). Firmware upgrade files are available from the downloads section under the support tab on the LMI web site. See *Firmware Upgrade* (page 62) for more information on obtaining the latest firmware.

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.                              |
| localInfo                   | Sensor Info | 10     | Info for this device.                      |
| remoteCount                 | 32u         | 66     | Number of discovered sensors.              |
| remoteInfo<br>[remoteCount] | Sensor Info | 70     | List of info for discovered sensors.       |

### SensorInfo

| 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                   |

| Field   | Type | Offset | Description                                                    |
|---------|------|--------|----------------------------------------------------------------|
|         |      |        | 0 – Ready<br>1 – Running                                       |
| role    | 32s  | 48     | Sensor role<br>0 – Main<br>1 – Buddy                           |
| buddyId | 32s  | 52     | Serial number of paired device (main or buddy). 0 if unpaired. |

## Get States

The Get System Info command a list of useful 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.                                                            |
| count              | 32u  | 10     | Number of state variables.                                               |
| sensorState        | 32s  | 14     | Sensor state<br>-1 – Conflict<br>0 – Ready<br>1 – Running                |
| 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<br>0 – Live data                                         |

| Field            | Type | Offset | Description                               |
|------------------|------|--------|-------------------------------------------|
|                  |      |        | 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.                              |

## 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.                              |

## 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.                              |

## 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.                              |
| 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. Copy a saved configuration to "\_live.job" to make the configuration live.

### Command

| Field           | Type | Offset | Description                  |
|-----------------|------|--------|------------------------------|
| length          | 64s  | 0      | Command size – in bytes.     |
| id              | 64s  | 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.                              |

## Read File

Downloads a file from the connected sensor. Read the file "\_live.job" and "\_live.prof" to download the live configuration and template.

### Command

| Field    | Type | Offset | Description                  |
|----------|------|--------|------------------------------|
| length   | 32u  | 0      | Command size – 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 – in bytes.     |
| id           | 16u  | 4      | Reply identifier (0x1007). |
| status       | 32s  | 6      | Reply status.              |
| length       | 32u  | 10     | File length                |
| data[length] | byte | 14     | File contents              |

## Write File

The Write File command uploads a file to the connected sensor. Write to "\_live.job" to write the make the job file live. Except for writing to the live files, 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.                              |

## Delete File

The Delete File command removes a file from the connected sensor.

### 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.                              |

## Get Default Job

The Get Default Job command gets the name of a default job file that will be loaded at boot time.

### 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.                              |
| name[64] | char | 10     | File name (null-terminated).               |



## Set Default Job

The Set Default Job command sets the name of a default job file that will be loaded at boot time.

### 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).                 |

### 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.                              |

## Get Loaded Job

The Get Loaded Job command returns the currently loaded (i.e., live) file name and modified status for a file type.

### 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.                                                              |
| fileName[64] | char | 10     | Name of the currently loaded file.                                         |
| changed      | 8u   | 74     | Whether or not the currently loaded file has been changed (1: yes; 0: no). |

## 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.                              |

### 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.                                   |
| reference | 32s  | 10     | Alignment reference<br>0 – Fixed<br>1 – Dynamic |

### 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.                              |

### 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.                              |
| timestamp | 64u  |        | 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.                              |
| encoder | 64s  | 10     | Current encoder position, in ticks.        |

### Reset Encoder

The Reset Encoder command is used to reset the current encoder value.

#### 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.                              |

### Start

The Start command starts the sensor system (system enters the Running state).

### Command

| Field    | Type | Offset | Description                                  |
|----------|------|--------|----------------------------------------------|
| length   | 32u  | 0      | Command size including this field, in bytes. |
| id       | 16u  | 4      | Command identifier (0x100D).                 |
| reserved | 64s  |        | Reserved field – set to 0.                   |

### 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.                              |

## 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).

### Command

| Field  | Type | Description                                                                             |
|--------|------|-----------------------------------------------------------------------------------------|
| length | 64s  | Command size – in bytes.                                                                |
| id     | 64s  | Command identifier (0x100F).                                                            |
| target | 64s  | Target scheduled start value (in ticks or microseconds, depending on the trigger type). |

### Reply

| Field  | Type | Description                |
|--------|------|----------------------------|
| length | 64s  | Reply size – in bytes.     |
| id     | 64s  | Reply identifier (0x101D). |
| status | 64s  | Reply status.              |

## Stop

The Stop command stops the sensor system (system enters the Ready state).

### 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.                              |

## 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.                              |
| opId   | 32s  | 10     | Operation ID.                              |

## 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.                              |
| opId   | 32s  | 10     | Operation ID.                              |

## 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.                              |

### 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. See *Digital Output* (page 199) for information on setting up the digital output.

#### 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) or position (um) of when the event should happen.<br><br>The target value is ignored if the <b>Signal</b> setting in <b>Digital</b> in the <b>Output</b> panel is not set to <b>Scheduled</b> . The output will be triggered immediately. See <i>Digital Output</i> (page 199) for information on setting <b>Signal</b> . |
| value  | 8u   | 16     | Specifies the target state:<br>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.                              |

### 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. See *Analog Output* (page 202) for information on setting up the analog output.

#### Command

| Field  | Type | Offset | Description                                  |
|--------|------|--------|----------------------------------------------|
| length | 32u  | 0      | Command size including this field, in bytes. |
| id     | 16u  | 4      | Command identifier (0x4519).                 |

| Field  | Type | Offset | Description                                                                                                                                                                                                                                                                                                                                                      |
|--------|------|--------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 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>The target value is ignored if the <b>Signal</b> setting in <b>Analog</b> in the <b>Output</b> panel is not set to <b>Scheduled</b> . The output will be triggered immediately. See <i>Analog Output</i> (page 202) for information on setting the Signal type. |
| value  | 32s  | 16     | Output current (micro-amperes).                                                                                                                                                                                                                                                                                                                                  |

#### 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.                              |



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.                              |



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.                              |

## 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.                              |
| 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  | 10     | Data length.                                 |
| data[length] | byte | 14     | 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.                              |

### Restore Factory

The Restore Factory command restores the connected sensor to factory default settings. 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).                                                                       |
| resetAddress | 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.                              |

### 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.                              |

## 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.                              |
| enable | 8u   | 10     | 0: disabled; 1: enabled.                   |

## 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.                              |

## Set Playback Source

The Set Playback Source command sets the data source for data acquisition.

### 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.                              |

## Get Playback Source

The Get Playback Source command gets the data source for data acquisition.

### 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.                              |
| source | 32s  | 10     | Source<br>0 – Live<br>1 – Replay buffer    |

## 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).                 |
| 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 (0x4522).                 |
| status      | 32s  | 6      | Reply status.                              |
| 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. |
| id     | 16u  | 4      | Reply identifier (0x4503).                 |
| status | 32s  | 6      | Reply status.                              |

## 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.                              |



When the system is running in the Replay mode, this command advances replay data (playback) by one frame. This command returns error if no live playback data set is loaded. You can use the Copy File command to load a replay data set to live.

## 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.                              |
| 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.                              |

## 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.                              |

## 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.                              |

## 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.                              |

## Read File (Progressive)

The progressive Read File command reads the content of a file as a stream.

### 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.                            |

### 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.                              |

| Field         | Type | Offset | Description                            |
|---------------|------|--------|----------------------------------------|
| progressTotal | 32u  | 10     | Progress indicating completion (100%). |
| progress      | 32u  | 14     | Current progress.                      |



The reply may be followed by a series of continue replies.

## Export CSV (Progressive)

The progressive Export CSV command exports replay data as a CSV stream.

### Command

| Field  | Type | Offset | Description                                  |
|--------|------|--------|----------------------------------------------|
| length | 32u  | 0      | Command size including this field, in bytes. |
| id     | 16u  | 4      | Command identifier (0x4507).                 |

### 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.                              |
| progressTotal | 32u  | 10     | Progress indicating completion (100%).     |
| progress      | 32u  | 14     | Current progress.                          |



All recorded profile data is exported in the CSV. Only the current surface scan is exported (determined by the playback position).

The reply may be followed by a series of continue replies. See the section on progressive reply.

## Export Bitmap (Progressive)

The progressive Export Bitmap command exports replay data as a bitmap stream.

### 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.                            |

### Reply

| Field  | Type | Offset | Description                                |
|--------|------|--------|--------------------------------------------|
| length | 32u  | 0      | Reply size including this field, in bytes. |

| Field         | Type | Offset | Description                            |
|---------------|------|--------|----------------------------------------|
| id            | 16u  | 4      | Reply identifier (0x4508).             |
| status        | 32s  | 6      | Reply status.                          |
| progressTotal | 32u  | 10     | Progress indicating completion (100%). |
| progress      | 32u  | 14     | Current progress.                      |



The reply may be followed by a series of continue replies. See the section on progressive reply.

## Upgrade Commands

A client can send commands and receive responses over the Control and Upgrade TCP channels.

### Command Channels

| Channel | Port | Description                                    |
|---------|------|------------------------------------------------|
| Control | 3190 | Sensor accepts commands for most operations.   |
| Upgrade | 3192 | Sensor accepts commands for firmware upgrades. |

The Control and Upgrade channels can be connected simultaneously, but the sensor will accept only a single connection on each port. If an additional connection is attempted on a port that is already connected, the previous connection will be closed and the new connection will be accepted.

After connecting to a Gocator device, you can use the Get 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 will be updated in the event that breaking changes are made to the Gocator Protocol.

## Get Protocol Version

The Get Protocol Version command reports the Upgrade protocol version of the connected sensor.

### Command

| Field  | Type | Description                  |
|--------|------|------------------------------|
| length | 64s  | Command size – in bytes.     |
| id     | 64s  | Command identifier (0x0100). |

### Reply

| Field        | Type | Description            |
|--------------|------|------------------------|
| length       | 64s  | Reply size – in bytes. |
| id           | 64s  | Reply identifier.      |
| status       | 64s  | Reply status.          |
| majorVersion | 64s  | Major version.         |
| minorVersion | 64s  | Minor version.         |



## Start Upgrade

The Start Upgrade command begins a firmware upgrade for the Main sensor and any Buddy sensors. All sensors will automatically reset 3 seconds after the upgrade process is complete.

### Command

| Field          | Type | Offset | Description                                                    |
|----------------|------|--------|----------------------------------------------------------------|
| length         | 64s  | 0      | Command size – in bytes.                                       |
| id             | 64s  | 4      | Command identifier (0x0000).                                   |
| skipValidation | byte | 6      | Whether or not to skip validation (0 – do not skip, 1 – skip). |
| length         | 32u  | 7      | Length of the upgrade package (bytes).                         |
| data[length]   | byte | 11     | Upgrade package data.                                          |

### Reply

| Field  | Type | Offset | Description                                |
|--------|------|--------|--------------------------------------------|
| length | 32u  | 0      | Reply size including this field, in bytes. |
| id     | 16u  | 4      | Reply identifier (0x0000).                 |
| status | 32s  | 6      | Reply status.                              |

## Get Upgrade Status

The Get Upgrade Status command determines the progress of a firmware upgrade.

### Command

| Field  | Type | Offset | Description                                  |
|--------|------|--------|----------------------------------------------|
| length | 32u  | 0      | Command size including this field, in bytes. |
| id     | 16u  | 4      | Command identifier (0x1)                     |

### Reply

| Field    | Type | Offset | Description                                                                                          |
|----------|------|--------|------------------------------------------------------------------------------------------------------|
| length   | 32u  | 0      | Reply size including this field, in bytes.                                                           |
| id       | 16u  | 4      | Reply identifier (0x1).                                                                              |
| status   | 32s  | 6      | Reply status.                                                                                        |
| state    | 32s  | 10     | Upgrade state:<br>-1 – Failed<br>0 – Completed<br>1 – Running<br>2 – Completed, but should run again |
| progress | 32u  | 14     | 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 | 32u  | 0      | Command size including this field, in bytes. |
| id     | 16u  | 4      | Command identifier (0x2)                     |

### Reply

| Field       | Type | Offset | Description                                |
|-------------|------|--------|--------------------------------------------|
| length      | 32u  | 0      | Reply size including this field, in bytes. |
| id          | 16u  | 4      | Reply identifier (0x2).                    |
| status      | 32s  | 6      | Reply status.                              |
| length      | 32u  | 10     | Length of the log (bytes).                 |
| log[length] | char | 14     | Log content.                               |

## Data Results

A client can receive data messages from a Gocator sensor by connecting to the Data or Health TCP channels.

### Result Channels

| Channel | Port | Description                   |
|---------|------|-------------------------------|
| Data    | 3196 | Sensor sends data messages.   |
| Health  | 3194 | Sensor sends health messages. |

The ports above can be connected simultaneously and the sensor will also accept multiple connections on each port.

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 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. |

GDP messages are always sent in groups. The last message flag in the control field is used to indicate the final message within 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. |

| Field     | Type  | Offset | Description                                  |
|-----------|-------|--------|----------------------------------------------|
| 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 (us).                                                                                                                                                                                                                                                                                                                               |
| 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 (main if buddied).                                                                                                                                                                                                                                                                                                       |
| 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.                                           |
| 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                                                |

| Field         | Type       | Offset | Description                                                      |
|---------------|------------|--------|------------------------------------------------------------------|
|               |            |        | 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).                                                   |
| reserved[2]   | 8u         | 26     | Reserved.                                                        |
| 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.<br>Bits 0-14: Message type identifier. |
| 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).                                                    |
| reserved[3]   | 8u       | 37     | 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. |
| 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).                                                    |
| 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. |
| 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).                                                    |

| Field        | Type | Offset | Description       |
|--------------|------|--------|-------------------|
| 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. |
| 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).                                                    |
| 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).                                                    |
| rotation      | 32s  | 45     | Rotation (microdegrees).                                          |
| reserved[3]   | 8u   | 49     | Reserved.                                                         |
| ranges[L][W]  | 16s  | 50     | 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. |
| 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).                                                     |

| Field             | Type | Offset | Description                                                      |
|-------------------|------|--------|------------------------------------------------------------------|
| 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.                                             |

## 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. |
| count (C)       | 32u         | 6      | Count of measurements in this message.                            |
| reserved[2]     | 8u          | 10     | Reserved.                                                         |
| id              | 16u         | 12     | Measurement identifier.                                           |
| measurements[C] | Measurement | 16     | 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.                                                                                                                                           |

## Alignment 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.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               |
| 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. |
| 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. |



| Field           | Type | Offset | Description                                      |
|-----------------|------|--------|--------------------------------------------------|
| 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). |
| quality         | 32s  | 19     | Match quality (thousandth).                      |
| qualityDecision | byte | 24     | Quality match decision.                          |
| reserved[2]     | byte | 25     | 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. |
| 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. |
| 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.                                              |

## Health Results

A client can receive data messages from a Gocator sensor by connecting to the Data or Health TCP channels.

### *Result Channels*

| Channel | Port | Description                   |
|---------|------|-------------------------------|
| Data    | 3196 | Sensor sends data messages.   |
| Health  | 3194 | Sensor sends health messages. |

The ports above can be connected simultaneously and the sensor will also accept multiple connections on each port.

