DynaVision®

Single Point
DLS2000A Sensor

Models: 4-12 & 10-24

User Manual

by
LMI Technologies Inc.

LMI 3D MACHINE VISION

Version C

PROPRIETARY

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Trademarks and Restrictions

DynaVision® is a registered trademark of LMI Technologies Inc.

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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Printed in Canada

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WELCOME TO THE DLS2000A

The DLS2000A is a member of the DynaVision® family of laser-based ranging sensors. These sensors employ a laser and the triangulation principle to make precise measurements of range as shown in Figure 1.

UNPACKING

Upon receipt, unpack and visually inspect the sensor. The sensor is a single metal enclosure with a connector on one side, and with laser and sensor viewing windows on the opposite side. Ensure there is no damage to the enclosure, connector or view windows.

The enclosed diskette contains:

DLS2000A Demo Program (DLS2000 SPUtil.EXE)

SAFETY

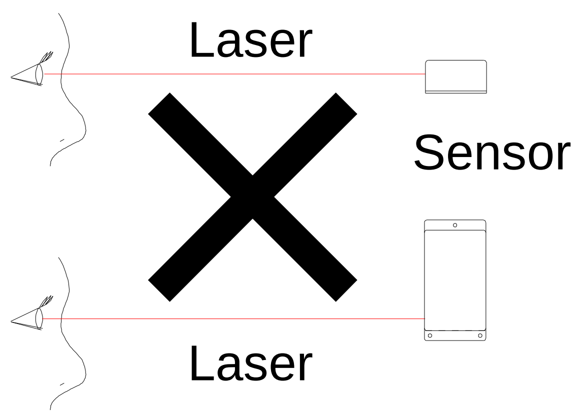
Laser Safety

DynaVision® scanners employ one or more lasers that illuminate the measurement surface. This requires that specific safety precautions be taken when servicing the optimizer system.

The DLS2000A is classed by the U.S. Food and Drug Administration (FDA), Code of Federal Regulations (CFR) 21, Part 1040, as Class IIIb. This classification is clearly marked on the DLS2000A.

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

WARNING! The DLS2000A is a Class IIIb type laser device. Regardless of the power rating, or whether or not the laser is visible, the laser should not be viewed directly, or through a mirror, as it may result in severe damage to the eyes.



WARNING: DO NOT look directly into the laser beam

OEM Safety Responsibilities

LMI Technologies Inc. has filed a report with the US Food and Drug Administration (FDA) to assist OEM's in achieving certification of their own applications by referencing the report accession number. The following paragraphs outline areas that are not covered by LMI Technologies Inc submission and need to be specifically addressed by the OEM.

Laser Warning Sign Format

Laser warning signs must be located in the vicinity of the sensors such that they will be readily observed. Refer to the following diagram for an example of the laser warning sign. Different warning signs are required for different laser classifications. These are specified in the CFR Title 21, Section 1040. An example is shown below for a Class IIIb sensor.

Laser Emission Warning Indicators

As specified by the US Food and Drug Administration, Department of Health and Human Services, Code of Federal Regulations 21 Section 1040 (CFR 21-1040), the controls which operate the single point sensors must incorporate a visible or audible signal when the lasers of the sensors are active. Typically this consists of a warning lamp, which is illuminated when power is supplied to the sensor.

Additionally, CFR 21-1040 standards require that the indicator be clearly visible through protective eyewear designed specifically for the wavelengths of the emitted laser radiation.

Beam Attenuators

CFR 21-1040 standards also specify that a permanently attached method of preventing human access to the laser radiation other than switches, power connectors, or key control must be employed.

None of the items mentioned above are supplied with the DLS2000A and are the responsibility of the OEM to supply when incorporating the DLS2000A into their system or product.

USING THE DLS2000A

The DLS2000A can be used in a wide variety of measurement applications, including:

- Object profiling
- Thickness measurement
- Parts inspection
- Object alignment
- Range measurement
- On line quality control

The DLS2000A is a 'smart' sensor incorporating an internal processor to handle calibration, scaling and data conversion. The DLS2000A provides programmable analog outputs (0-10 VDC and 4-20mA) and a digital serial output (RS-485 @ 57.6kBaud).

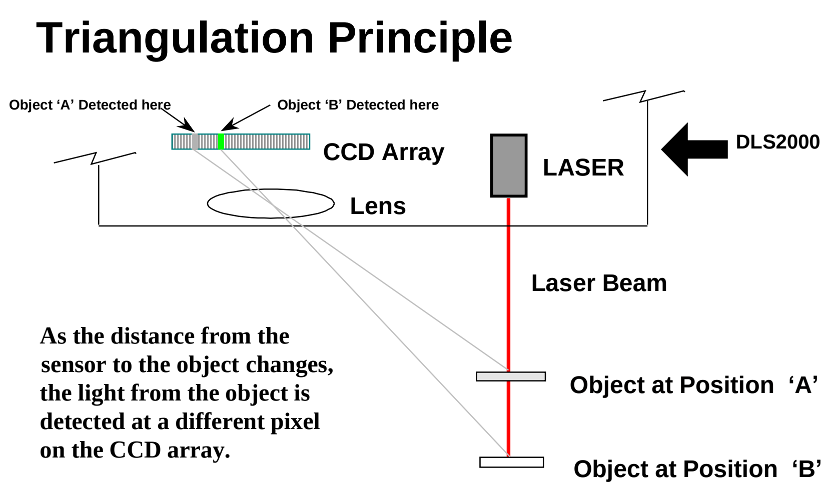


Figure 1

Standoff / Range

The distance from the reference face of the sensor to the sensor's first measurement is the **Standoff**. The sensor cannot make any measurements before the **Standoff**. If a target is placed within this area, the analog output would read zero voltage output, 4mA current output and the digital output will return a "Out of Range".

The distance from the sensor's **standoff** to the sensor's maximum measurement point (for which it has been calibrated) is the **Range**. In between these two points the sensor will return a valid reading indicating how far the measurement surface is away from the **standoff**.

What is the maximum distance an object can be placed from the sensor's reference point?

The **Standoff** distance plus the **Range** distance is the maximum distance an object can be placed away from the face of the sensor.

Figure 2 (Model 4-12)

Figure 3 (Model 10-24)

Standoff distance + Range distance = Object’s Maximum Distance

If the object distance from the face of the sensor is greater than the **Object's Maximum Distance**, the sensors analog output will read zero volts and the digital output will return a “Out of Range”.

Object Distance > (Standoff + Range) = Out of Range

How do laser triangulation sensors work best?

Laser triangulation sensors work best when the measurement surface is a diffuse reflector such as the surface of a piece of paper, wood, or non-shiny metal and plastic.

Do I need a computer to use the DLS2000A?

No, the DLS2000A can be used without a computer/control system using the voltage or current and/or with a computer using RS-485 serial communication.

Without a computer:

The DLS2000A can be employed as an analog sensor and does not require connection to an external computer. Connect the cable to:

- a suitable power supply (see Connections)
- a voltage measurement device, or
- a current measurement device

With a computer:

The DLS2000A can be used in a computer-based data acquisition or control system. Commands requesting data are sent to the sensor and the sensor responds by providing range values. Commands and data are exchanged with the DLS2000A using a simple serial protocol (see Applications Programming). To operate the sensor:

- Connect the cable (see Multi-Drop Configurations)
- Run the demonstration application SPUtil.EXE (enclosed diskette). This application will display the range readings from the DLS2000A in real time (see Getting Started).

GETTING STARTED

Necessary Equipment

You will need:

- a DC power supply (15VDC-30VDC @ 250mA)
- an instrument capable of measuring zero 0 - 10 volts DC and/or 4-20mA
- a flat surface
- Windows 98 or Windows XP (if you are using the sensor with a computer)
- an RS-232 to RS-485 converter

Caution: Always have the DC power supply turned **OFF** when connecting or disconnecting the cable to the DLS2000A.

Operating your DLS2000A sensor is quite simple. You can use it either as a stand-alone device, or interfaced to a personal computer through the serial communication port.

1. Place the sensor onto a table or flat surface. Be sure that the pathway between target and the laser window (round hole) and the camera (elongated window) is not obstructed.

2. Connect the DLS2000A in one of the following ways:

a. Stand-alone device connect the enclosed cable to:
- a suitable power supply
- a voltage or current measurement device (e.g. a DVM)
- With the power supply **OFF** connect the cable to the DLS2000A
- If you are using the analog output only, turn on your voltage measurement device.
- Go to step 3.

OR

b. Interfaced to a computer connect the enclosed cable to:
- a suitable power supply
- a voltage or current measurement device (e.g. a DVM) (optional)
- the serial port of a computer
- With the power supply **OFF** connect the cable to the DLS2000.
- Start the SPUtil.EXE application on the computer.
- Set the software to use the correct serial port settings. This is located under the connections tab.
- Go to step 3.

The DLS2000A can be connected to both a computer and a voltage/current-measuring device at the same time.

NOTE: Do not look directly into the laser output window nor point it in the direction of another person (see Safety).

3. Position a suitable target (e.g. a cardboard box or wood block) within the measurement Range of the DLS2000A (see Figures 2&3).

4. Turn on the power supply to the DLS2000A. The DLS2000A does not have a power switch so turning on the power supply will activate the DLS2000A. You should now see a red laser spot on the target and a display of the range readings on the computer screen, and/or a voltage/current reading on the voltage/current measurement device.

Analog outputs, by default, are configured as 0 to 10V and 4 to 20 mA over full 12.000” or 24.00” range, however this can be easily changed using SPUtil.exe program. You can redefine Max/Min DA (0–9.999V) and Max/Min DA Range (0–12.000”) values to set the analog output for desired configuration.

Min DA : Analog output reading when target is at minimum range.
Max DA : Analog output reading when target is at maximum range.

Min DA Range: Range (in inches) at which analog output is minimum (Min DA).
Max DA Range: Range (in inches) at which analog output is maximum (Max DA).

Note:

- For the range values “Max DA Range” must be greater than “Min DA Range”.
- For the voltage values, the order of “Min DA” and “Max DA” determines the analog output. If Min DA is greater than Max DA the analog output is reversed (i.e. as the target moves further away form the face of the sensor the analog output voltage decreases.)

MECHANICAL MOUNTING

The sensor enclosure contains a mounting plate with three pre-drilled mounting holes (see Figure 4). The accuracy of the sensor is dependent on a secure mechanical mounting.

Figure 4

Calibration of the DLS2000A is relative to the reference face of the sensor. The minimum distance the target can be from the reference face of the sensor is the standoff distance (see Figures 2&3).

Any movement or vibration of the sensor relative to the object being measured will result in measurement errors.

The surface the sensor is mounted to must be flat within 0.030” (0.76mm) between the three mounting points.

Model 4-12 Specifications

Mechanical

Dimensions 184.4mm x 98.6mm x 38.4mm

Electrical

Power Supply Voltage	15 VDC - 30 VDC @ 250mA
Analog Output (Programmable)	0 VDC - 10 VDC 4mA – 20mA
Maximum Analog Output Load	550Ω using current output >= 2000Ω using voltage output

Laser

Visible Laser	(RED)
Wave Length	655 nm
Laser Power	< 7 mW

Performance

Standoff	4.528" (115mm)
Range	12.000" (304.8mm)
Resolution (Digital):	(0.001") 0.025mm
Resolution (Analog):	(0.003") 0.075mm
Scan Rate	1869Hz

Environmental

Ambient Temperature	Operating			
		MIN	0 °C	(32 °F)
		MAX	+50 °C	(122 °F)
	Storage			
		MIN	-30 °C	(-22 °F)
		MAX	+70 °C	(158 °F)

Relative Humidity: 95% Maximum Non-Condensing at 40 °C (104 °F)

Housing : Gasket aluminum enclosure

Model 10-24 Specifications

Mechanical

Dimensions 184.4mm x 98.6mm x 38.4mm

Electrical

Power Supply Voltage	15 VDC - 30 VDC @ 250mA
Analog Output (Programmable)	0 VDC - 10 VDC 4mA – 20mA
Maximum Analog Output Load	550Ω using current output >= 2000Ω using voltage output

Laser

Visible Laser	(RED)
Wave Length	655 nm
Laser Power	< 7 mw

Performance

Standoff	10.000” (254.0mm)
Range	24.000” (609.6mm)
Resolution (Digital):	(0.002”) 0.051mm
Resolution (Analog):	(0.006”) 0.152mm
Scan Rate	1869Hz

Environmental

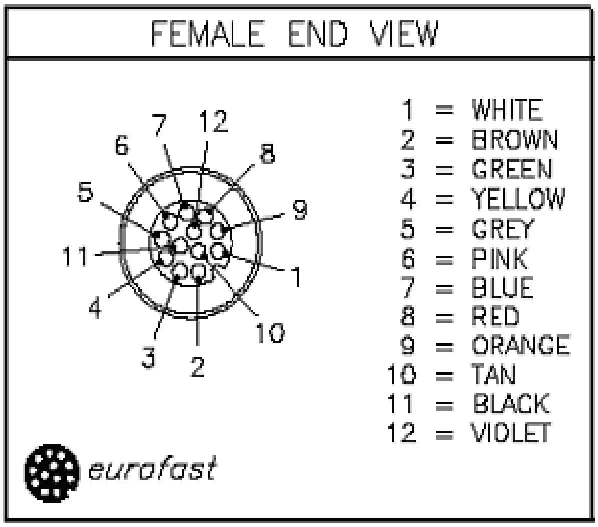
Ambient Temperature	Operating			
		MIN	0 °C	(32 °F)
		MAX	+50 °C	(122 °F)
	Storage			
		MIN	-30 °C	(-22 °F)
		MAX	+70 °C	(158 °F)

Relative Humidity: 95% Maximum Non-Condensing at 40 °C (104 °F)

Housing : Gasket aluminum enclosure

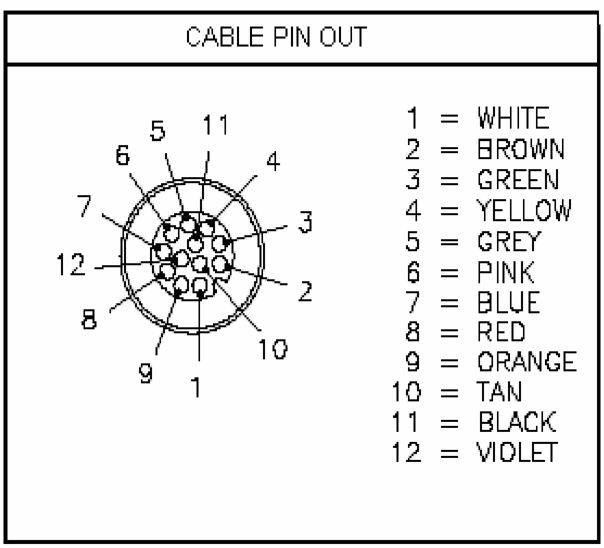
Connector Pin Out

The following diagram shows the connector pin out on the sensor as it is **viewed facing the sensor**. The table details pin assignments for the Sensor Connector.



Pin	Signal
1	Rx+ (Receive)
2	Rx- (Receive)
3	Tx+ (Transmit)
4	Tx- (Transmit)
5	Out Rng
6	Analog 1 Out (0 – 10V)
7	Analog 1 Common
8	Analog 2 Common
9	Analog 2 Out (4-20mA)
10	Sync
11	GND
12	POWER

Optional Supplied Cable Pin Out

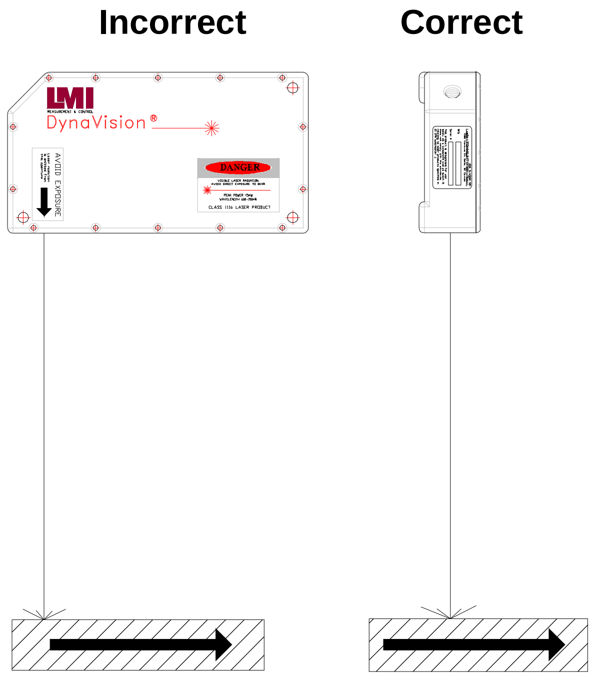


Cabling Instructions for Turck BS 81121-0/PG9

Pin #	Color
1	White
2	Brown
3	Green
4	Yellow
6	Pink
7	Blue
8	Red
9	Orange
11	Black
12	Violet
10	Tan
5	Grey

SENSOR ORIENTATION

Refer to the following diagram locating the light beam and viewing angles. The light beam is projected perpendicular to the face of the sensor.