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 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. |

GDP messages are always sent in groups. The last message flag in the control field is used to indicate the final message within 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. |
| count (C)     | 32u       | 6      | Count of indicators in this message.                              |
| source        | 8u        | 10     | Source (0 – Main, 1 – Buddy).                                     |
| reserved[3]   | 8u        | 13     | Reserved                                                          |
| indicators[C] | Indicator | 16     | 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       | 64s  | 0      | Unique indicator identifier (see below). |
| instance | 64s  | 4      | Indicator instance.                      |
| value    | 64s  | 8      | Value (identifier-specific meaning).     |

The following health indicators are defined for Gocator sensor systems:

#### *Health Indicators*

| <b>Indicator</b>      | <b>Id</b> | <b>Instance</b> | <b>Value</b>                                                                                       |
|-----------------------|-----------|-----------------|----------------------------------------------------------------------------------------------------|
| 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).                                                |
| Internal Temperature  | 2002      | -               | Internal temperature (centidegrees Celsius).                                                       |
| 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   | 2501      | Output Index    | Number of dropped outputs.                                                                         |
| Digital Output Drops  | 2601      | Output Index    | Number of dropped outputs.                                                                         |
| Serial Output Drops   | 2701      | Output Index    | Number of dropped outputs.                                                                         |
| Sensor State          | 20000     | -               | Gocator sensor state.<br>-1 – Conflict<br>0 – Ready<br>1 – Running                                 |

| Indicator               | Id    | Instance     | Value                                                                                                                                         |
|-------------------------|-------|--------------|-----------------------------------------------------------------------------------------------------------------------------------------------|
| Current Sensor Speed    | 20001 | -            | Current sensor speed. (Hz)                                                                                                                    |
| Maximum Speed           | 20002 | -            | The sensor's maximum speed.                                                                                                                   |
| 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.                                                                                                |
| Laser Overheat          | 20020 | -            | Indicates whether laser overheat has occurred.<br>0 – Has not overheated<br>1 – Has overheated<br>Only available on certain 3B laser devices. |
| Laser Overheat Duration | 20021 | -            | The length of time in which the laser overheating state occurred.<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, 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.                                                         |

| Indicator            | Id    | Instance       | Value                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             |
|----------------------|-------|----------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 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 overflowed 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> |

Additional undocumented indicator values may be included in addition to the indicators defined above.

# Modbus TCP Protocol

Modbus TCP is designed to allow industrial equipment such as Programmable Logic Controllers (PLC), sensors, and physical input/output devices to communicate over an Ethernet network.

Modbus TCP 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 enables the client to:

- Switch to a different active job.
- Align and run sensors.
- Receive sensor states, stamps, and measurement results.

Modbus TCP is enabled in the **Output** panel. For more information, see *Ethernet Output* (page 196).

If buffering is enabled with the Modbus protocol, the PLC must read the Buffer Advance output register (see page 309) to advance the queue before reading the measurement results.

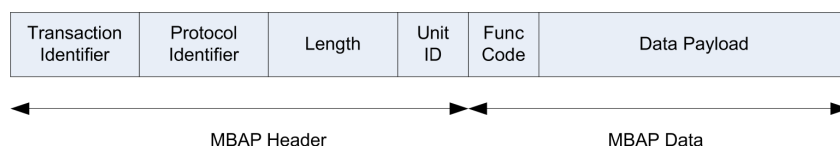
## Concepts

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 TCP 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 will be closed 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.                                                                                                             |

| Field   | Length (Bytes) | Description                                                                                                                           |
|---------|----------------|---------------------------------------------------------------------------------------------------------------------------------------|
| 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 - 371        | Sensor States            | RO         | Report sensor states. See <i>State</i> (next page) for detailed descriptions.                                  |
| 900 - 999        | Stamps                   | RO         | Return stamps associated with each profile or surface. See <i>State</i> (next page) for detailed descriptions. |
| 1000 - 1060      | Measurements & Decisions | RO         | 20 measurement and decision pairs. See <i>Measurement Registers</i> (page 310) 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) until the alignment process is complete. |



| Value | Name                  | Description                                                                                                                                                 |
|-------|-----------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 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.                                                                                                 |

## 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>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 (us).                                                                                                                        |
| 311              | Job File Length   | 16u  | Number of characters in the current job file name.                                                                                        |
| 312 – 371        | Live Job Name     |      | Current Job Name.<br>Name of currently loaded job file. Does not include the extension. Each 16-bit register contains a single character. |

### 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 (us).                                                                                                                                                                                                                     |
| 985              | Exposure Low     |      |                                                                                                                                                                                                                                          |
| 986              | Temperature High | 32u  | Sensor temperature (degress celcius * 1000).                                                                                                                                                                                             |
| 987              | Temperature Low  |      |                                                                                                                                                                                                                                          |
| 988              | Position High    | 64s  | Encoder position                                                                                                                                                                                                                         |
| 989              | Position         |      |                                                                                                                                                                                                                                          |
| 990              | Position         |      |                                                                                                                                                                                                                                          |
| 991              | Position Low     |      |                                                                                                                                                                                                                                          |
| 992              | Time Low         | 64u  | Timestamp (us).                                                                                                                                                                                                                          |
| 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      |      |                                                                                                                                                                                                                                          |
| 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 um (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 to a different active job.
- Align and run sensors.
- Receive sensor states, stamps, and measurement results.

EtherNet/IP is enabled in the **Output** panel. For more information, see *Ethernet Output* (page 196).

## 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. For example, an "assembly object" is a type of object with a data attribute that can be accessed with the GetAttribute and SetAttribute commands. The Gocator uses assembly objects to take commands and provide sensor state and measurement values.

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 not supported.

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 (Write Single Attribute) |

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                                                                                                     |
| 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.                                                                                                                                                   |

## 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       | 0x4   |

| Information       | Value                       |
|-------------------|-----------------------------|
| Instance          | 0x320                       |
| Attribute Number  | 3                           |
| Length            | 100 bytes                   |
| Supported Service | 0x0E (Get Single Attribute) |

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                                                                |
| 2       | Alignment state             |      | Alignment status:<br>0 - Not aligned<br>1 - Aligned<br>The value is only valid when byte1 is set to 0.                                      |
| 3-10    | Encoder                     | 64s  | Current encodesr position                                                                                                                   |
| 11-18   | Time                        | 64s  | Current timestamp                                                                                                                           |
| 19      | Current Job Filename Length | 16u  | Number of characters in the current job filename. (e.g., 9 for "myjob.job"). The length includes the .job extension. Valid when byte 1 = 0. |
| 20-43   | Current Job Filename        |      | Name of currently loaded job file. Includes the ".job" extension. Each byte contains a single character. Valid when byte 1 = 0.             |
| 44 - 99 | Reserved                    |      | Reserved bytes                                                                                                                              |

## Sample State Assembly

The sample state object contains measurements and their associated stamp information.

#### Sample State Assembly

| Information | Value |
|-------------|-------|
| Class       | 0x04  |
| Instance    | 0x321 |

| Information       | Value                       |
|-------------------|-----------------------------|
| Attribute Number  | 3                           |
| Length            | 380 bytes                   |
| Supported Service | 0x0E (Get Single Attribute) |

#### Attribute 3

| Attribute | Name    | Type       | Value | Description                                          | Access |
|-----------|---------|------------|-------|------------------------------------------------------|--------|
| 3         | Command | Byte Array |       | 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 us                                                                                                                                           |
| 14-17   | Temperature      | 32u  | Sensor temperature in degrees Celsius * 1000 (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 um (0x80000000 if invalid)                                                                                                                |
| 84      | Decision 0       | 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 |
| ...     | ...              |      |                                                                                                                                                                |
| 375-378 | Measurement 59   | 32s  | Measurement value in um (0x80000000 if invalid)                                                                                                                |
| 379     | Decision 59      | 8u   | Measurement decision. A bit mask, where:<br>Bit 0:                                                                                                             |



| Byte | Name | Type | Description              |
|------|------|------|--------------------------|
|      |      |      | 1 - Pass                 |
|      |      |      | 0 - Fail                 |
|      |      |      | Bits 1-7:                |
|      |      |      | 0 - Measurement value OK |
|      |      |      | 1 = Invalid value        |
|      |      |      | 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  $(80 + 5 * ID)$ . 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* (page 196) for information on the **Output** panel.

# ASCII Protocol

This section describes the ASCII protocol available over the Ethernet and serial outputs. The protocol communicates using ASCII strings. The output result format from the sensor is user-configurable.

## Ethernet Communication

Gocator's Ethernet communication is bidirectional. Measurement results are sent on the Ethernet output in one of two modes: Polling or Asynchronous. The ASCII protocol over Ethernet enables the client to:

- Switch to a different job.
- Align, run, and trigger sensors.
- Receive sensor states, health indicators, stamps, and measurement results

As with the Gocator Protocol (see page 265), there are separate channels for Control, Data, and Health messages. The Control channel is used for commands. The Data channel is used to receive and poll for measurement results. The Health channel is used to receive health indicators.

The port number used for each channel is configurable. Each port can accept multiple connections, up to a total of 16 connections for all ports.

Channels can share the same port or operate on individual ports. The default port number is 8190 for all channels. The following port numbers are reserved for Gocator internal use: 80, 843, 2000-2100, 2500-2600, 3100-3250.

## Asynchronous and Polling Operation

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, when the sensor receives a Get Result command, it will send the latest measurement results on the same data channel that the request is received.

## 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 |

## Standard Result Format

Measurement results can either be sent 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 measurement. The measurement type is the same as defined elsewhere (see page 294). |
| 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.                                                    |

| Field         | Shorthand      | Length | Description                                                                                                                                                      |
|---------------|----------------|--------|------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 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<br>Bits 1-7:<br>0 – Measurement value OK<br>1 – Invalid value<br>2 – Invalid anchor |

## 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 page 66).

### Formats

| Message | Format                |
|---------|-----------------------|
| Command | Trigger, start target |

| Message | Format                                                                                                                                                                                                                                                                                                                        |
|---------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
|         | 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

## Load Job

The Load Job command switches the active sensor configuration.

#### Formats

| Message | Format                                                                                                                                                                                                                             |
|---------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Command | LoadJob, job file name<br>If the job file name is not specified, the command returns the current job name. An error message is generated if there is no job 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>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>OK, time, <time value>, encoder, <encoder position>, frame, <frame count> ERROR, <Error Message><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 ','.

### Get Result

The Get 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



## Get Value

The Get 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.<br>OK, <custom data string> ERROR, <Error Message><br>If arguments are specified,<br>OK, <data string in standard format, except that the decisions are not sent> ERROR,<br><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
```

## Get Decision

The Get 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 ','.

### Get Health

The Get Health command retrieves health indicators. See *Health Results* (page 302) for details on health indicators.

| Formats |                                                                                                                                                                                                                                                                                                     |
|---------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Message | Format                                                                                                                                                                                                                                                                                              |
| Command | Health, health indicator ID.health indicator instance ...<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 '!'.<br> |
| Reply   | OK, <health indicator of first ID>, <health indicator of second ID><br>ERROR, <Error Message>                                                                                                                                                                                                       |

Examples:

```
health,2002,2017
OK,46,1674
Health
ERROR,Insufficient parameters.
```

# Software Development Kit

The Gocator Software Development Kit (SDK) includes open-source software libraries and documentation that can be used to programmatically access and control Gocator sensors. The latest version of the SDK can be downloaded by going to <http://lmi3d.com/support/downloads/>, selecting a Gocator series, and clicking on the *Product User Area* link.

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

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/downloads/>.

## Sample Project Environment Variable

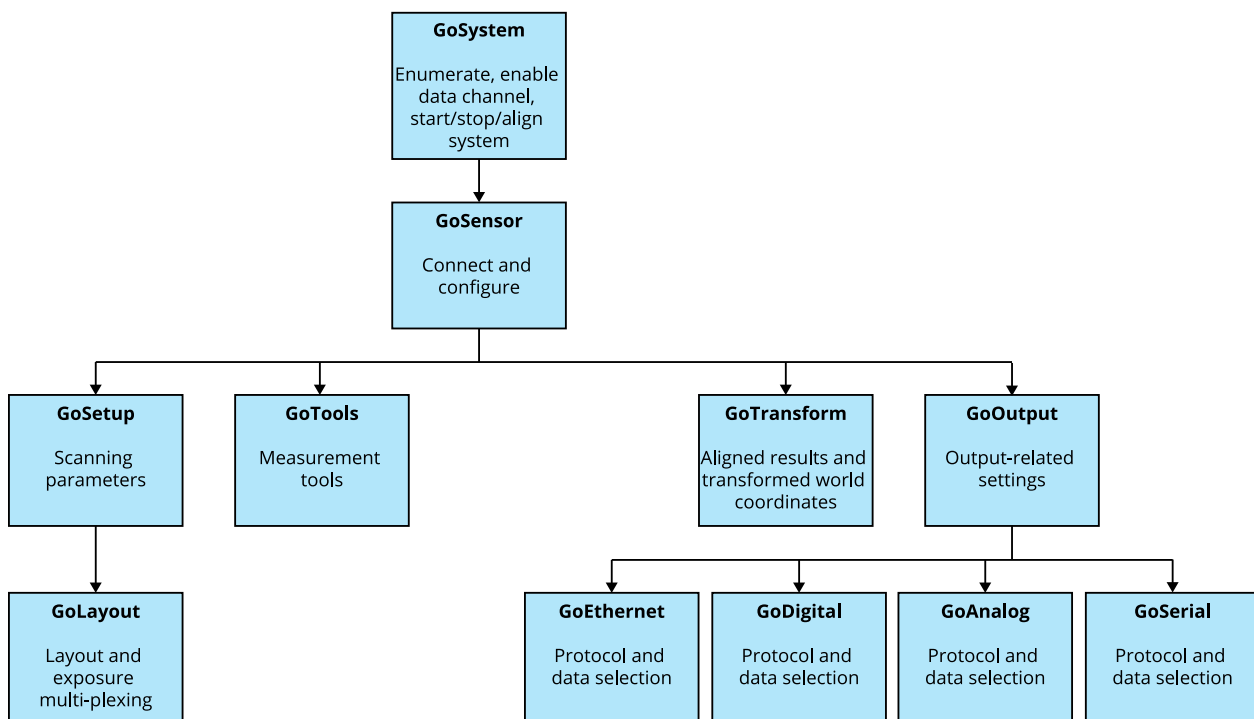
All sample projects use the environment variable `GO_SDK_4`. The environment variable should point to the `GO_SDK` directory, for example, `C:\14400-4.0.9.156_SOFTWARE_GO_SDK\GO_SDK`.

## 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 4.0 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   |

| Type       | Description                           |
|------------|---------------------------------------|
| 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                                                                                                      |
|-----------------------|------------------------------------------------------------------------------------------------------------------|
| GoDataMsg             | Represents a base message sourced from the data channel. See <i>GoDataSet Type</i> (below) for more information. |
| 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.                                          |
| 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.

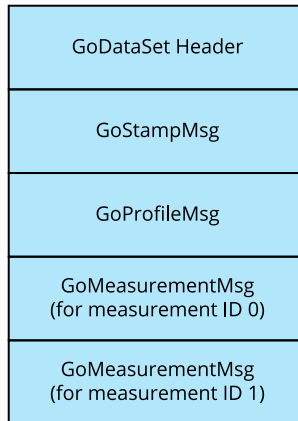


See *Setup and Locations* (page 327) for more information on the code samples.

## 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 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* (page 329) 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. |

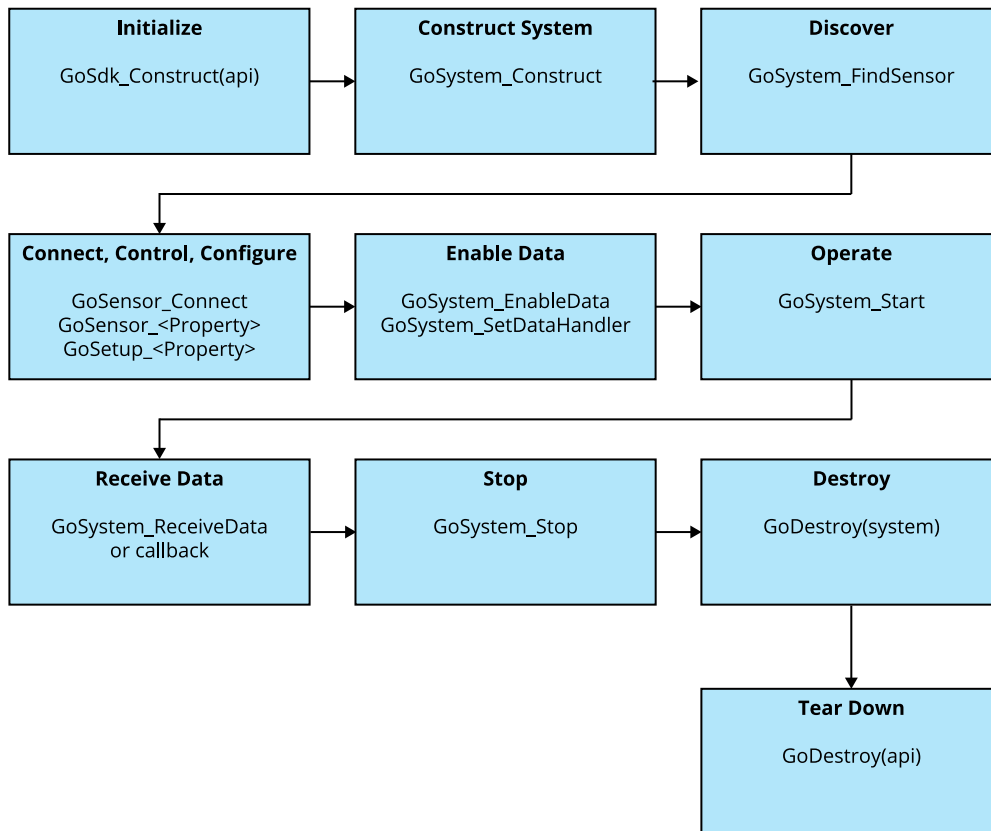
Refer to the *SetupMeasurement* example for details on how to add and configure tools and measurements. Refer to the *ReceiveMeasurement* example for details on how to receive measurement decisions and values.



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* (page 327) 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* (page 328) 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>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_SetAligningReference() 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.

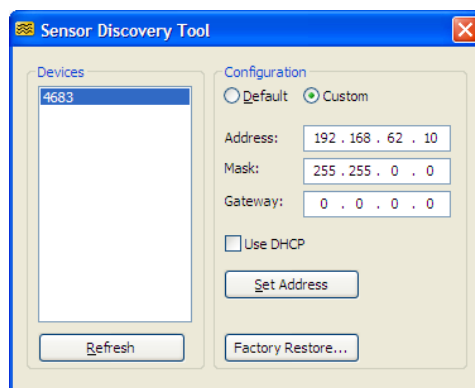
# Tools and Native Drivers

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

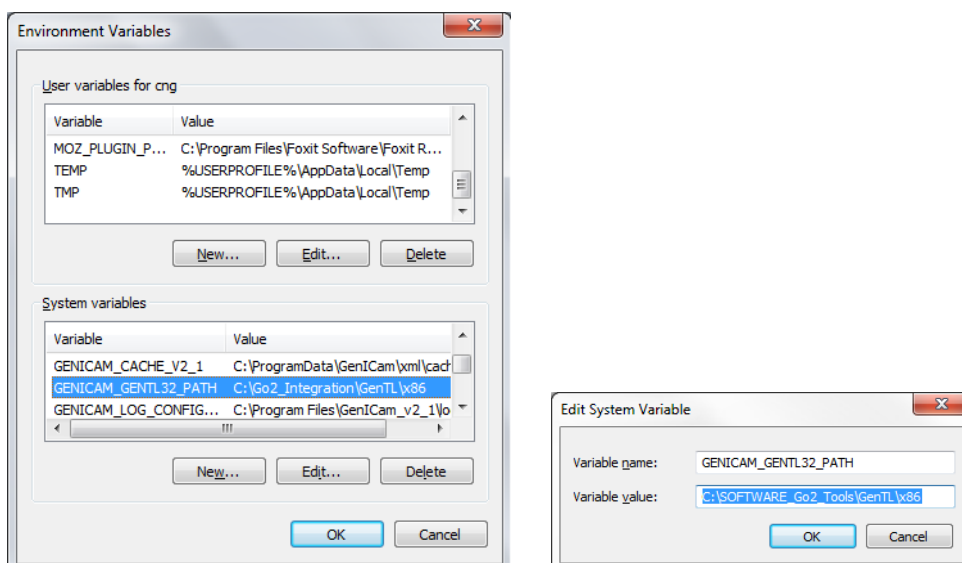
GenTL is an industry standard method of controlling and acquiring data from an imaging device. Gocator provides a GenTL driver that allows GenTL-compliant third-party software (e.g., Halcon and Common Vision Blox) to acquire and process 3D point clouds and intensity generated from the Gocator's Profile (with **Uniform Spacing** disabled) and Surface modes in real-time.

You can get the tool package containing the driver from the downloads area on the LMI Technologies website at <http://lmi3d.com/support/downloads/>.

After downloading the tool package (14405-x.x.x.x\_SOFTWARE\_GO\_Tools.zip), unzip the file. The driver is found under the GenTL\x86 directory.

*To install the driver in Windows 7:*

1. Open the **Control** panel.
2. Select **System and Security** and then click **System**.
3. Click **Advanced System Settings**.  
The **Advanced System Settings** link is typically in the left column of the window.
4. For 32-bit systems, click **New** to create a system environment variable GENICAM\_GENTL32\_PATH and point it to the GenTL\x86 directory.  
If the system environment variable already exists, click **Edit**.
5. For 64-bit systems, click **New** to create a system environment variable GENICAM\_GENTL64\_PATH and point it to the GenTL\x64 directory.  
If the system environment variable already exists, click **Edit**.



To work with the Gocator GenTL driver, the Gocator must operate in Surface mode with its part output enabled in the Ethernet Output Panel. Check "Acquire Intensity" and enable intensity output in the **Ethernet** panel in the **Output** page if intensity data is required.

Refer to the documentations in the GenTL\ directory for instructions on how to interface to various third party software.

Gocator 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 required to support the sensor's FOV 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 pixel channel</p> <p>See <i>Data Results</i> (page 294) for an explanation of the stamp information.</p>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   |

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 (us)                                                                      |
| 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)                                           | <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 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> |