Non-reflective materials

If the surface of the material being measured is non-reflective (e.g. wood, non-shiny metal), the sensor should be mounted so the beam is projected perpendicular to the surface.

Semi-reflective materials

If the surface of the material being measured is semi-reflective (e.g. glossy painted surface), the sensor should be rotated counter-clockwise to reduce the direct reflection of the beam back to the sensor.

APPLICATION PROGRAMMING

General Overview

All communication between the host computer and the sensor is via an RS-485 serial interface.

All commands are initiated from the host computer to the sensor, with the sensor responding to the commands.

Communications Specifications

The DLS2000A is designed to use the RS-422/485 standard for its serial communication. This is a differential driver/receiver pair. It is capable of transmitting up to 4000 feet.

The serial ports of most personal computers are based on the two wire RS-232 standard. To use a personal computer as the host for a multi-drop configuration, you will need an RS-232 to RS-485 converter box.

The RS-485 option allows the sensor to be used in multi-drop configurations. This means that up to 32 units can be connected to the same serial line. Each device must have a different address so that you are able to distinguish which unit you are talking to. A standard utility is supplied to allow you to set the address of each DLS2000A unit.

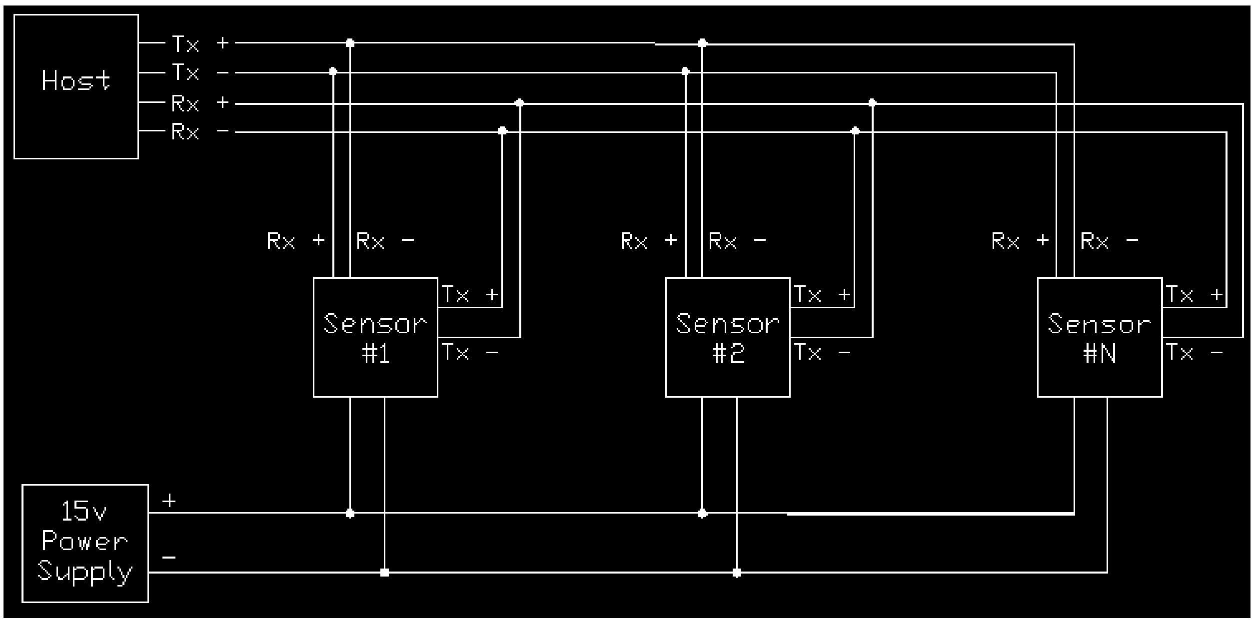
Interconnect Specification

Transmit and Receive lines are connected to the serial I/O port of a host computer. This serial I/O port must be configured as follows:

- Asynchronous
- 57600 baud.
- 8 Data Bits
- One Stop Bit
- No Parity

Multi-Drop Configurations

DLS2000A sensors can be wired in a multi-drop configuration. The serial communication must be wired as full duplex, meaning four wires are required to complete the hardware connection as follows:



- Tx+ of all the DLS2000A sensors are connected to the Rx-
- Tx- of all the DLS2000A sensors are connected to the Rx+
- Rx+ of all the DLS2000A sensors are connected to the Tx-
- Rx- of all the DLS2000A sensors are connected to the Tx+

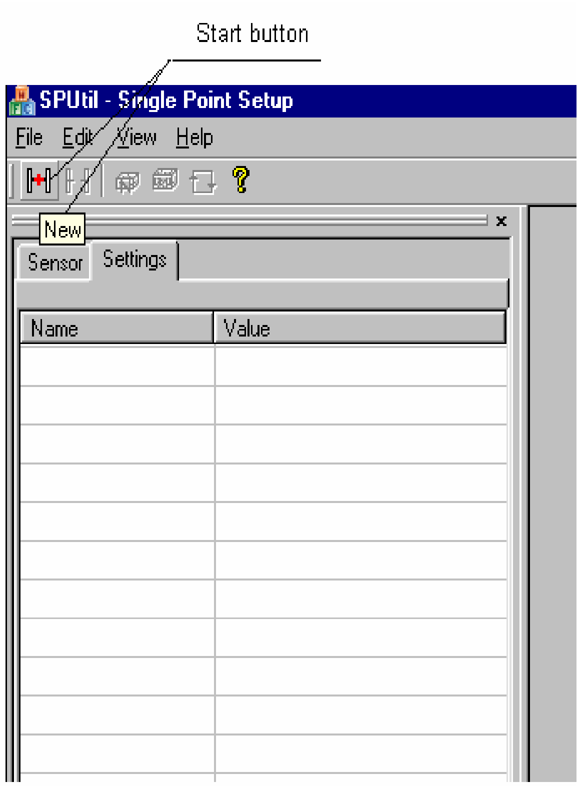
A 120Ω termination resistor must be connected across the Tx+ and Tx-, and the Rx+ and Rx- at the end farthest away from the host computer.

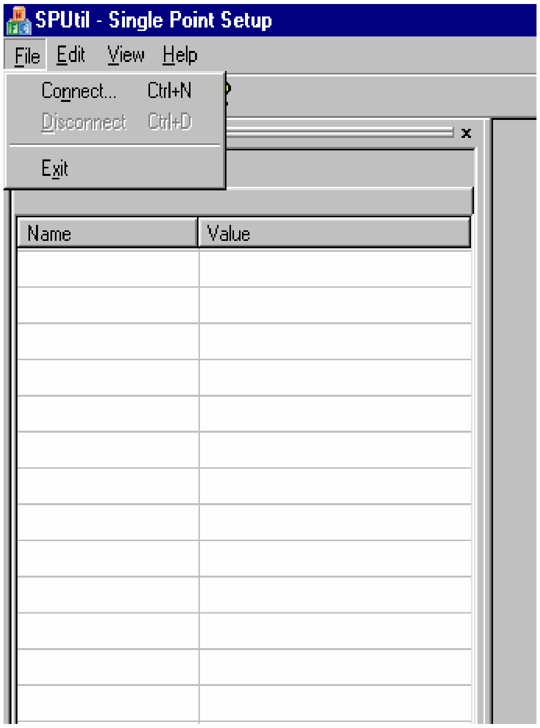
A utility is supplied (SPUtil.exe), from which you can set the address of each DLS2000A.
Remember that this program only works in Microsoft® Windows® environments.

Using DLS2000A Setup Utility

Connecting to the Sensor

Start the SPUtil.exe software: click on the "New" button or select the File" Connect" option.

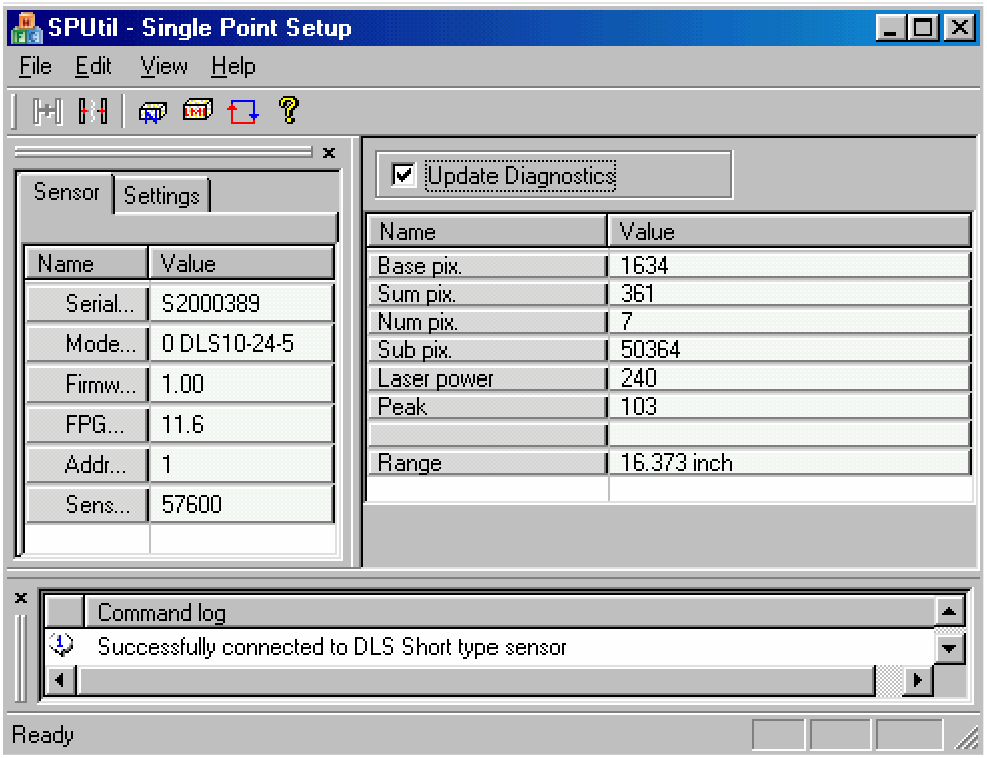




Select the proper COM Port, Baud Rate (57600 - Factory Default Rate), the unit address and click on "**OK"** button. If the unit address is not known, check the" **Use Global Address"** option.

NOTE : Do not use **"Use global address"** option in multi-drop configuration. All sensors have default address of 1. In case of multi-drop configuration, ensure that each sensor has been assigned a unique address before being placed on single communication line.

Sensor parameters can be viewed by checking "Update diagnostics" window.



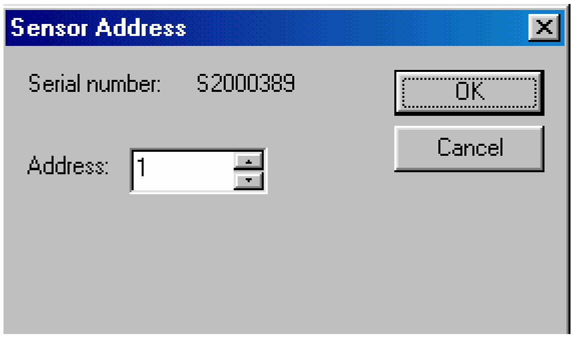
Serial number The number shown here is the sensor's serial number which is labeled on the side of the sensor enclosure. It is used for identification purposes and cannot be changed (Factory Programmed).

Model String This is the sensor's model number (Factory Programmed).

Firmware This is the firmware version of the sensor (Factory Programmed).

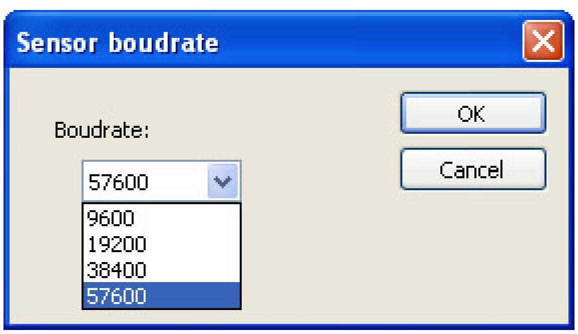
FPGA version This is the sensor's FPGA version of the sensor (Factory Programmed) and cannot be changed.

Sensor Address The sensor address may range from 1 to 255, the maximum number of sensors that can be placed on a single multi drop line. Each sensor must have a different address. To change the address of the sensor, double click on the current address. New window will appeared, enter mew address and click on "OK" button.



Note: When changing the address, only one sensor must be communicating with the host.

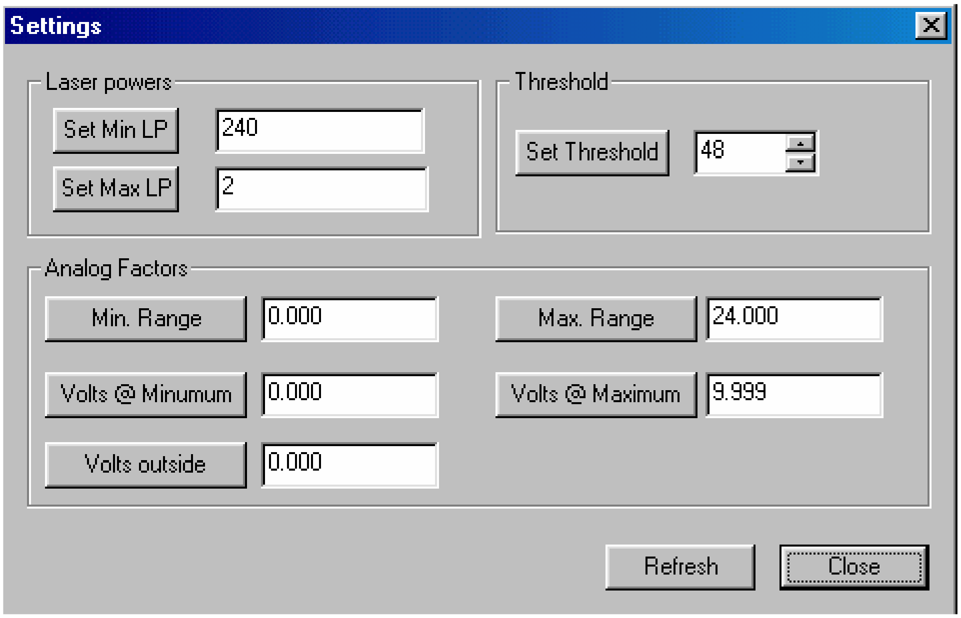
Baud Rate This is the sensor's Baud Rate that it uses to communicate to the Host. To change Baud Rate of the sensor, double click on the current Baud Rate. New window will appeared select the Baud Rate from the list and click on "OK" button. The available rates are 9600, 19200, 39400, and 57600.



The factory default Baud Rate is 57600.

Setup Sensor Parameters

Settings In the “Settings” window all sensor settings can be changed accordingly. Double clicker on any setting will open DLS2000A Settings display



<u>Laser Power</u>

Max Laser Power During automatic laser power adjustment, this limits the maximum power. The power can be adjusted from 1-254: the lower the value, the higher the laser power. Together with “Min Laser Power” you can setup the Laser Power range in which the sensor will operate. To change the maximum laser power, enter the new power setting and click on “Max Laser Power”. The recommended value for Max Laser Power is 2.

Min Laser Power During automatic laser power adjustment, this limits the minimum power. The power can be adjusted from 1-254: the higher the value, the lower the laser power. Together with “Max Laser Power” you can setup the Laser Power range in which the sensor will operate. To change the minimum laser power, enter the new power setting and click on “Min Laser Power”. The recommended (Factory Defaults) value for Min Laser Power is 240.

Threshold This refers to the A to D converted threshold for detecting the laser spot and filtering it through the background light. The threshold can be adjusted from 0-255. The lower the value the more sensitive camera becomes to laser light but also becomes more sensitive to background ambient light. Recommended value for threshold is 48.

Analog Factor

Min Range Sets the sensor's range at which the analog output is at the "volt@min". For any range less than this value, sensor will output the analog reading of "**volt @ OutOfRange**" and digital reading of "Out of Range".

Max Range Sets the sensor's range at which the analog output is at the "volt at max". For any range greater than this value, sensor will output the analog reading of "**volt @ OutOfRange**" and digital reading of "Out of Range".