| (max part height) .. 2* (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</p>                                                                                                                                                                                                                                                                                                       |



| Rows                                        | Details                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    |
|---------------------------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
|                                             | <p>row of the intensity information, not the first row of the whole 16-bit grey scale image.</p> <p><math>X = X \text{ offset} + P_x * X \text{ resolution}</math></p> <p><math>Y = Y \text{ offset} + P_y * Y \text{ resolution}</math></p> <p>Z = 16-bit intensity value</p> <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> (page 294) 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 (us)                                                                      |
| 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 intensity is enabled or not                                              |

## Registers

GenTL registers are multiple 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              | Enable the resampling logic in the GenTL driver<br>0 – Disable resampling<br>1 – Enable resampling<br>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.                         |
| 296              | EncoderValue0              | RO         | 4              | Report the current encoder value (least significant 32-bit).<br>The current encoder value is latched from the sensor when this register is read.                                                                                                                   |
| 300              | EncoderValue1              | RO         | 4              | Report the current encoder value (most significant 32-bit).<br>The encoder value is latched when EncoderValue0 register is read. User should read EncoderValue0 before reading EncoderValue1.                                                                      |
| 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. |
| 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

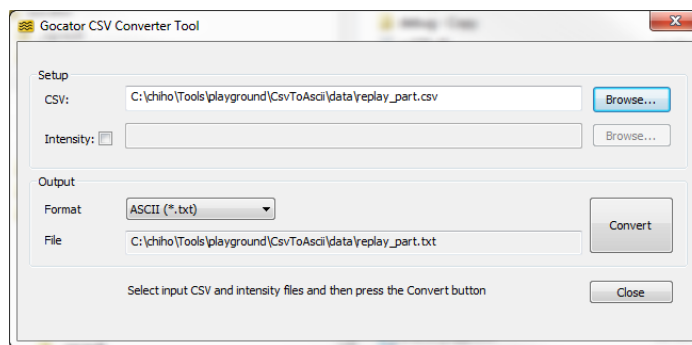
The settings file, Go2GenTL.xml, resides in the same directory as the Gocator GenTL driver. Users can set the resample mode and output format by changing the setting in this file.

| 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                                                                                                    |

## 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 different formats, including ASCII (XYZI), 16-bit BMP, 16-bit PNG, and GenTL formats. You can get the tool package (14405-x.x.x.x\_SOFTWARE\_GO\_Tools.zip) from the download area on LMI's website at <http://lmi3d.com/support/downloads/>. See *Downloading, Exporting, and Uploading Recorded Data* (page 46) for more information on exporting recorded data.

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 (see page 338). 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. 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.
4. Press the **Convert** button.

# Troubleshooting

Review the guidance in this chapter if you are experiencing difficulty with a Gocator sensor system. See *Return Policy* (page 384) for further assistance if the problem that you are experiencing is not described in this section.

## 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* (page 336) for more information.

When attempting to log in, the password is not accepted.

- See *Sensor Recovery Tool* (page 336) 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* (page 347) for more information.
- The exposure setting may be too low. See *Exposure* (page 74) 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* (page 66) 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* (page 347) to review the measurement specifications for your sensor model.
- Check that the exposure time is set to a reasonable level. See *Exposure* (page 74) 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* (page 66) 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* (page 79) 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 the Gocator and its associated hardware.

# Gocator 2300 Series

The Gocator 2300 series consists of the sensor models defined below.

| MODEL                                        | 2320            | 2330          | 2340          | 2350          | 2370          | 2375         | 2380          |
|----------------------------------------------|-----------------|---------------|---------------|---------------|---------------|--------------|---------------|
| Data Points / Profile                        | 1280            | 1280          | 1280          | 1280          | 1280          | 1280         | 1280          |
| Linearity Z<br>(+/- % of MR)                 | 0.01            | 0.01          | 0.01          | 0.01          | 0.04          | 0.05         | 0.04          |