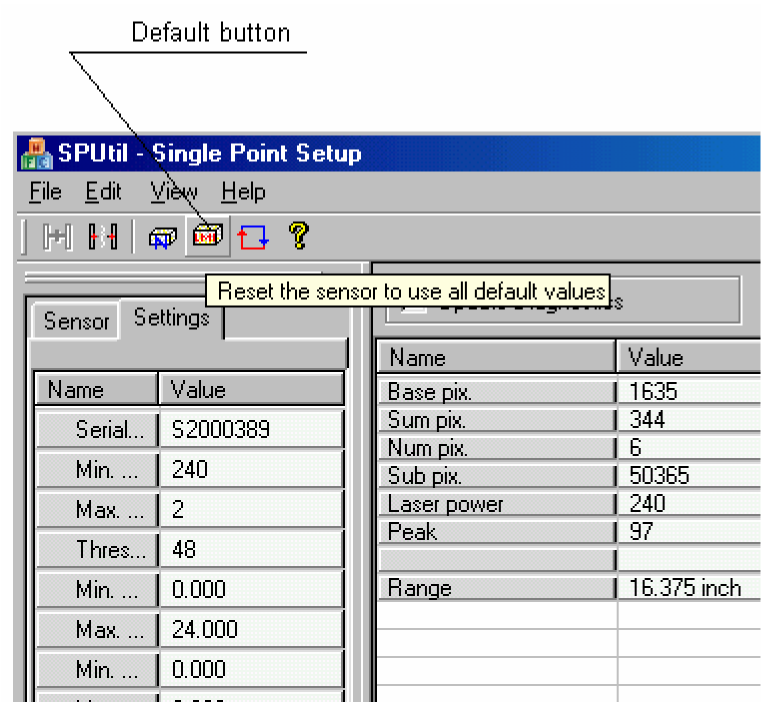
Volts @ Minimum Analog output when the object sensed is at the nearest point ("**Min Range**") of the sensor's range. This allows "digital to analog mini

Volt @ Maximum Analog output when the object sensed is at the furthest point ("**Max Range**") of the sensor's range.

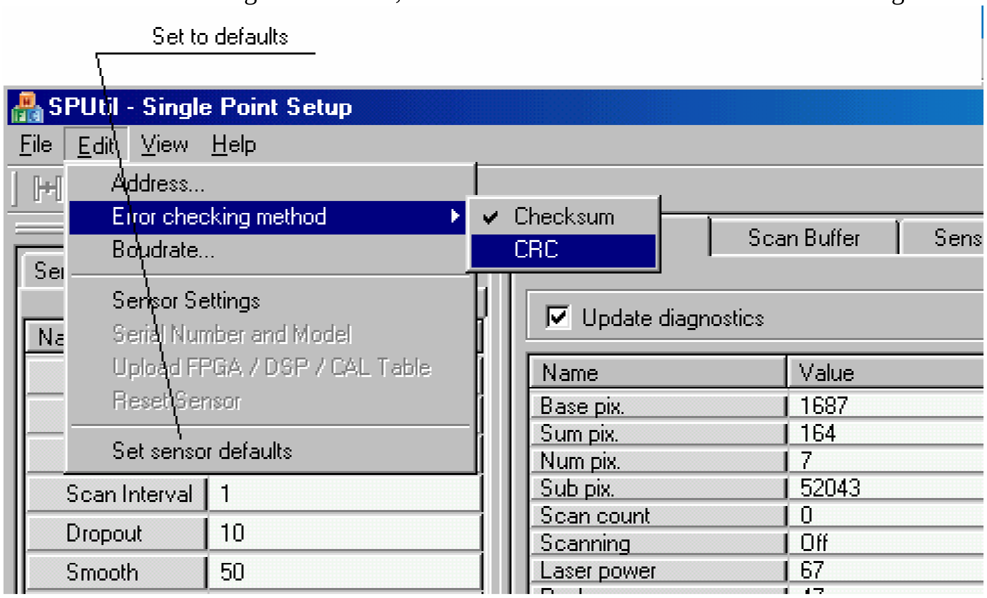
Volts outside Voltage output when the object sensed is outside the defined "min range" and "max range".

Set to Defaults Sets all sensor parameters to factory defaults:

- use Default button
- use Edit/ Set sensor defaults option

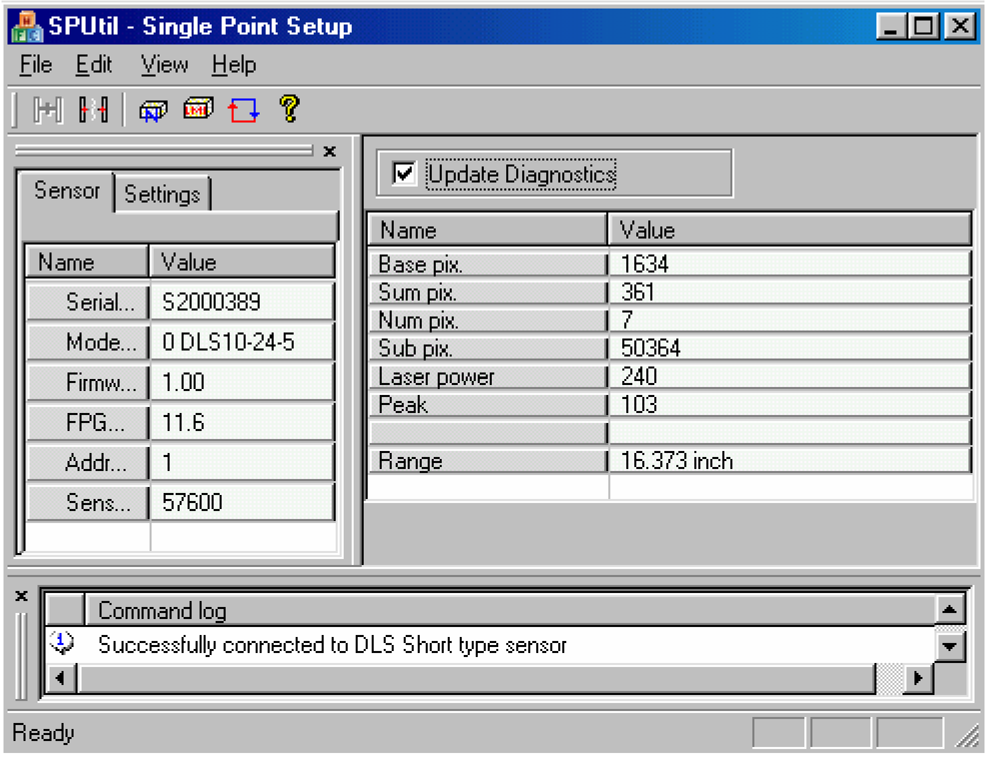


Error Checking Error checking method used by sensor to communicate with the Host: Checksum (Default) or CRC
To change the method, select the one from the “Edit”/”Error checking method”.



View Ranges/ Spot Info

Allows the user to view range/spot information.



All of the items in the "Diagnostic" window is used for diagnostic purposes, and serve to alert technicians to the operation status of the sensor. For the sensor to start displaying all diagnostics information's "Update diagnostics" button need to be checked.

- **'BasePix'** references where on the camera array the spot is falling
- **'SumPix'** is the total area covered by the spot, showing technicians the shape of the light spot.
- **'NumPix'** is the number of pixels wide the light spot is on the camera.
- **'SubPix'** is the number of pixels seen by the camera, broken up into sub divisions.
- **'Laser Power'** is the actual (current) laser power of the sensor.
- **'Peak'** is the highest pixel of the spot.
- **'Range'** is the continuous (Digital) range reading displaying by the sensor.

COMMUNICATIONS PROTOCOL

This section describes the contents of the packet used to transmit commands and data between a host computer and a DLS2000A sensor.

General Packet Protocol

An asynchronous RS-485 serial communication link serves as the hardware interface between the host and the sensor(s). The software protocol describes the packet or group of information that is transmitted. Generally this consists of:

- an address
- a command
- optional data
- a checksum/CRC

Packet Description

A packet consists of a string of bytes. The same format is used to transmit from the host to the sensor and back.

What is a packet's maximum size?

The maximum size of any single packet is 259 bytes. If the data block to be transmitted exceeds 259 bytes, then the total data block must be transmitted with more than one packet. For example, if the total data consists of 700 bytes then this will take a total of 3 packets of data to be sent.