| Resolution Z (mm)                            | 0.0018 - 0.0030 | 0.006 - 0.014 | 0.013 - 0.037 | 0.019 - 0.060 | 0.055 - 0.200 | 0.154 - 0.56 | 0.092 - 0.488 |
| Resolution X (mm)<br>(Profile Data Interval) | 0.014 - 0.021   | 0.044 - 0.075 | 0.095 - 0.170 | 0.150 - 0.300 | 0.275 - 0.550 | 0.27 - 0.80  | 0.375 - 1.100 |
| Repeatability Z (µm)                         | 0.4             | 0.8           | 1.2           | 2             | 8             | N/A          | 12            |
| Clearance<br>Distance (CD) (mm)              | 40              | 90            | 190           | 300           | 400           | 650          | 350           |
| Measurement<br>Range (MR) (mm)               | 25              | 80            | 210           | 400           | 500           | 1350         | 800           |
| Field of View (FOV)<br>(mm)                  | 18 - 26         | 47 - 85       | 96 - 194      | 158 - 365     | 308 - 687     | 345 - 1028   | 390 - 1260    |
| Recommended Laser<br>Class                   | 2M              | 2M            | 3R            | 3R            | 3B            | 3B-N         | 3B            |
| Other Laser Classes                          | 3R              | 3R, 3B        | 3B            | 3B            |               |              |               |
| Dimensions (mm)                              | 35x120x149.5    | 49x75x142     | 49x75x197     | 49x75x272     | 49x75x272     | 49x75x272    | 49x75x272     |
| Weight (kg)                                  | 0.8             | 0.74          | 0.94          | 1.3           | 1.3           | 1.3          | 1.3           |

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.

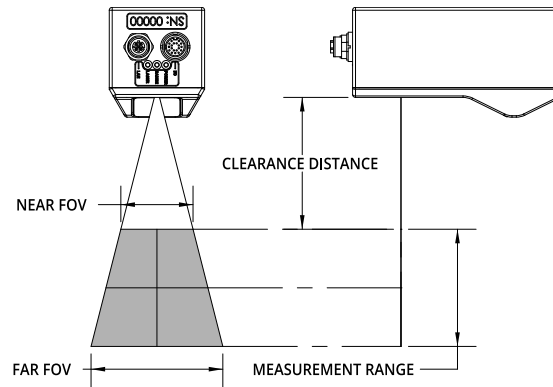
Repeatability Z is measured with a flat target at the middle of the measurement range. It is the 95% confidence variation of the average height over 4096 frames. Height values are averaged over the full FOV.

See *Resolution and Accuracy* (page 38) for more information.



## ALL 2300 SERIES MODELS

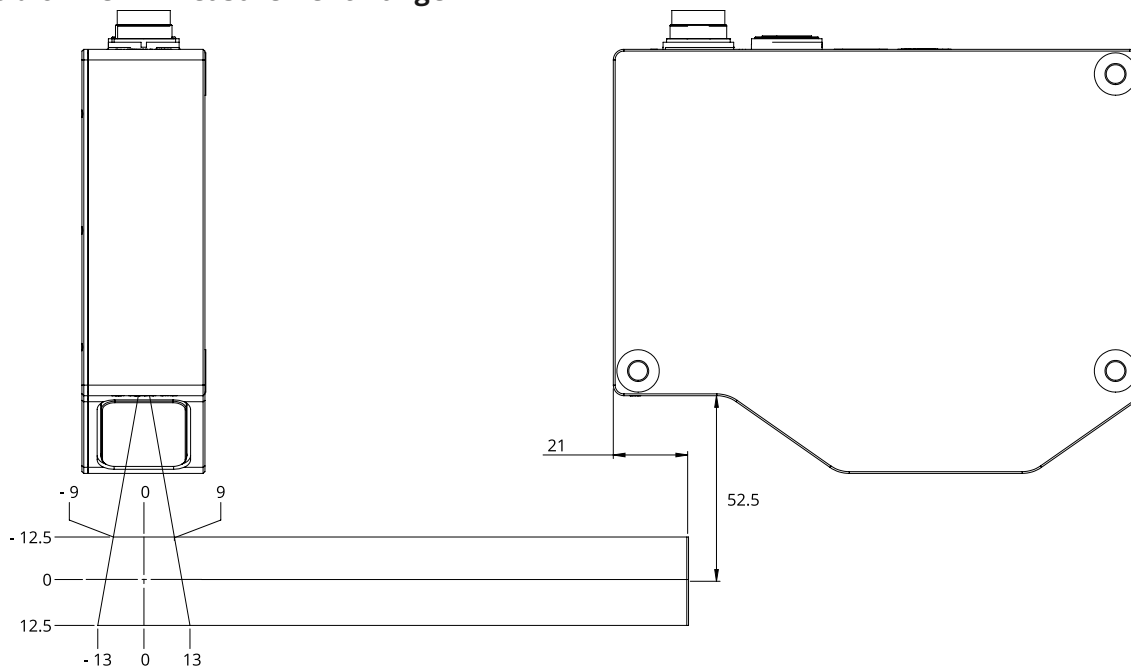
|                       |                                                                            |
|-----------------------|----------------------------------------------------------------------------|
| Scan Rate             | Approx. 170Hz to 5000 Hz                                                   |
| 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) |
| 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                                                               |



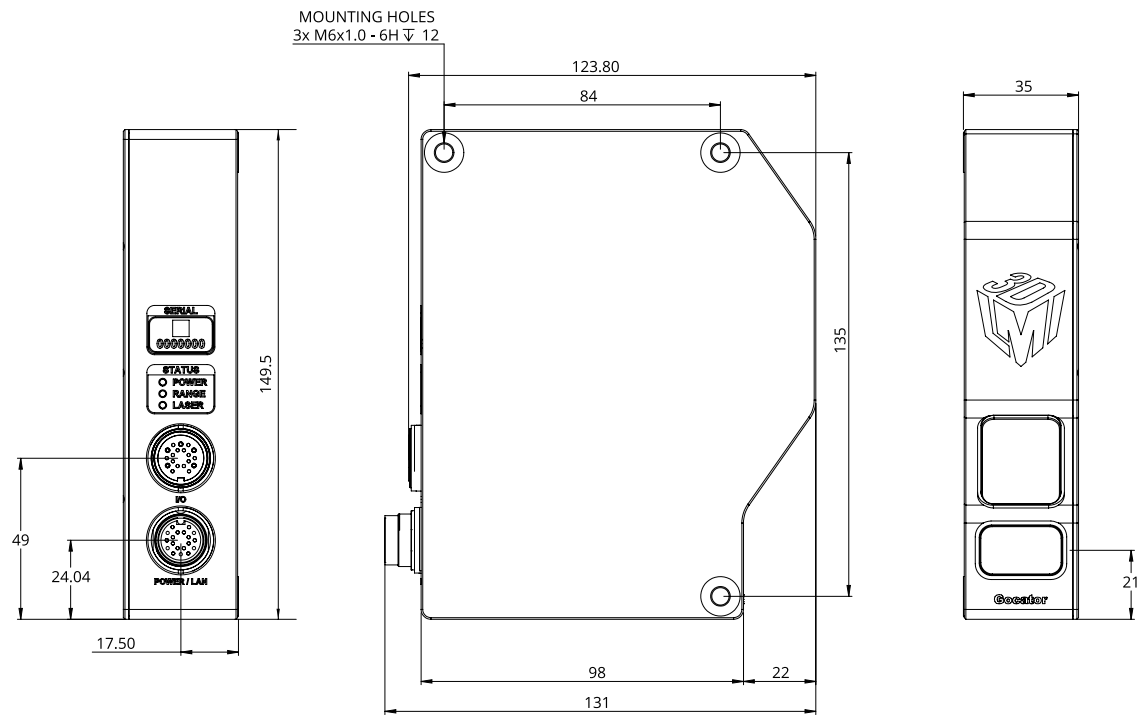
Mechanical dimensions for each sensor model are illustrated on the following pages.

## Gocator 2320

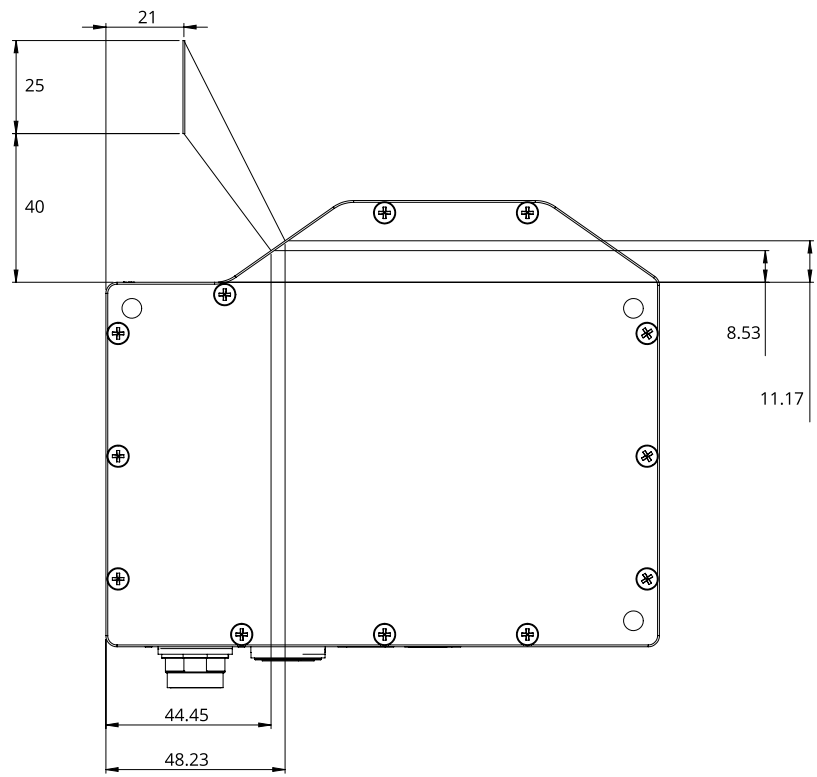
### Field of View / Measurement Range



Dimensions

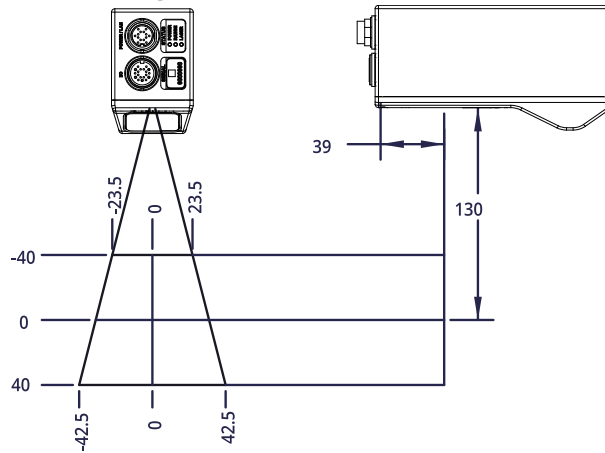


Envelope

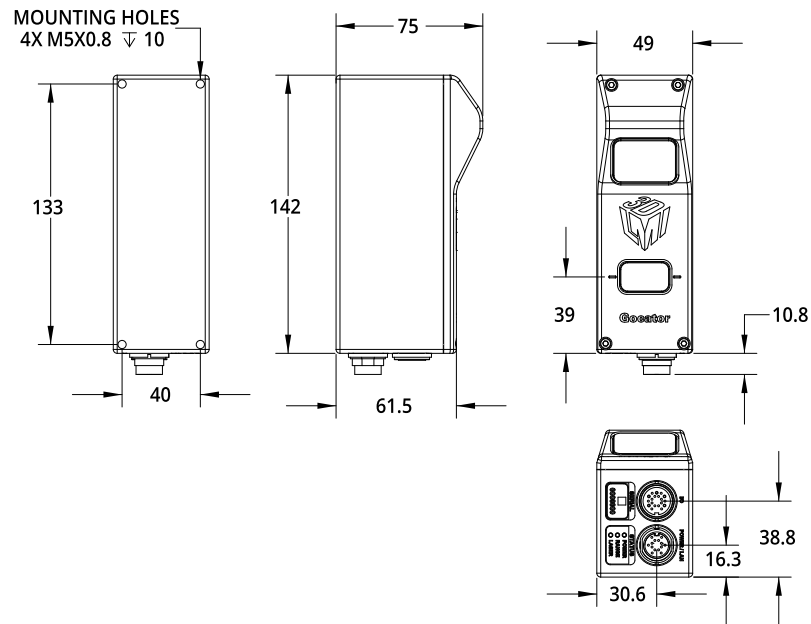


# Gocator 2330

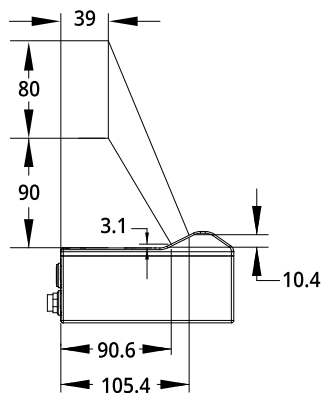
## Field of View / Measurement Range



## Dimensions

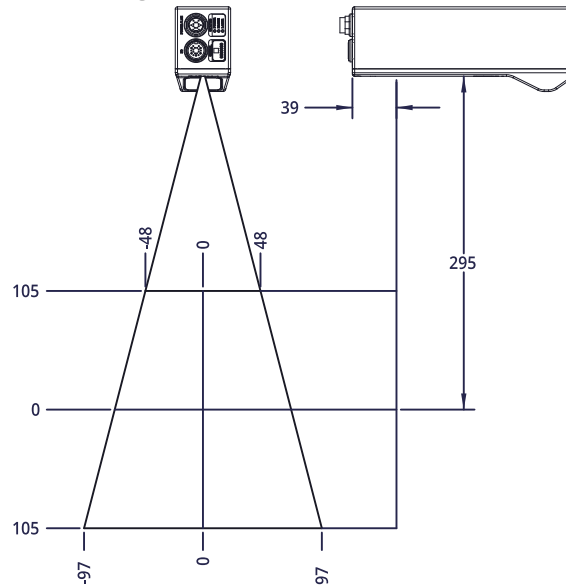


## Envelope

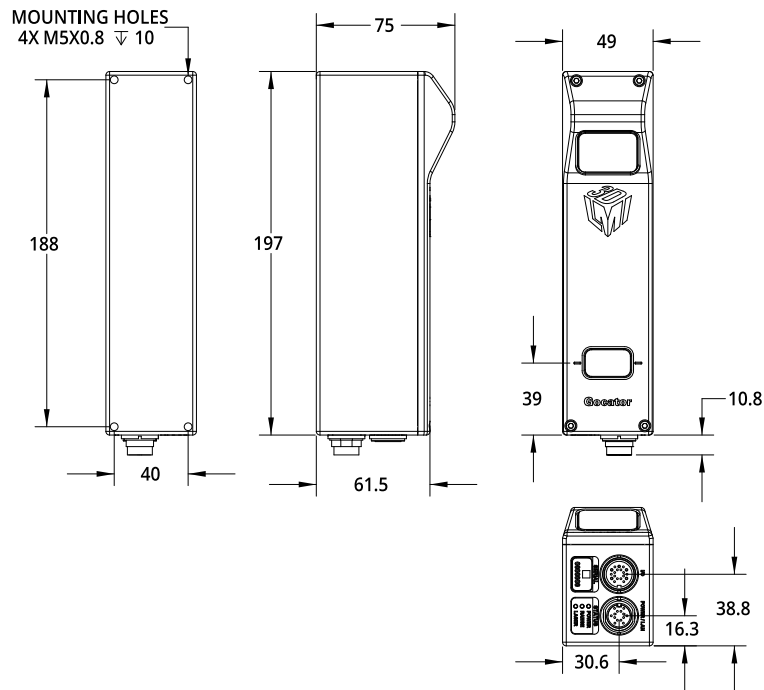


# Gocator 2340

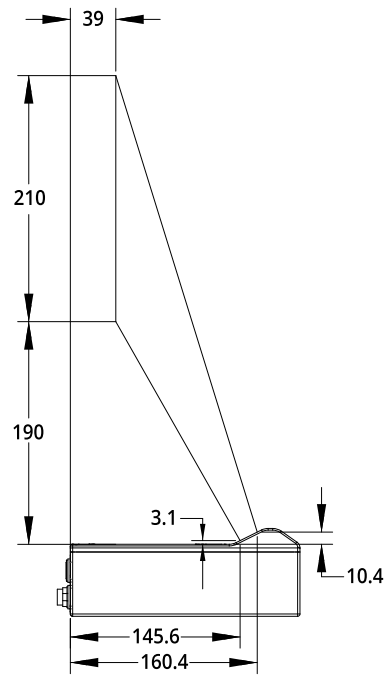
## Field of View / Measurement Range



## Dimensions

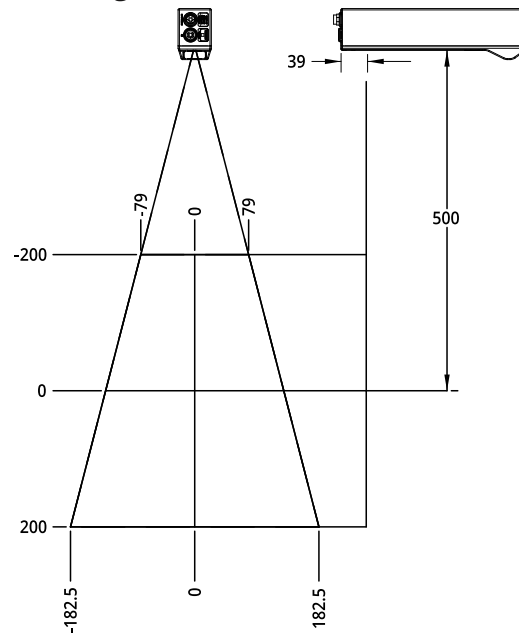


## Envelope

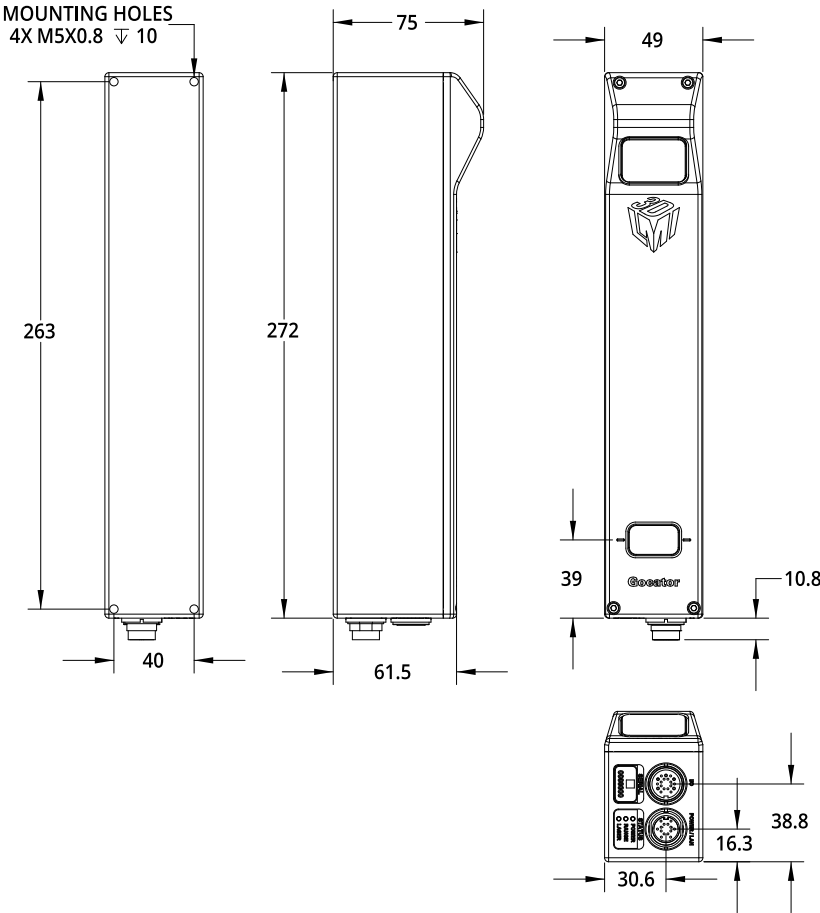


## Gocator 2350

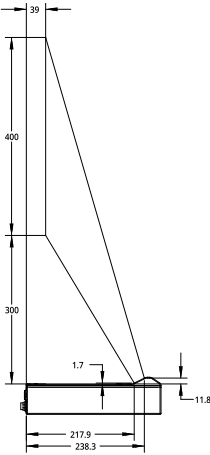
### Field of View / Measurement Range



Dimensions

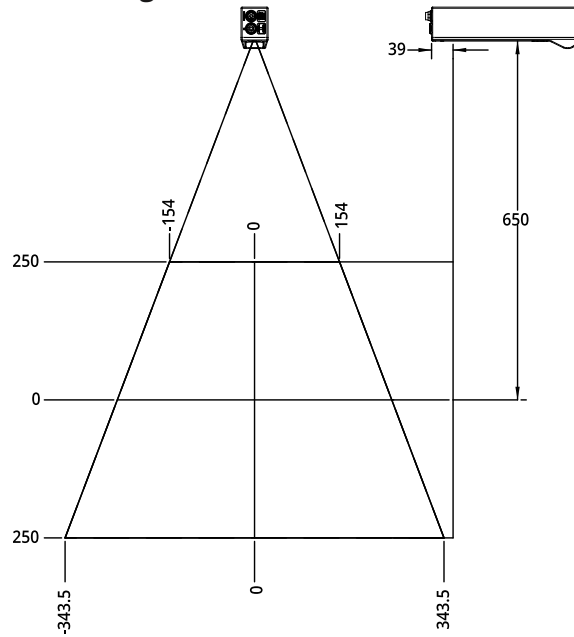


Envelope

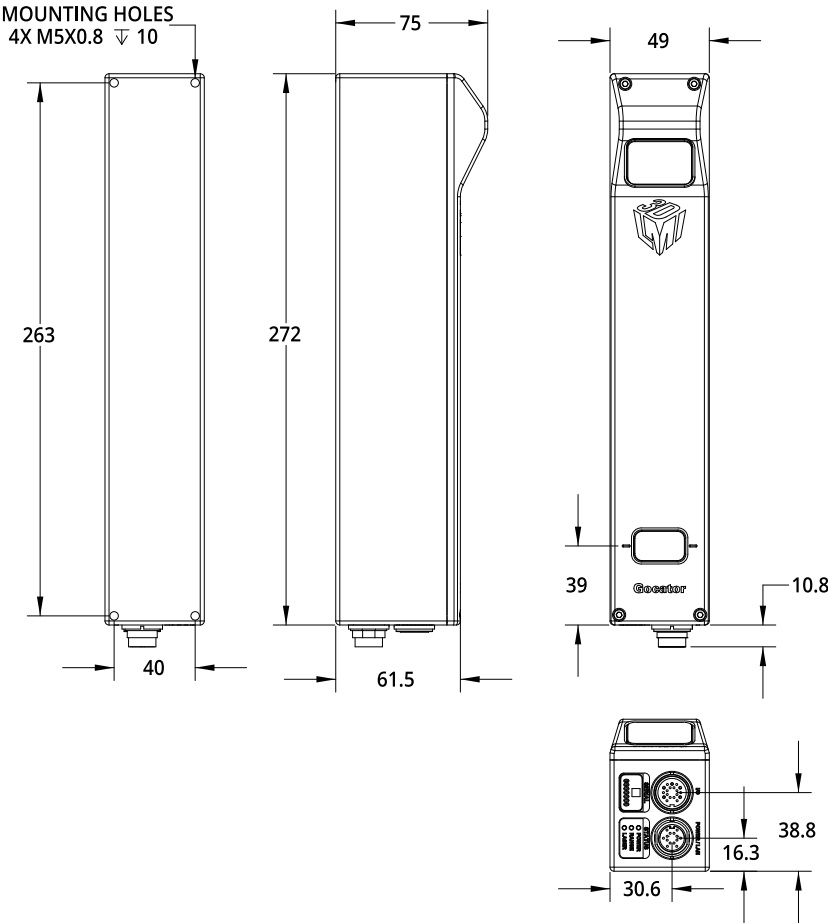


## Gocator 2370

### Field of View / Measurement Range

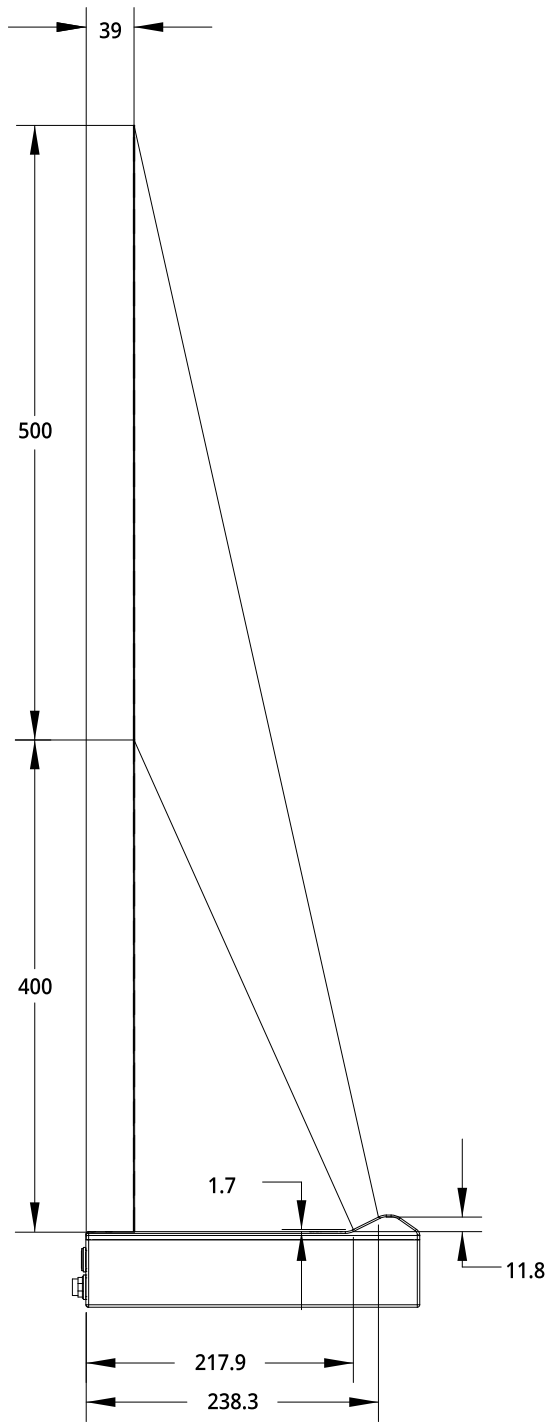


Dimensions



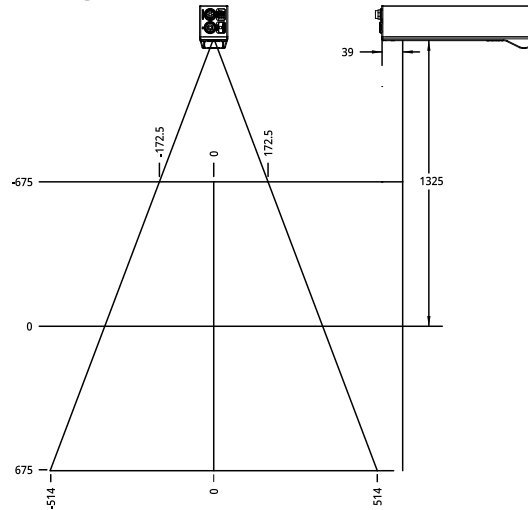


Envelope

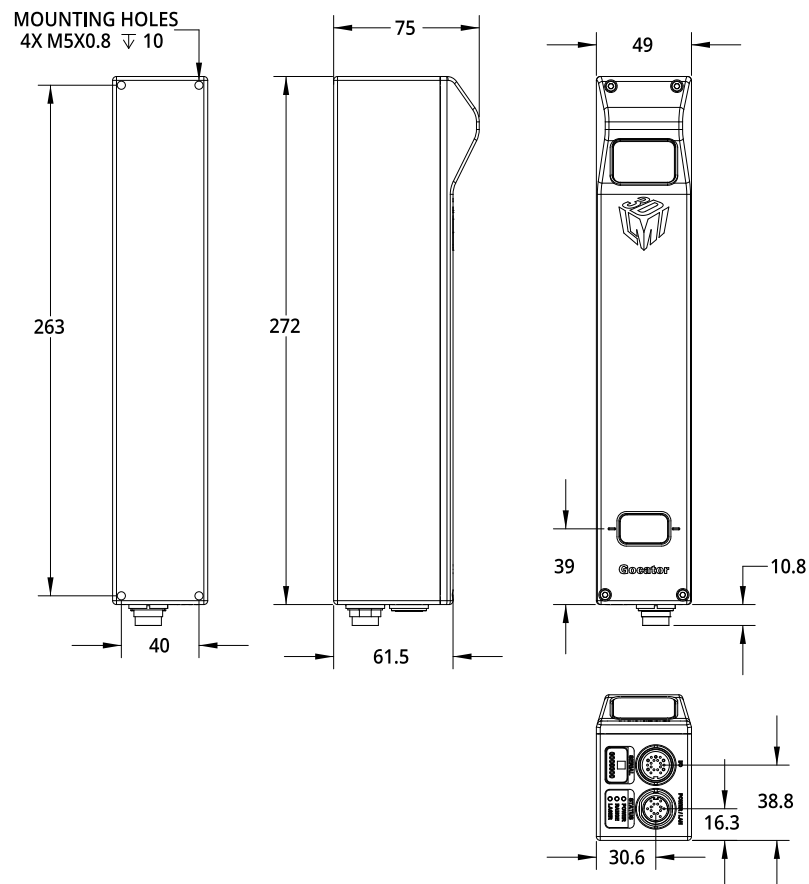


# Gocator 2375

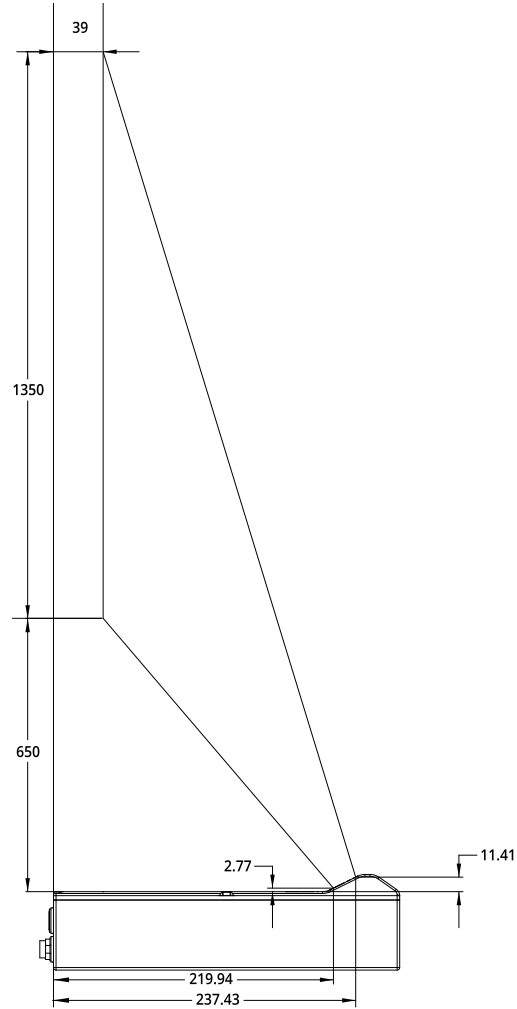
## Field of View / Measurement Range



## Dimensions

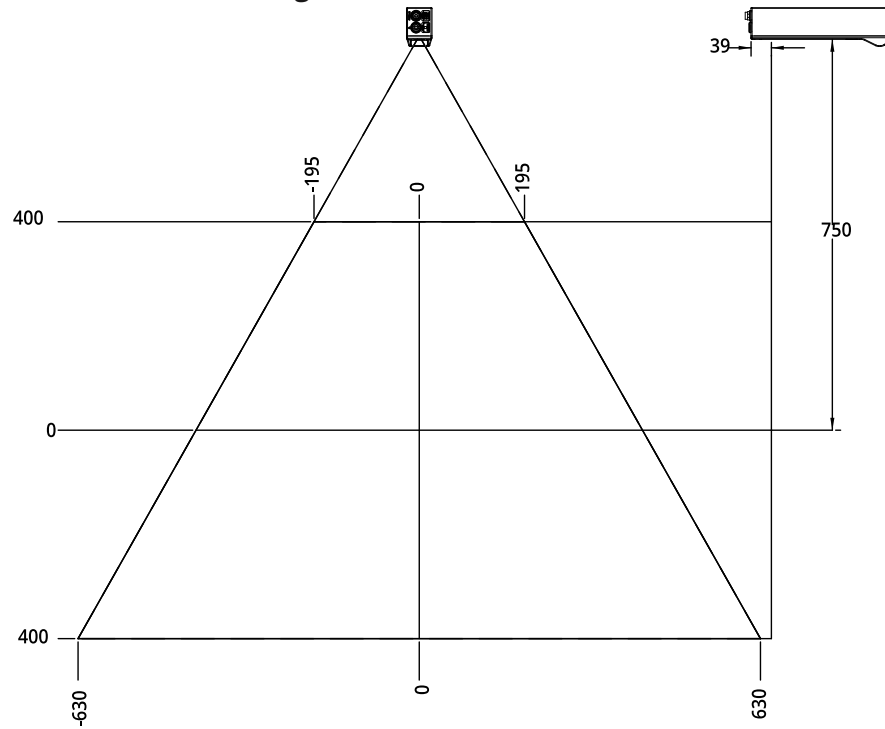


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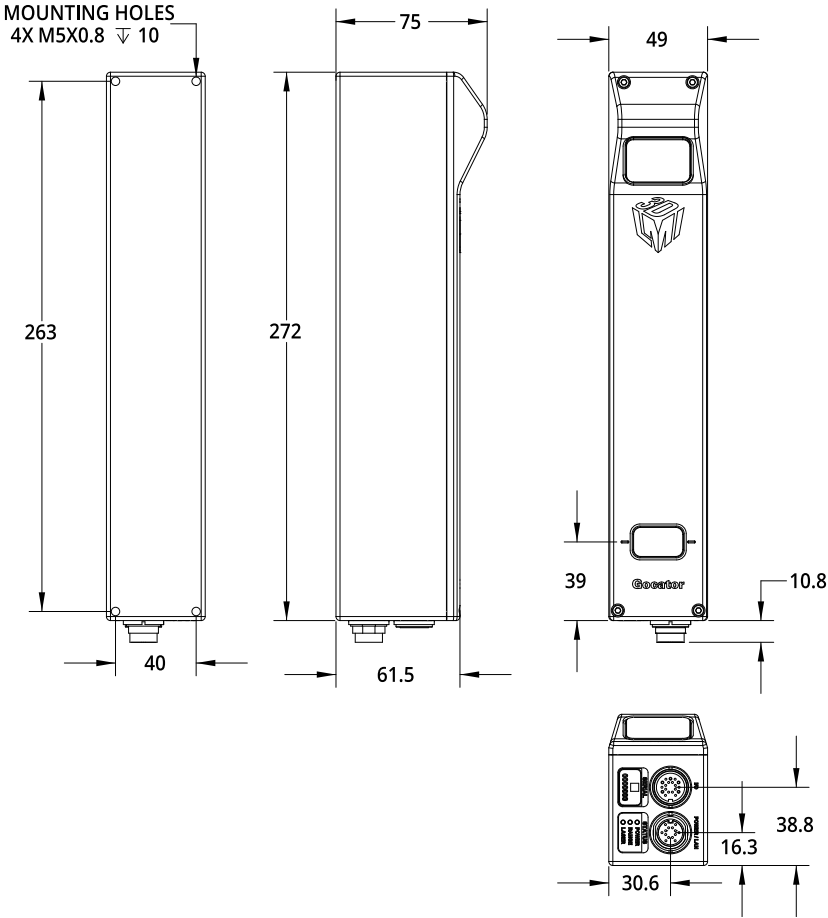


## Gocator 2380

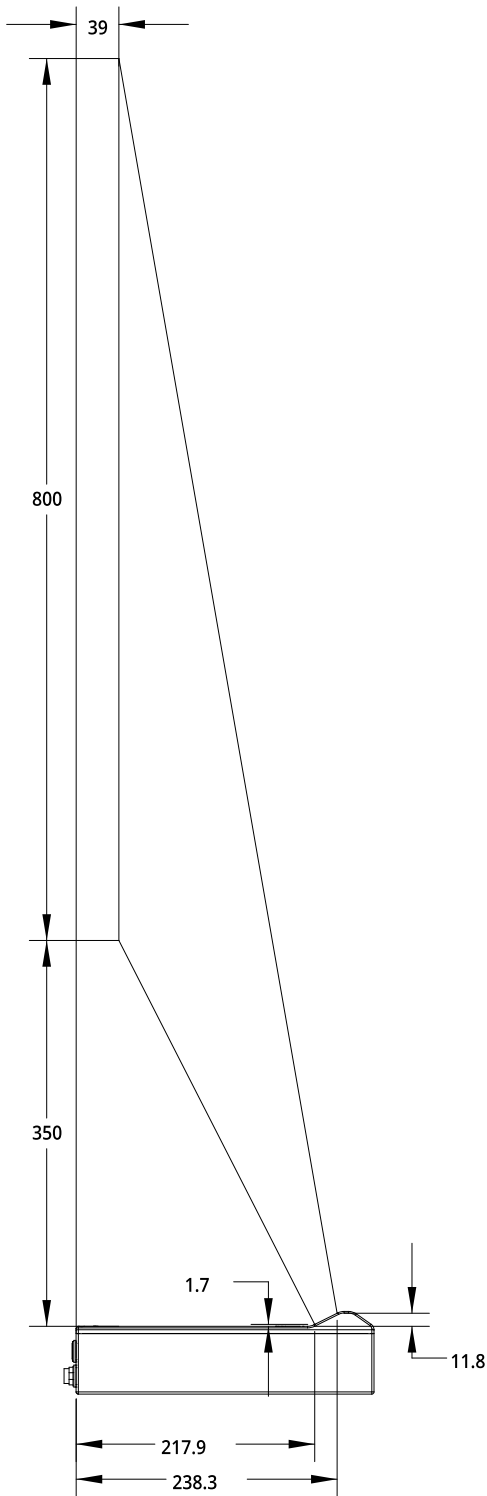
### Field of View / Measurement Range



Dimensions



Envelope



# Gocator 2880 Sensor

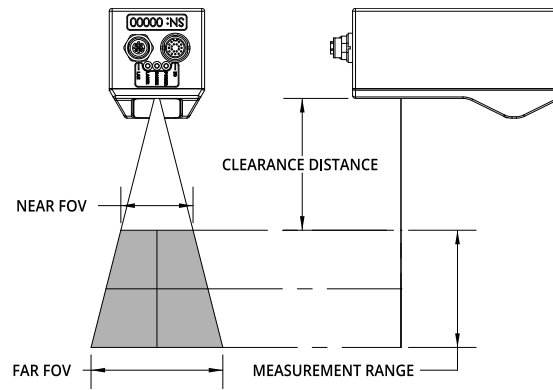
The Gocator 2880 is defined below.

| 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           |

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.

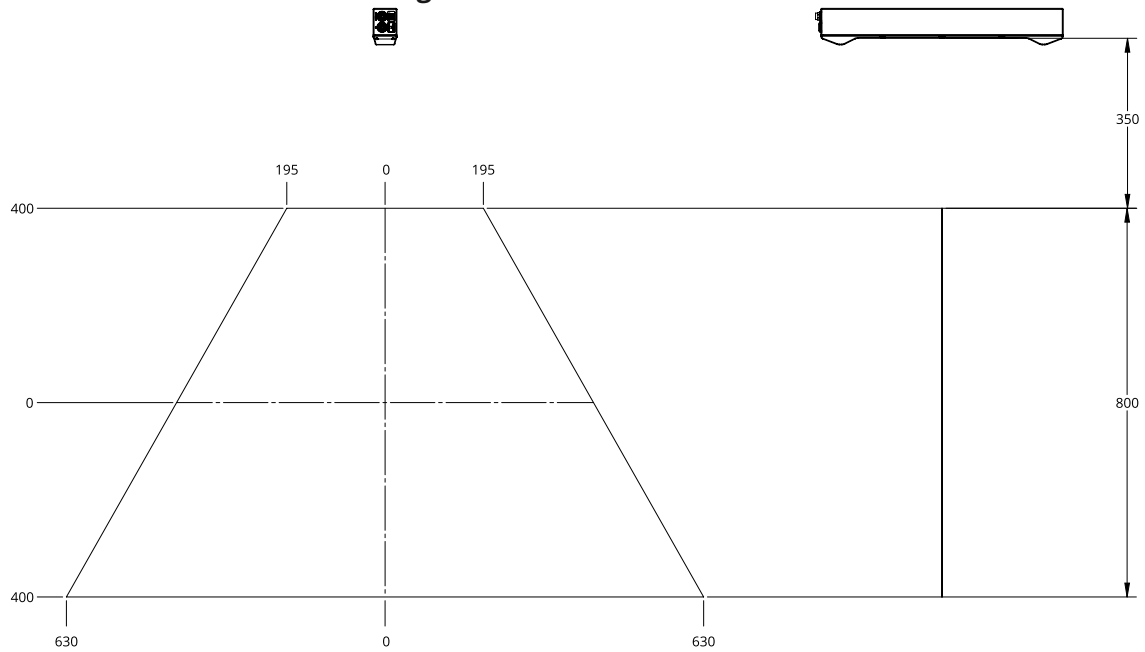
| ALL 2300 SERIES MODELS |                                                                            |
|------------------------|----------------------------------------------------------------------------|
| Scan Rate              | Approx. 170Hz to 5000 Hz                                                   |
| 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) |
| 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                                                               |



Mechanical dimensions for the sensor model are illustrated on the following pages.

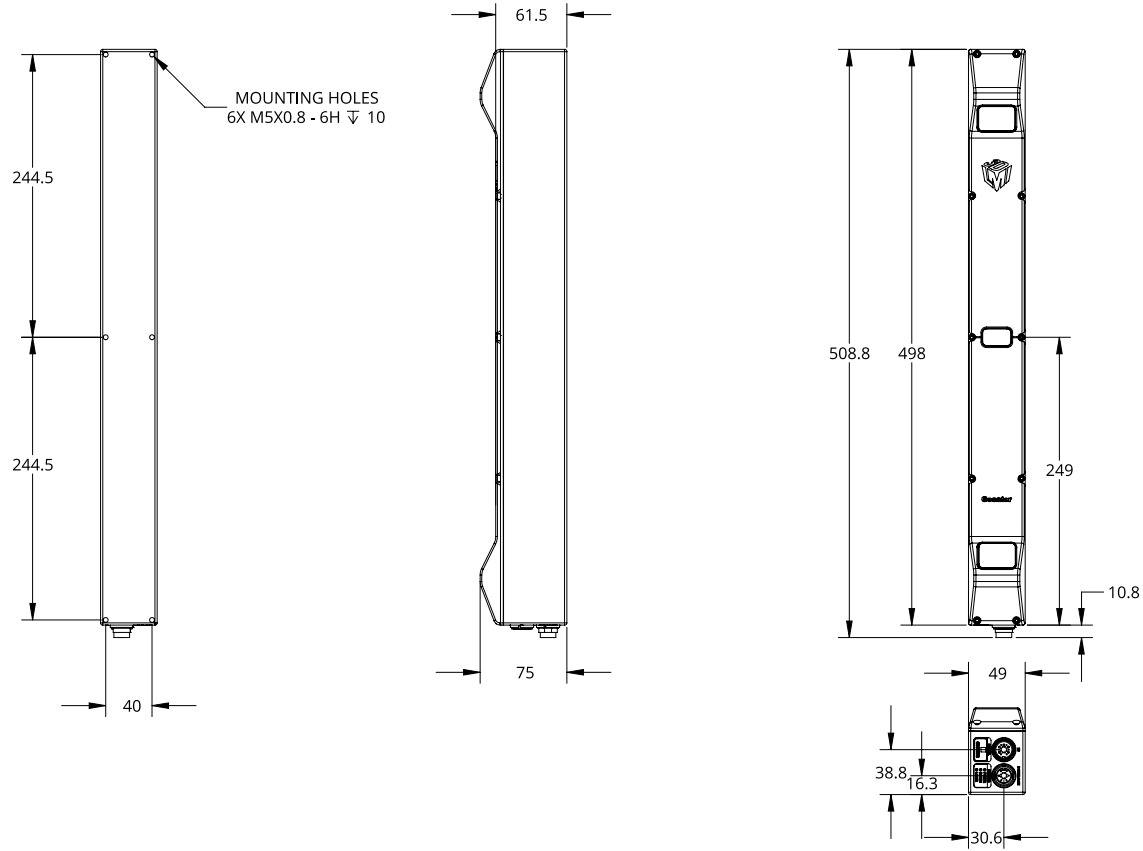
## Gocator 2880

### Field of View / Measurement Range

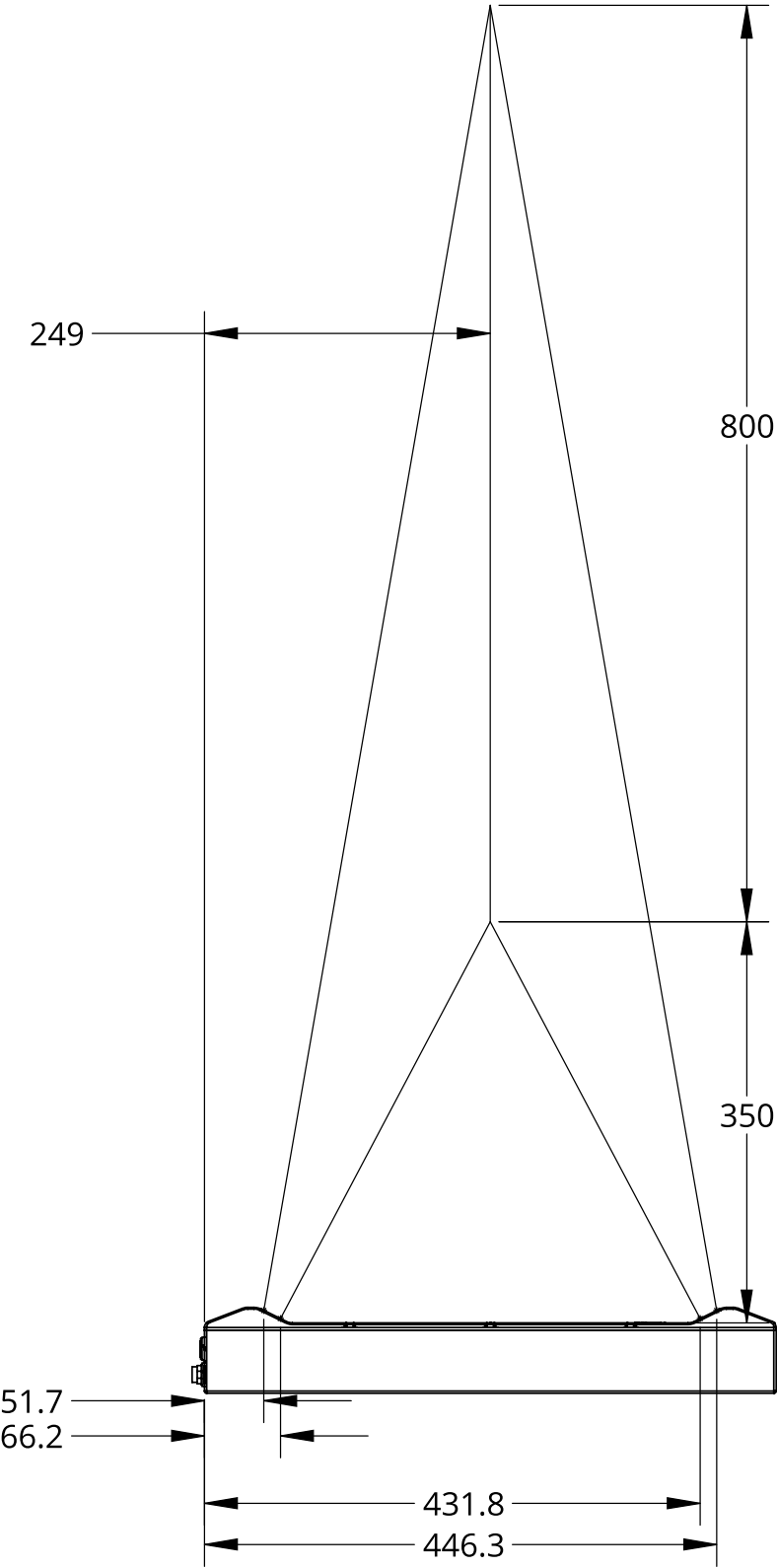




Dimensions



Envelope



# Gocator Power/LAN Connector

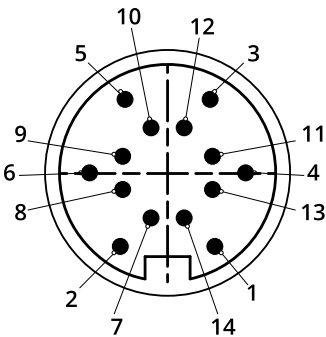
The Gocator Power/LAN connector is a 14 pin, M16 style connector that provides power input, laser safety input and Ethernet.

 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    | 1   | White/<br>Orange & Black |
| GND_24-48V    | 1   | Orange/ Black            |
| DC_24-48V     | 2   | White/<br>Green & Black  |
| DC_24-48V     | 2   | Green/ Black             |
| Safety-       | 3   | White/ Blue &<br>Black   |
| Safety+       | 4   | Blue/<br>Black           |
| Sync+         | 5   | White/<br>Brown & Black  |
| Sync-         | 6   | Brown/ Black             |
| Ethernet MX1+ | 7   | White/ Orange            |
| Ethernet MX1- | 8   | Orange                   |
| Ethernet MX2+ | 9   | White/ Green             |
| Ethernet MX2- | 10  | Green                    |
| Ethernet MX3- | 11  | White/ Blue              |
| Ethernet MX3+ | 12  | Blue                     |
| Ethernet MX4+ | 13  | White/ Brown             |
| Ethernet MX4- | 14  | 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

Positive voltage is applied to DC\_24-48V. See *Gocator 2300 Series* (page 348) for the sensor's power requirement. Ground is applied to GND\_24-48VDC.

### *Power requirements*

| Function     | Pins | Min  | Max  |
|--------------|------|------|------|
| DC_24-48V    | 2    | 24 V | 48 V |
| GND_24-48VDC | 1    | 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+ | 4    | 24 V | 48 V |
| Safety_in- | 3    | 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 2300 & 2880 I/O Connector

The Gocator 2300 & 2880 I/O connector is a 19 pin, M16 style connector that provides encoder, digital input, digital outputs, serial output, and analog output signals.

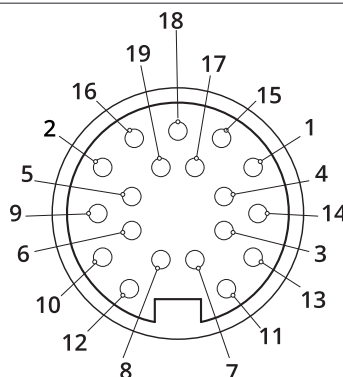


This connector is rated IP67 only when a cable is connected or when a protective cap is used.

This section defines the electrical specifications for Gocator 2300 I/O Connector pins, organized by function.

## Gocator I/O Connector Pins

| Function                  | Pin | Lead Color on Cordset     |
|---------------------------|-----|---------------------------|
| Trigger_in+               | 1   | Grey                      |
| Trigger_in-               | 2   | Pink                      |
| Out_1+ (Digital Output 0) | 3   | Red                       |
| Out_1- (Digital Output 0) | 4   | Blue                      |
| Out_2+ (Digital Output 1) | 5   | Tan                       |
| Out_2- (Digital Output 1) | 6   | Orange                    |
| Encoder_A+                | 7   | White/Brown & Black       |
| Encoder_A-                | 8   | Brown / Black             |
| Encoder_B+                | 9   | Black                     |
| Encoder_B-                | 10  | Violet                    |
| Encoder_Z+                | 11  | White/Green & Black       |
| Encoder_Z-                | 12  | Green / Black             |
| Serial_out+               | 13  | White                     |
| Serial_out-               | 14  | Brown                     |
| Reserved                  | 15  | Blue / Black              |
| Reserved                  | 16  | White / Blue & Black      |
| Analog_out+               | 17  | Green                     |
| Analog_out-               | 18  | Yellow & Maroon/<br>White |
| Reserved                  | 19  | Maroon                    |



View: Looking into the connector **on** the sensor

## Grounding Shield

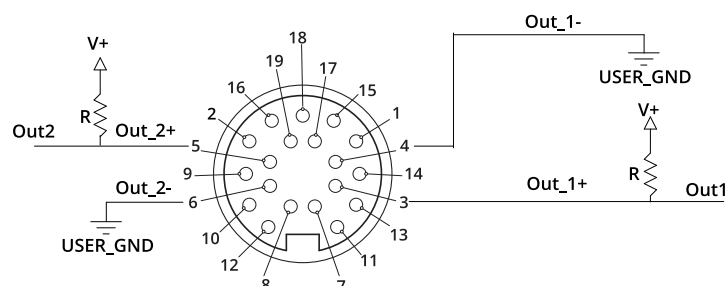
The grounding shield should be mounted to the earth ground.

## Digital Outputs

Each Gocator sensor has two optically isolated outputs. Both outputs are open collector and open emitter, this allows a variety of power sources to be connected and a variety of signal configurations.

Out\_1 (Collector – Pin 3 and Emitter – Pin 4) and Out\_2 (Collector – Pin 5 and Emitter Pin 6) 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    | 3, 4 | 40 mA                 | 70 V                          | 20 us           |
| Out_2    | 5, 6 | 40 mA                 | 70 V                          | 20 us           |

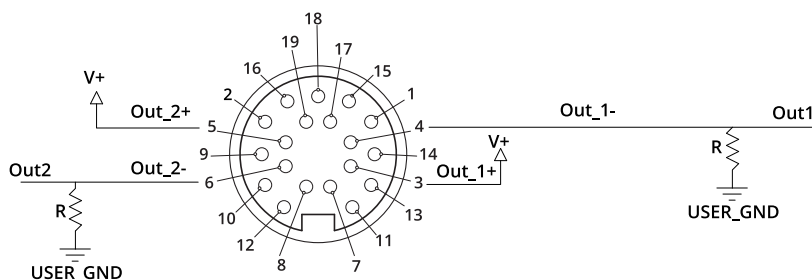


The resistors shown above are calculated by  $R = (V+) / 2.5 \text{ mA}$ .

The size of the resistors is determined by power =  $(V+)^2 / R$ .

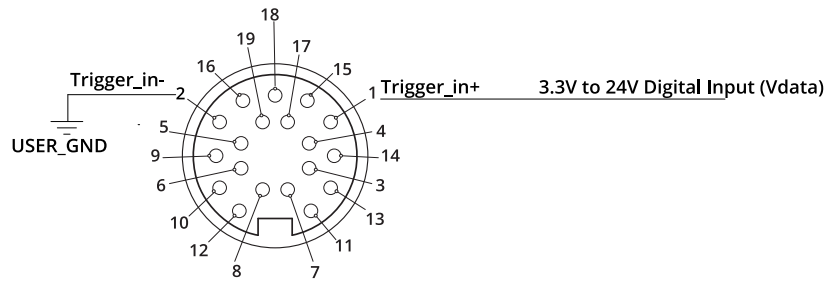
## Inverting Outputs

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-. The resistor selection is the same as what is shown above.



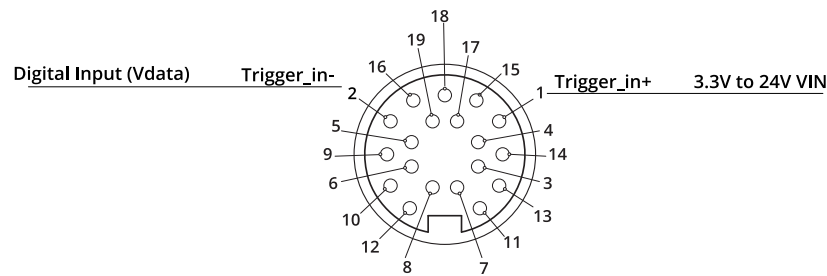
## Digital Inputs

Every Gocator sensor has a single optically-isolated input. To use this input without an external resistor, supply 3.3 - 24 V to Pin 1 and GND to Pin 2.



Active High

If the supplied voltage is greater than 24 V, connect an external resistor in series to Pin 1. The resistor value should be  $R = [(V_{in} - 1.2V) / 10mA] - 680$ .



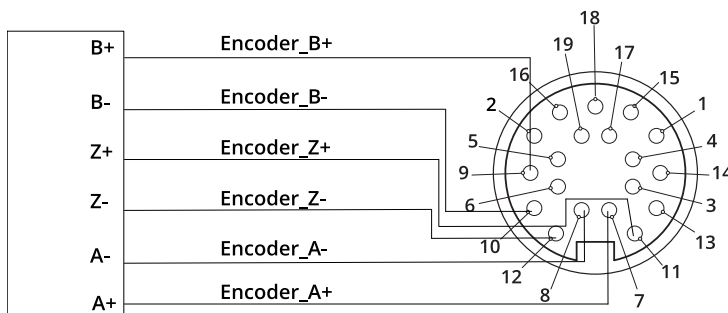
Active Low

To assert the signal, the digital input voltage should be set to draw a current of 3 mA to 40 mA from Trigger\_In+. The current that passes through Trigger\_In+ 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 | 1, 2 | 3.3 V       | 24 V        | 3 mA        | 40 mA       | 20 us           |