PACKET FORMAT

[STX] [Address] [Length] [Command] [Data] [Checksum] or [CRC]

[STX]	1 byte	Start transmission character (02)
[Address]	1 byte	0 broadcast to all sensors. 1.255 addressing a specific sensor. Note: This byte identifies the sender when received by the host.
[Length]	1 byte	When using Checksum for error checking this is the number of bytes from command to the last data byte. When using CRC for error checking this is the number of data bytes only
[Command]	1 byte	1.255 See command descriptions.
[Data]	XX byte s	Number of bytes is command dependent.
[Checksum]	1 byte	2s Complement sum of all bytes inclusive of STX and last data byte
OR		
[CRC]	2 byte	16 bit CRC of all bytes inclusive of STX and last data byte .

PACKET EXAMPLE:

To request the Start scan from the sensor, the host computer program should send the following message packet:

If using Checksum

02	Address	1	3	Checksum (1Byte)
STX Character	Device Address	Command Size	Command (Start scan)	

Let's assume that sensor has serial address of 1;
Example 1

Start scan (command 3) :
$02 + $01 + $01 + $03 + $F9
where Length = 1 (1 command byte)

The validity of the data in all packets transmitted to and from the sensor is checked using the last byte of the packet –checksum ("2's complement of the sum of all bytes in the packet)
02+01+01+03 = 07
256-07 = 249
Checksum is 249 = $F9

Example 2

Set Scan Interval (command 5) Let set interval to 400 ($0190)
$02 + $01 + $03 + $05 +$90 + $01 +$64
where Length = 3 (1 command byte + 2 data bytes)
02+01+03+05+144+01= 156
256-156=100
Checksum is 100 =$64

Example 3

Set Scan Filters (command 14 ($0E)) : Let set Dropout factor to 15 ($000F);
Smooth to 75 ($004B) and Order to 5 ($0005)
$02 + $01 + $07 + $0E + $ 0F + $00 + $4B + $00 + $05 + $00 +$89
where Length = 7 (1 command byte and 6 data bytes)
02+01+07+14+15+75+5=119
256-119=137
Checksum is 137 = $89

If using CRC
Lets assume that sensor has serial address of 1;

02	1	0	3	CRC (2 Bytes)
STX Character	Device Address	Command Size	Command (Start scan)	

Example 1

Start scan (command 3) :
$02 + $01 + $00 + $03 + $76 + $40
where Length = 0 (no data send)

Example 2

Set Scan Interval (command 5) Let set interval to 400 ($0190)
$02 + $01 + $02 + $05 +$01 + $90 + $ED +$0F
where Length = 2 (2 data bytes)

Example 3

Set Scan Filters (command 14 ($0E)) : Let set Dropout factor to 15 ($000F);
Smooth to 75 ($004B) and Order to 5 ($0005)
$02 + $01 + $06 + $0E + $00 + $0F + $00 + $4B + $00 + $05 +$A0 + $15
where Length = 6 (6 data bytes)

For details on how to calculate CRC see our Pseudo-Code description on page 50 of this Manual

NUMERIC FORMATS

The following describes the format of numbers contained within a packet.

Byte Always an unsigned 8 bit number 0.255.

Words All words used in commands data streams are signed 16 bit numbers.
When using CRC, MSB of the data word is sent first
When using Checksum LSB of the data word is sent first.

Decimal points are assumed depending on data content.
Example: If the data were 12345, this would represent 12.345 inch.

COMMUNICATIONS ERROR HANDLING

This section describes the error handling of the serial communications.

The validity of the data in all packets transmitted to and from the sensor is checked using the last byte of the packet as a Checksum or CRC.

How do I process a received data packet?

When receiving a data packet from the sensor, the host application should verify the validity of the Checksum or CRC byte. Additionally, the application should ensure that the command value returned matches the one sent in the request packet sent to the sensor.

What is the structure of a command packet?

Each command packet has the same structure as a data packet (see Packet Example). This means you must terminate each command packet with a Checksum or CRC.

What if the sensor detects an error?

If the sensor detects an error in the transmission it will ignore the command and not respond. If there is no response from the sensor within 20 ms then the host application should assume an error occurred and retransmit the original command.

Re-Synchronizing Timing

This section describes the method of synchronizing the serial transmission between the host and the sensor.

Start of Transmission (STX)

Transmission of packets is initiated by the "STX" (Start of Transmission) character.

How do I make sure the host and sensor are synchronized?

Allow a period of 20 ms to pass without a response from the sensor BEFORE initiating a retransmission of the request to ensure synchronization.

Sensor

Upon receipt of an "STX" character, the sensor will allow a maximum of 50 ms for the next byte to be transmitted by the host.

What if transmission time exceeds 50 ms?

The sensor will abort receiving the packet and start looking for another STX character.

To guarantee resynchronization of all sensors on a serial line, the host application should stop all transmission for 200ms. After this time, all sensors on the serial line will be waiting to receive an STX character.

Host

Upon receipt of an 'STX' character the host should allow a maximum of 500 ms for the complete response packet to be transmitted from the sensor.

What if the complete packet is not received in 500 ms?

The host application should abort the command and start looking for another STX character.

DynaVision® APPLICATION PROGRAMMING INTERFACE

Development of application programs for the DLS2000A is a simple task.

Requirements are:

- a suitable serial interface driver
- a program that reads requests and receives character data (byte stream) using the Packet Format described in the previous paragraphs
-

By writing an application in the host computer, you can:

- request data from the sensor
- read and process data values returned from the sensor

Commands

Command	**12**	**GET_RANGE**		
Purpose	Returns the current range reading.			
Command Format	**[Command]**			
	Command	(1 Byte)	12	
Response Format	**[Command] [Range]**			
	Command	(1 Byte)	12	
	Range	(1 Word)		

Command **18** **SET SERIAL ADDRESS OF THE SENSOR**

Purpose Assigns a specific address to the sensor identified by the serial number. This command can be broadcasted to all sensors (packet Adders is zero). Each sensor checks the [serial#] and if it matches the serial # stamped on the face if the sensor, the [address] is set. This address is then used to send commands to a specific sensor.

Command Format **[Command] [Serial# (8 Bytes)] [Address]**

Response Format	**if using CRC:**	**[Command]**			
		Command	(Byte)	18	Success
				0	Fail
	If using ChkSum: None				

Command	**132**	**GET SERIAL ADDRESS OF THE SENSOR**		
Purpose	Read the sensor’s serial address			
Command Format:	**[command]**			
Response Format:	**[command] [Address]**			
	Command	(1 Byte)	132	
	Address	(1 Byte)		

Command 92 SET BAUD RATE OF THE SENSOR

Purpose To put sensors to specific baud to match the RS-485 serial input and output ports baud rate.

Command Format: **[command] [Baud]**

Command	(1Byte)	92
Baud	(1Byte)	(0 : 9600, 1 : 19200, 2 : 38400, 3 : 57600)

Response Format **if using CRC:** **[Command]**

Command	(Byte)	92	Success
		0	Fail

If using ChkSum : None

Command 135 GET BAUD RATE OF THE SENSOR

Response Read Sensors Baud setting

Response Format: **[command] [Baud]**

Command	(1 Byte)	135
Baud	(1 Byte)	

Command 77 SET ERROR CHECHING TO CRC / CHECKSUM

Purpose Change sensor’s error-check from CRC to Checksum or vice-versa.

Command Format: **[command][Mode]**

Command	(1 Byte)	77
Mode	(1 Byte)	0: CRC / 1: Chksum

Response Format **if using CRC:** **[Command]**

Command	(Byte)	77	Success
		0	Fail

If using ChkSum: None

Command	**66**	**SET TO DEFAULTS**		
Purpose:	Sets all sensor parameters to Factory Defaults.			
Command Format:	**[command]**			
	Command	(1 Byte)	66	
Response Format	**if using CRC:**	**[Command]**		
		Command	(Byte)	66 Success 0 Fail
	If using ChkSum : None			

Command	**93**	**WRITE MINIMUM ANALOG RANGE**		
Purpose	Sets sensor's minimum range; for targets closer than this range, sensor will output Out of range value($FFFF).			
Command Format:	**[command][Min Range]**			
	Command	(1 Byte)	93	
	Min. Range	(1 Word)	(0 . . 12000)	
Response Format	**if using CRC :**	**[Command]**		
		Command	(Byte)	93 Success 0 Fail
	If using ChkSum : None			

Command	**140**	**GET MINIMUM ANALOG RANGE**	
Purpose	Returns the sensor's minimum range		
Command Format	**[Command]**		
	Command	(1Byte)	140
Response Format	**[Command] [Min. Range]**		
	Command	(1 Byte)	140
	Min. Range	(1 Word)	

Command 94 — WRITE MAXIMUM ANALOG RANGE

Purpose: Sets sensor's maximum range; for targets further than this range, sensor will output Out of range value($FFFF).