## 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 | 7, 8   | -7 V                | 12 V | -200 mV                        | -125 mV | -50 mV | 1 MHz         |
| Encoder_B | 9, 10  | -7 V                | 12 V | -200 mV                        | -125 mV | -50 mV | 1 MHz         |
| Encoder_Z | 11, 12 | -7 V                | 12 V | -200 mV                        | -125 mV | -50 mV | 1 MHz         |

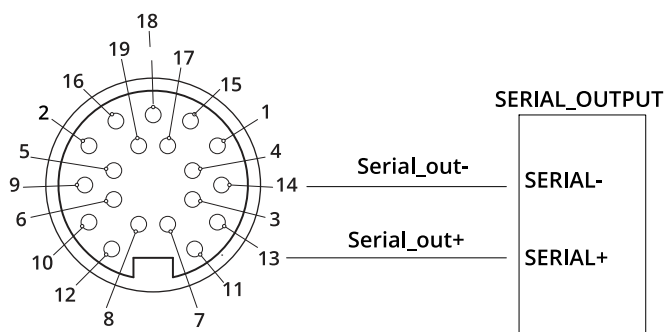
 Gocator only supports differential RS485 signalling. Both + and - signals must be connected.

## Serial Output

Serial RS-485 output is connected to Serial\_out as shown below.

### Function Pins

Serial\_out 13, 14

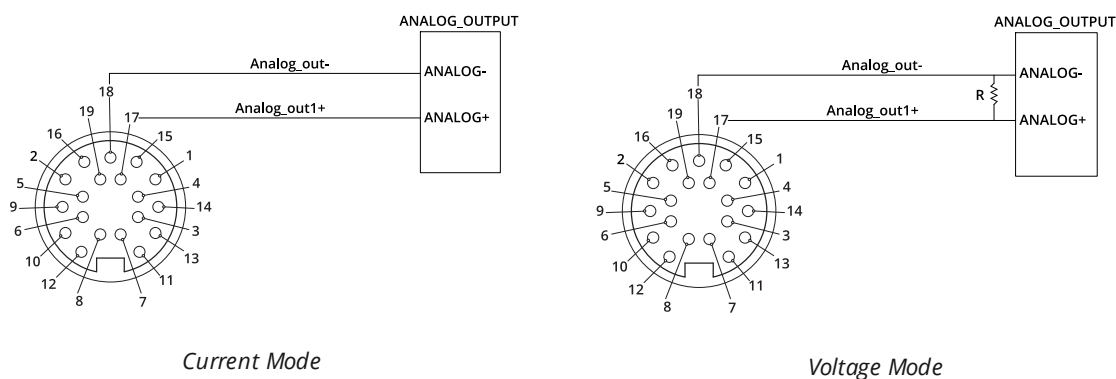


## Analog Output

The Sensor I/O Connector defines one analog output interface: Analog\_out.

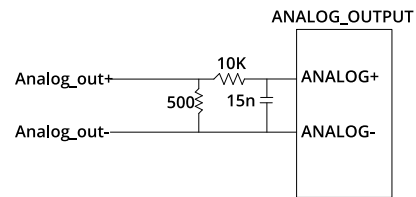
### Function Pins Current Range

Analog\_out 17, 18 4 – 20 mA



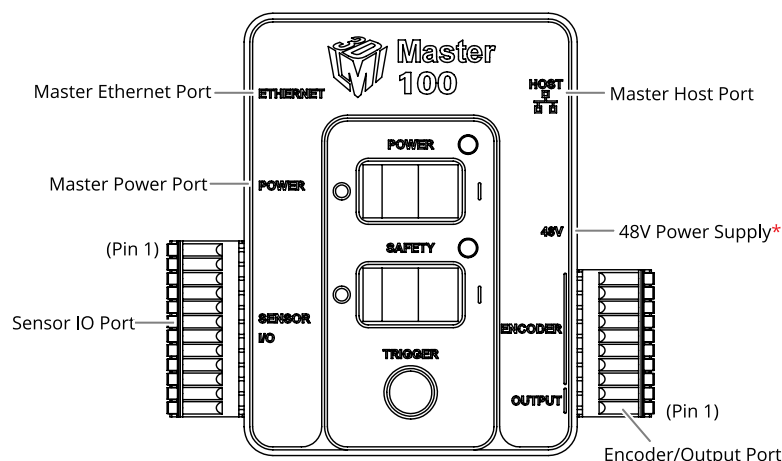


To configure for voltage output, connect a 500 Ohm  $\frac{1}{4}$  Watt resistor between Analog\_out+ and Analog\_out- and measure the voltage across the resistor. To reduce the noise in the output, we recommend using an RC filter as shown below.



# Master 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

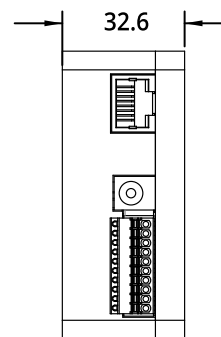
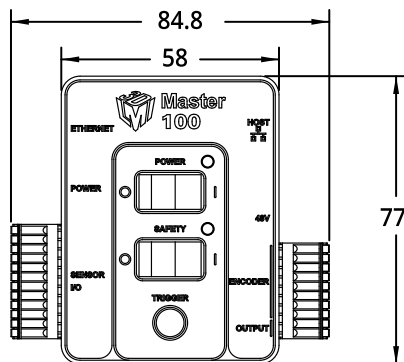
| Gocator I/O Pin | Master Pin | Conductor Color     |
|-----------------|------------|---------------------|
| Encoder_A+      | 1          | White/Brown & Black |
| Encoder_A-      | 2          | Brown/Black         |
| Encoder_Z+      | 3          | White/Green & Black |
| Encoder_Z-      | 4          | 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

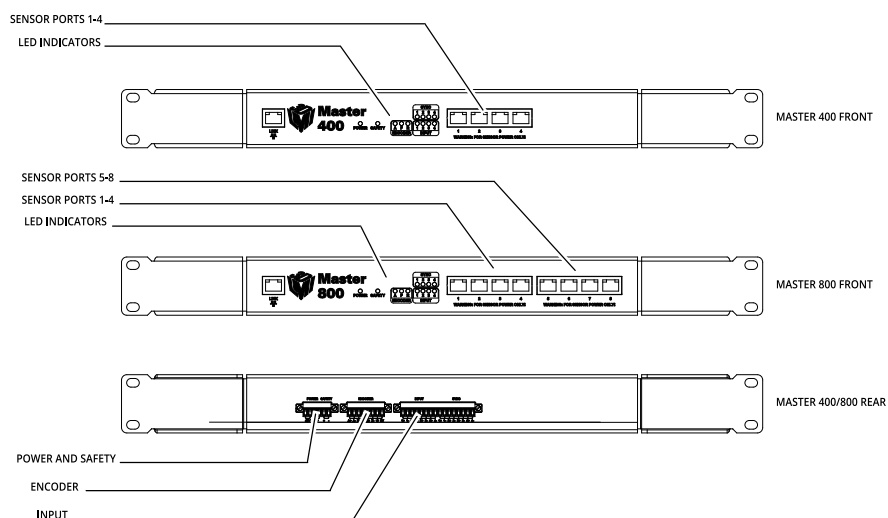
| Function                     | Pin |
|------------------------------|-----|
| Output_1+ (Digital Output 0) | 1   |
| Output_1- (Digital Output 0) | 2   |
| Encoder_Z+                   | 3   |
| Encoder_Z-                   | 4   |
| Encoder_A+                   | 5   |
| Encoder_A-                   | 6   |
| Encoder_B+                   | 7   |
| Encoder_B-                   | 8   |
| Encoder_GND                  | 9   |
| Encoder_5V                   | 10  |

## Master 100 Dimensions



# Master 400/800

The Master 400/800 provides sensor power and safety interlock, and broadcasts system-wide synchronization information (i.e., time, encoder count, encoder index, and digital I/O states) to all devices on a sensor network.



## Power and Safety (6 pin connector)

| Function        | Pin |
|-----------------|-----|
| +48VDC          | 1   |
| +48VDC          | 2   |
| GND(48VDC)      | 3   |
| GND(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 12VDC to 48VDC across the pin to enable the laser.

## Digital Input (16 pin connector)

| Function    | Pin |
|-------------|-----|
| Input 1     | 1   |
| Input 1 GND | 2   |
| Reserved    | 3   |
| Reserved    | 4   |
| Reserved    | 5   |

| Function | Pin |
|----------|-----|
| Reserved | 6   |
| Reserved | 7   |
| Reserved | 8   |
| Reserved | 9   |
| Reserved | 10  |
| Reserved | 11  |
| Reserved | 12  |
| Reserved | 13  |
| Reserved | 14  |
| Reserved | 15  |
| Reserved | 16  |



This 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 for Master 400/800*

| Master 400 / 800             |                                                                    |
|------------------------------|--------------------------------------------------------------------|
| Power Supply Voltage         | +48VDC                                                             |
| Power Supply current (Max.)  | 10A                                                                |
| Power Draw (Min.)            | 15W                                                                |
| Safety Voltage               | +12 to +48VDC                                                      |
| Encoder signal voltage range | RS485 Differential                                                 |
| Digital input voltage range  | Logical LOW: 0 VDC to +0.1VDC<br>Logical HIGH: +11 VDC to +22.5VDC |



When using a Master 400/800, its chassis must be well grounded.



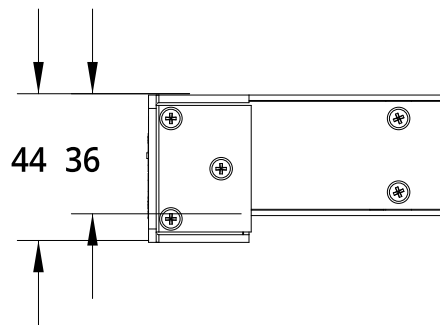
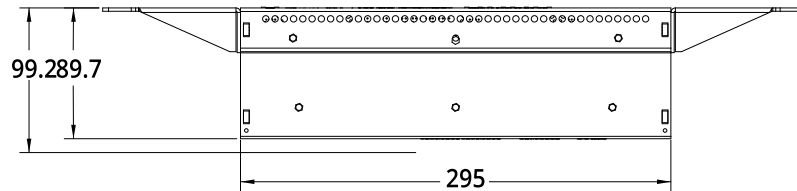
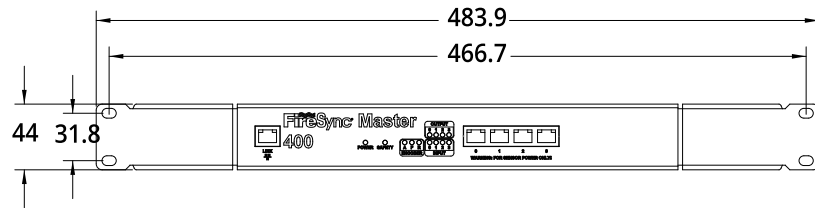
The +48VDC power supply must be isolated from AC ground. This means that AC ground and DC ground are not connected.



The Power Draw specification is based on a Master with no sensors attached. Every sensor has its own power requirements which need to be considered when calculating total system power requirements.

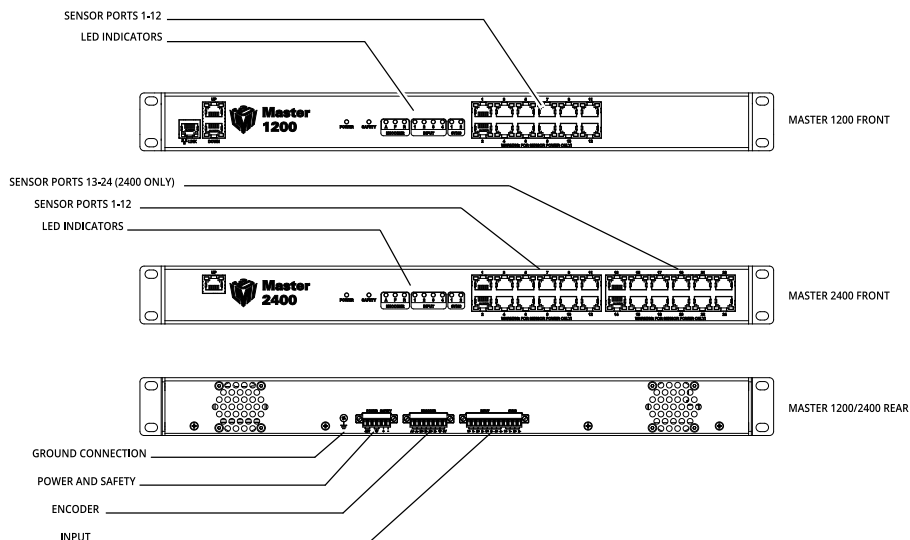
## Master 400/800 Dimensions

The dimensions of Master 400 and Master 800 are the same.



# Master 1200/2400

The Master 1200/2400 provides sensor power and safety interlock, and broadcasts system-wide synchronization information (i.e., time, encoder count, encoder index, and digital I/O states) to all devices on a sensor network.



## Power and Safety (6 pin connector)

| Function        | Pin |
|-----------------|-----|
| +48VDC          | 1   |
| +48VDC          | 2   |
| GND(48VDC)      | 3   |
| GND(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 12VDC to 48VDC across the pin to enable the laser.

## Digital Input (16 pin connector)

| Function    | Pin |
|-------------|-----|
| Input 1     | 1   |
| Input 1 GND | 2   |
| Reserved    | 3   |
| Reserved    | 4   |

| Function | Pin |
|----------|-----|
| Reserved | 5   |
| Reserved | 6   |
| Reserved | 7   |
| Reserved | 8   |
| Reserved | 9   |
| Reserved | 10  |
| Reserved | 11  |
| Reserved | 12  |



This 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 for Master 1200/2400*

| Master 1200 / 2400           |                                                                    |
|------------------------------|--------------------------------------------------------------------|
| Power Supply Voltage         | +48VDC                                                             |
| Power Supply current (Max.)  | 10A                                                                |
| Power Draw (Min.)            | 15W                                                                |
| Safety Voltage               | +12 to +48VDC                                                      |
| Encoder signal voltage range | RS485 Differential                                                 |
| Digital input voltage range  | Logical LOW: 0 VDC to +0.1VDC<br>Logical HIGH: +3.5 VDC to +6.5VDC |



When using a Master 1200/2400, its chassis must be well grounded.



The +48VDC power supply must be isolated from AC ground. This means that AC ground and DC ground are not connected.

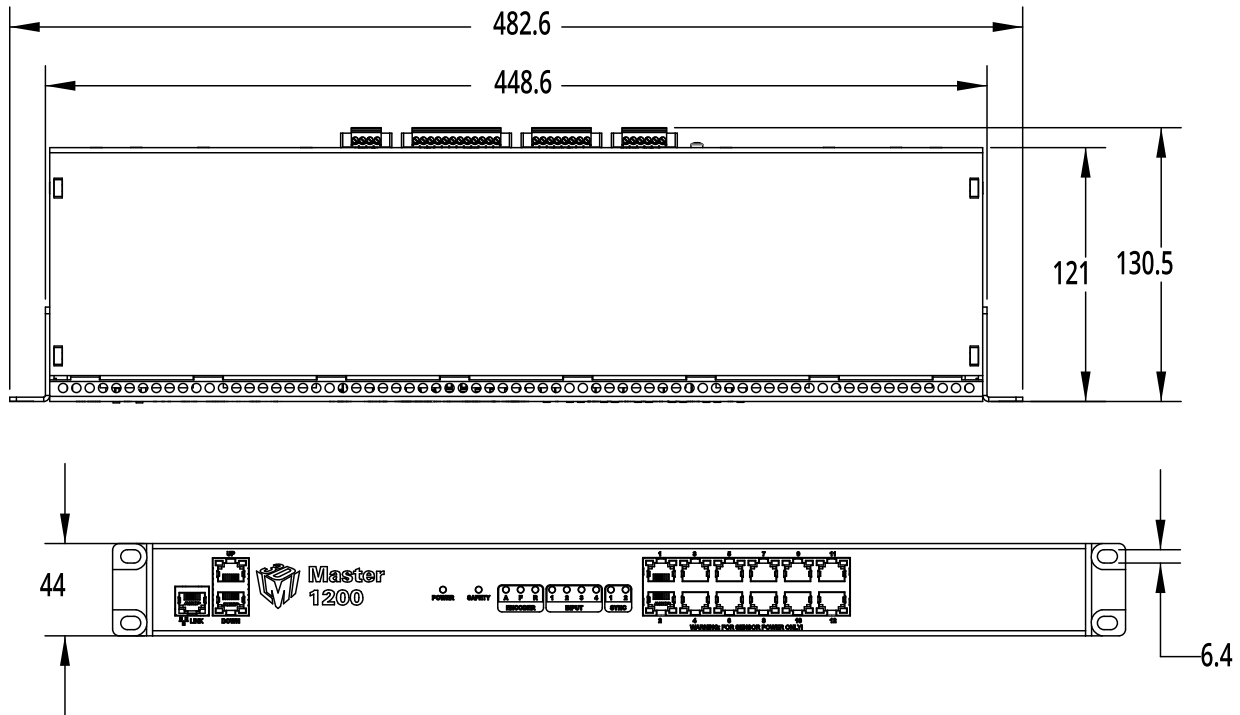




The Power Draw specification is based on a Master with no sensors attached. Every sensor has its own power requirements which need to be considered when calculating total system power requirements.

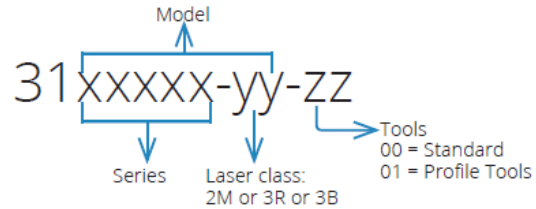
## Master 1200/2400 Dimensions

The dimensions of Master 1200 and Master 2400 are the same.



# Parts and Accessories

## Gocator Part Number Legend



### Gocator 2300 Sensors

| Description                                | Part Number   |
|--------------------------------------------|---------------|
| Gocator 2320 with Class 2M laser (2320-2M) | 312320A-2M-00 |
| with Class 3R laser (2320-3R)              | 312320A-3R-00 |
| Gocator 2330 with Class 2M laser (2330-2M) | 312330A-2M-00 |
| with Class 3R laser (2330-3R)              | 312330A-3R-00 |
| with Class 3B laser (2330-3B)              | 312330A-3B-00 |
| Gocator 2340 with Class 3R laser (2340-3R) | 312340A-3R-00 |
| with Class 3B laser (2340-3B)              | 312340A-3B-00 |
| Gocator 2350 with Class 3R laser (2350-3R) | 312350A-3R-00 |
| with Class 3B laser (2350-3B)              | 312350A-3B-00 |
| Gocator 2370 with Class 3B laser (2370-3B) | 312370A-3B-00 |
| Gocator 2375 with Class 3B laser (2375-3B) | 312375A-3B-00 |
| Gocator 2380 with Class 3B laser (2380-3B) | 312380A-3B-00 |
| Standard tools                             | 31XXXXX-YY-00 |
| Measurement tools                          | 31XXXXX-YY-01 |

### Gocator 2880 Sensor

| Description                                | Part Number   |
|--------------------------------------------|---------------|
| Gocator 2880 with Class 3B laser (2880-3B) | 312880A-3B-00 |

### Masters

| Description                                       | Part Number |
|---------------------------------------------------|-------------|
| Master 100 - for single sensor (development only) | 30705       |
| Master 400 - for networking up to 4 sensors       | 30680       |

| <b>Description</b>                            | <b>Part Number</b> |
|-----------------------------------------------|--------------------|
| Master 800 - for networking up to 8 sensors   | 30681              |
| Master 1200 - for networking up to 12 sensors | 30649              |
| Master 2400 - for networking up to 24 sensors | 30650              |

#### *Cordsets*

| <b>Description</b>                                            | <b>Part Number</b> |
|---------------------------------------------------------------|--------------------|
| 2m I/O cordset, open wire end                                 | 30864-2m           |
| 5m I/O cordset, open wire end                                 | 30862              |
| 10m I/O cordset, open wire end                                | 30863              |
| 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  | 30859              |
| 10m Power and Ethernet cordset, 1x open wire end, 1x RJ45 end | 30860              |
| 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          |
| 2m Power and Ethernet to Master cordset, 2x RJ45 ends         | 30858-2m           |
| 5m Power and Ethernet to Master cordset, 2x RJ45 ends         | 30856              |
| 10m Power and Ethernet to Master cordset, 2x RJ45 ends        | 30857              |
| 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          |

#### *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.

# Return Policy

## **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.

LMI Technologies Inc. is not responsible for damages to a sensor that are the result of improper packaging or damage during transit by the courier.

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