Command Format: **[command][Mode]**

Command	(1 Byte)	94
Max. Range	(1 Word)	(0 .. 12000)

Response Format

if using CRC : **[Command]**

Command	(Byte)	94	Success
		0	Fail

If using ChkSum : None

Command 141 — GET MAXIMUM ANALOG RANGE

Purpose: Returns the sensor's maximum range

Command Format **[Command]**

Command	(1 Byte)	141

Response Format **[Command] [Max. Range]**

Command	(1 Byte)	141
Max. Range	(1 Word)	

Command 90 — WRITE MINIMUM ANALOG VALUE

Purpose: Sets the minimum voltage settings. This is the output when target is detected at the closest point (MIN. Range).

Command Format: **[command][Min_Da_Out]**

Command	(1 Byte)	90
Min_Da_Out	(1 Word)	(0 . . 9999)

Response Format

if using CRC : **[Command]**

Command	(Byte)	90	Success
		0	Fail

If using ChkSum : None

Command	**142**	**GET MINIMUM ANALOG VALUE**		
Purpose	Returns the minimum voltage setting			
Command Format	**[Command]**			
	Command	(1 Byte)	142	
Response Format	**[Command] [Min DAOut]**			
	Command	(1 Byte)	142	
	Min_Da_Out	(1 Word)		

Command	**91**	**WRITE MAXIMUM ANALOG VALUE**			
Purpose	Sets the maximum voltage settings. This is the output when target is detected at the Farthest point (MAX. Range).				
Command Format:	**[command][Max_Da_Out]**				
	Command	(1 Byte)	91		
	Max_Da_Out	(1 Word)	(0 . . 9999)		
Response Format	**if using CRC :**	**[Command]**			
		Command	(Byte)	91	Success
				0	Fail
	If using ChkSum : None				

Command	**143**	**GET MAXIMUM ANALOG VALUE**		
Purpose	Returns the maximum voltage setting			
Command Format	**[Command]**			
	Command	(1 Byte)	143	
Response Format	**[Command] [Max DAOut]**			
	Command	(1 Byte)	143	
	Max_Da_Out	(1 Word)		

Command 146 WRITE OUT_OF_RANGE ANALOG VALUE

Purpose

Sets the Out_Of_Range analog value for the sensor. This is the value that sensor outputs when target is out of the sensor's range

.

Command Format:

[command][OutR_Da_Range]

Command	(1 Byte)	146
OutR_Da_Out	(1 Word)	(0 . . 9999)

Response Format

if using CRC : [Command]

Command	(Byte)	146	Success
		0	Fail

If using ChkSum : None

Command 145 GET OUT_OF_RANGE ANALOG VALUE

Purpose

Returns Out_Of_Range analog value

Command Format

[Command]

Command	(1 Byte)	145

Response Format

[Command] [OutR_Da_Out]

Command	(1 Byte)	145
OutR_Da_Out	(1 Word)	

Command 84 WRITE MINIMUM LASER POWER

Purpose

Sets the minimum laser power (This is actually the OFF time of the laser power PWM; so higher the value , lower the laser power.)

Command Format:

[command][Min_Power]

Command	(1 Byte)	84
Min_Power	(1 Byte)	(1. . 254)

Response Format

if using CRC : [Command]

Command	(Byte)	84	Success
		0	Fail

If using ChkSum : None

Command	**130**	**GET MINIMUM LASER POWER**		
Purpose	Returns the minimum laser power setting.			
Command Format	**[Command]**			
	Command	(1 Byte)	130	
Response Format	**[Command] [Min. Power]**			
	Command	(1 Byte)	130	
	Min. Power	(1 Byte)		

Command	**83**	**WRITE MAXIMUM LASER POWER**			
Purpose	Sets the maximum laser power (This is actually the OFF time of the laser power PWM; so lower the value , higher the laser power.)				
Command Format:	**[command][Max_Power]**				
	Command	(1 Byte)	83		
	Max_Power	(1 Byte)	(1 . . 254)		
Response Format	**if using CRC :**	**[Command]**			
		Command	(Byte)	83	Success
				0	Fail
	If using ChkSum : None				

Command	**129**	**GET MAXIMUM LASER POWER**		
Purpose	Returns the maximum laser power setting.			
Command Format	**[Command]**			
	Command	(1 Byte)	129	
Response Format	**[Command] [Max. Power]**			
	Command	(1 Byte)	129	
	Max_Power	(1 Byte)		

Command 82 WRITE THRESHOLD

Purpose

This refers to the A to D converted threshold for detecting the laser spot and filtering it, lower the value the more sensitive camera becomes.

Command Format:

[command][Threshold]

Command	(1 Byte)	82
Threshold	(1 Byte)	(0 . . 255)

Response Format

if using CRC : [Command]

Command	(Byte)	82	Success
		0	Fail

If using ChkSum : None

Command 131 GET THRESHOLD

Purpose

Returns the threshold value.

Command Format

[Command]

Command	(1 Byte)	131

Response Format

[Command] [Threshold]

Command	(1 Byte)	131
Threshold	(1 Byte)	

Command 134 START STREAMING

Purpose Puts the senor to streaming data mode.

Command Format:

[command]

Command	(1 Byte)	134

Command 147 END STREAMING

Purpose Stop the sensor from streaming data mode.

Command Format:

[command]

Command	(1 Byte)	147

Command 21 GET SPOT

Purpose Returns a variety of values in relation to current spot

Command Format

[Command]

Command	(1 Byte)	21

Response Format

[Command] [Data . . Data]

Command	(1 Byte)	21
BasePix	(1 Word)	
SumPixel	(1 Word)	
NumPixel	(1 Word)	
SubPix	(1 Word)	
Range	(1 Word)	

Command Summary

The Pseudo Code below describes a simple application program.

Pseudo Code

MainLoop

```
// We'll talk to any attached sensor so we 'broadcast' to sensor address 0//
// We want to read the range.  Which is a command value of 12, and length 1//

WHILE (NOT Finished)                    // Until we're told to stop//
        SendSensorCmd(0, 1, 12)         // Send the sensor our request//
        ReadSensorRange                 // Read what the sensor sent//
ENDWHILE
```

SendSensorCmd(SensorAddress, CmdLength, CmdByte)

```
XmitBuffer[0] = STX                 // 1st byte is always an STX char//
XmitBuffer[1] = SensorAddress       // the Sensor Address//
XmitBuffer[2] = CmdLength
XmitBuffer[3] = CmdByte

If using CheckSum or error checking then
        Checksum = (STX + SensorAddress + CmdLength + CmdByte) * -1
        XmitBuffer[4] = Checksum            // put it at the end //
else
        for (i = 0; i < length[xmitBuffer]; i++)
        {
            ch = XmitBuffer[i]
            for (shifter = 0x80; shifter; shifter >>= 1)
                {
                        flag = (CRC & 0x8000)
                    CRC <<= 1
                    CRC |= ((shifter & ch) ? 1 : 0)
                     if (flag)
                      CRC ^= 0x1021
                }
            }
         XmitBuffer[4] = CRC  (MSB)
        Xmitbuffer [5] = CRC  (LSB)

 Write(XmitBuffer, COMPORT)
 StartTimeOutTimer
```

ReadSensorRange

```
        //checksum //
MsgReceivedFlag = FALSE             // Initialize status flags//
FirstByteFlag = TRUE

WHILE ((NOT TimeOut) AND (MsgReceivedFlag = FALSE))
    IF ByteRcvd                                         // Got a byte ?//
       IF FirstByteFlag = TRUE                          // Yes! Is it the 1st one?//
          IF ByteIn = STX                               // Yes! Is it an STX ?//
             BufferPtr = 0                              // Yes! Start storing the
             packet//
             FirstByteFlag = FALSE
             RcvBuffer[BufferPtr] = ByteIn
             BufferPtr = BufferPtr + 1
```

```
        ENDIF
    ELSE                                    // We've already got an STX so//
        RcvBuffer[BufferPtr] = ByteIn                   // add this byte to the
        queue//

        IF BufferPtr = 2                                // Is this the Length byte?//
            RcvLength = ByteIn + 3                      // Calc how many bytes we'll
            get//

        BufferPtr = BufferPtr + 1           // Update our pointer//
    ENDIF
ENDIF


//CRC  ReadSensorRange //

                MsgReceivedFlag
                XmitBuffer[4] = CRC = FALSE

                WHILE ((NOT TimeOut) AND (MsgReceivedFlag <TRUE))
                        IF ByteRcvd
                                IF FirstByteFlag = TRUE
                                        IF ByteIn = STX
                                                FirtsByteFlag = TRUE
                                                BufferPtr = 0
                                                FirstByteFlag = FALSE
                                        RcvBuffer[BufferPtr] = ByteIn
                                                BufferPtr = BufferPtr + 1
                                ELSE
                                        RcvBuffer[BufferPtr] = ByteIn

                                        IF BufferPtr = 2
                                                RcvLength = ByteIn + 3

                                        BufferPtr = BufferPtr + 1

     IF BufferPtr > RcvLength               //* Got the Full Message ? *//
     StopTimeOutTimer                       //* Yes! Stop the Timeout Timer *//
     MsgReceivedFlag = TRUE
                ENDWHILE

                IF MsgReceivedFlag = TRUE
                        RcvAddr = RcvBuffer[1]
                        RcvCmd = RcvBuffer[3]
                        RcvLen  = length[RcvBuffer] – 2
                        RcvCRC/Chksum = Last one or two bytes of RcvBuffer;
                Calculate CRC or Checksum


                IF RcvCRC/CheckSum <> CalcCRC/CheckSum
                                CRCError = TRUE
                        ELSE
                                IF RcvCmd <> CmdByte
                                        CommandError = TRUE
                                ELSE
                                SensorRange = WORD(RcvBuffer[4])
```

```
                ELSE
                    TimeOutError = TRUE
                    IF BufferPtr > RcvLength  // Got the Full Message ? //
        StopTimeOutTimer                                // Yes! Stop the Timeout
        Timer//
        MsgReceivedFlag = TRUE                          // Set the status flag - We're
        done//
    ENDIF
ENDWHILE

    IF MsgReceivedFlag = TRUE                           // Packet received or
    Timeout ? //
        RcvChecksum = 0                                 // Packet received. Then validate
        it//
        RcvAddr = RcvBuffer[1]
        RcvCmd = RcvBuffer[3]

        FOR loopctr = 0 TO RcvLength        // Calculate the checksum//
            RcvChecksum = RcvChecksum + RcvBuffer[loopctr]

        IF RcvChecksum <> 0                             // Is it valid?//
            ChecksumError = TRUE                        // No! Indicate the error//
        ELSE
            IF RcvCmd <> CmdByte            // Yes! Does the response match? //
                CommandError = TRUE         // No! Indicate the error//
            ELSE                                        // Otherwise, get the range
            value//
                SensorRange = WORD(RcvBuffer[4])
            ENDIF
        ENDIF
    ELSE
        TimeOutError = TRUE      // Too much time passed//
    ENDIF
```

Reading Streaming Data

When sensor is in the stream mode it continuously sends out range values until host sends any character (byte) to the sensor to end the streaming mode.

To put sensor into the streaming mode, send command **<u>134</u>** using above described Packet Format

Stream data format:

Sensor sends out 16bit(14 bit range data + 2 bit Sync bits) data of the following format

1xxx xxxx 0xxx xxxx

where MSB of each byte is used for synchronized the host software to the sensor.

MSB of '1' indicates upper byte(MSByte) and MSB 0f '0' indicates Lower byte(LSByte)

For ex. Range 12.000" (2EE0 Hex)

Sensor sends DD60 → 1101 1101 0110 0000

Now clear the MSB of each byte

0101 1101 0110 0000

split this word(2bytes) into two words 0000 0000 0101 1101 (upper word)
and 0000 0000 0110 0000 (lower word)

shift upper word left by 7 and add it to the lower word

0010 1110 1000 0000 (upper word shifted left by 7)
0000 0000 0110 0000 (lower word)
0010 1110 1110 0000 (Sum) = 2EE0 = 12000

MAINTENANCE

Since the DynaVision® scanner heads operate optically, the primary maintenance procedure is keeping the heads, and especially optical surfaces clean of sawdust, oil and pitch.

<u>Do not immerse the unit in fluids or use a high pressure spray to clean.</u>

The sensor contains optical and electronic components and under no circumstances should the enclosure be opened.

The following maintenance tasks should be preformed regularly to keep the scanner heads in good working order:

- Using clean air pressure system blow air over the laser and sensor glass surfaces to prevent dust particles from settling. It is important that the air be clean and free from oil and water.
- It is recommended that the face of the sensor be inspected and cleaned with isopropyl alcohol on a regular basis. Commercial glass cleaners should not be used; many have chemicals that leave a residue on the glass, which can affect optical performance.

Welding

DynaVision® scanners are optical apparatus, and care must be taken to ensure that nothing affects their optical performance.

The camera used inside each DLS2000A sensor head can be damaged by very intense light. Additionally, the debris generated while welding is normally hot enough to mar or imbed itself in the surface of the glass lenses covering the lasers and camera. Therefore, it is recommended that the sensor heads be shielded before any welding takes place in close proximity of the scanner frame.

TROUBLESHOOTING

This section will help you with any difficulties you may have in operating the DLS2000A sensor.

Before following the suggestions be sure that you have:

- a clean and regulated power source
- a calibrated voltage measurement device (DVM/Oscilloscope)
- a computer (optional)

Behavior
Laser off.
(When the laser is on, a red light appears in the small circular window - do not look at the laser.)

What to do

- Check to see if the power is turned on.
- Check cabling and ensure power is wired correctly.

Behavior

No data comes from the sensor's serial port.

What to do

1. Check cabling and ensure that power and signals are wired correctly. Make sure you have an RS-232 to RS-485 converter.
2. Check to see that the laser is on. The DLS2000A uses a visible (red) laser. Do not look into the laser exit window.
3. Check to see that the camera's field of view is not obstructed, and that the window is clean.
4. Connect an LED with a 3.3K ohm resistor in series across Pins #5 - (Out of Range) and #12.
5. Place a target within the sensor's range. The LED should be lit.
6. Block the path between the camera and the laser. The LED should go out.
7. Check the analogue output with an instrument capable of measuring DC voltage from 0 to 10 (e.g. DVM) VDC.
8. Move the target back and forth. Observe the analogue output. It should change as the target is moved. If the voltage changes it is likely that your serial port configuration and/or cabling is incorrect. If the voltage output does NOT change check wiring again.

Behavior

No data comes from sensor’s analogue output.

What to do

1. Check cabling and ensure that power and signals are wired correctly. Make sure you have an RS-232 to RS-485 converter.
2. Check to see that the laser is on. The DLS2000A uses a visible (red) laser. Do not look into the laser exit window.
3. Check to see that the camera’s field of view is not obstructed, and that the window is clean.
4. Connect an LED with a 3.3K ohm resistor in series across Pins #5 - (Out of Range) and #12.
5. Place a target within the sensor’s range. The LED should be lit.
6. Block the path between the camera and the laser. The LED should go out.
7. Connect the serial port of the sensor to a host computer using an RS-232 to RS-485 converter
8. Move the target back and forth. Observe the displayed range value on your computer. It should change as the target is moved. If the values change and there is still no analogue output, the analogue signals are probably incorrectly wired.

Behavior

In a multi-drop configuration, one or more sensors do not respond and do not provide data to the serial interface.

What to do

1. Connect the offending sensor by itself (see previous) to see if it operates correctly in a non-multi-drop environment.
2. If the sensor behaves correctly in #1, the problem may be that the sensor is incorrectly addressed when used in the multi-drop configuration.
   a) Be sure you are using an RS-232 to RS-485 converter.
   b) Check that the wiring of the multi-drop configuration is correct (See Multi-Drop Configurations).
   c) Check that the sensor addresses you are sending are correct. Use the program SPUtil.EXE to reset any invalid sensor addresses.

GETTING FURTHER HELP

If you wish further help on the DLS2000A contact your distributor.

For more information on Safety and Laser classifications, contact:
Center for Devices and Radiological Health, FDA
Office of Compliance (HFZ-305)
Attn: Electronic Product Reports
2098 Gaither Road
Rockville, Maryland 20850

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