# DLS2000A Long Range Single Point Sensor

## User Manual

**By LMI Technologies Inc.**

Version D

# PROPRIETARY



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## Trademarks and Restrictions



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## WELCOME TO THE DLS2000A LR (Long Range)

The DLS2000A_LR 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 page 7.

## 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_LR Setup Utility Demo Program ( SPUtil.exe)

## SAFETY

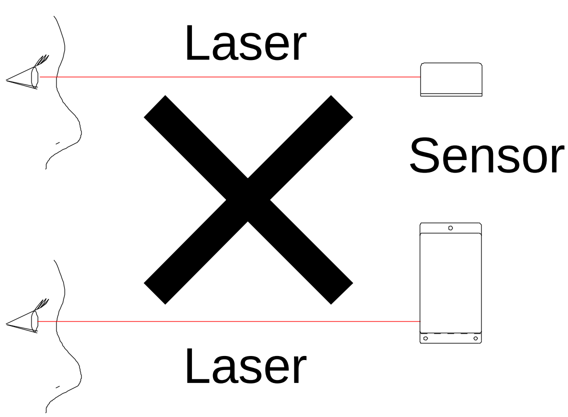
**Laser Safety**

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_LR 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_LR.

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

**WARNING! The DLS2000A_LR 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_LR and are the responsibility of the OEM to supply when incorporating the DLS2000A_LR into their system or product.**

## USING THE DLS2000A LR

The DLS2000A_LR 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_LR is a ‘smart’ sensor incorporating an internal processor to handle calibration, scaling and data conversion. The DLS2000A_LR provides analogue output (0-10 VDC), current output (4-20mA) and a digital serial output (RS-485 @ 57.6kBaud).

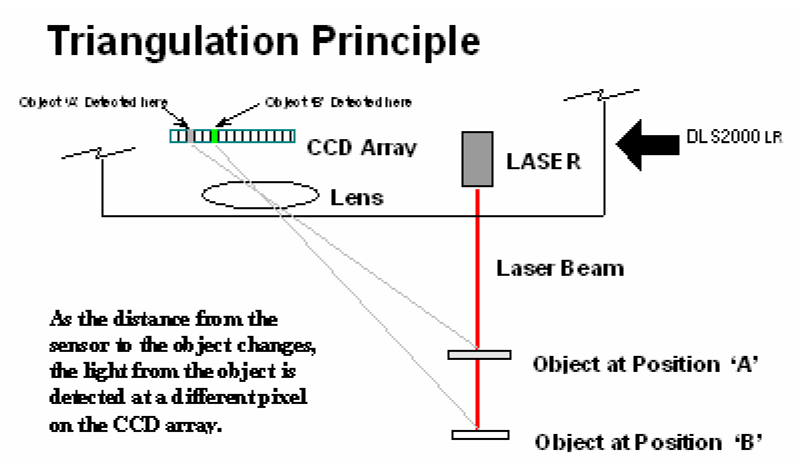



**Figure 1**

**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.

standoff = 19.50”(495mm) range = 118.11”(3000mm)

**DLS2000A_LR Standoff and Range**

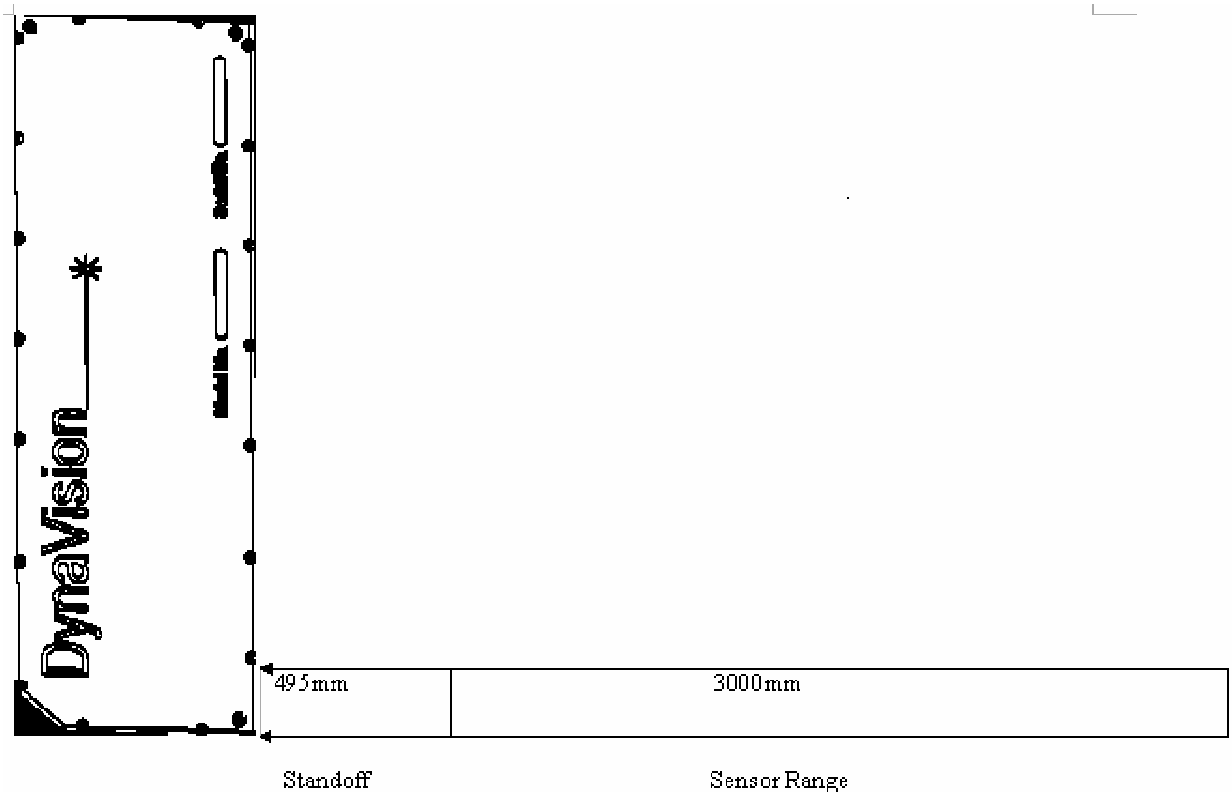


Figure 2

Standoff distance **(495mm)** + Range distance **(3000mm)** = Object's Maximum Distance **(3495mm)**

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 "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_LR?**

No, the DLS2000A_LR 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_LR can be employed as an analogue 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_LR 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_LR 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_LR 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 0 - 10 volts DC and/or 4-20mA
- a flat diffuse 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_LR.**

Operating your DLS2000A_LR 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_LR 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_LR
- If you are using the analogue 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 DLS2000A_LR.
- 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_LR can be connected to both a computer and a voltage/current-measuring device at the same time.**

**WARNING: 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_LR (see Figure 2).

4. Turn on the power supply to the DLS2000A_LR. The DLS2000A_LR does not have a power switch so turning on the power supply will activate the DLS2000A_LR. 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.

## MECHANICAL MOUNTING

The sensor enclosure contains a mounting plate with three pre-drilled mounting holes (see Figure 3.). **The accuracy of the sensor is dependent on a secure mechanical mounting.**

Figure 3

Calibration of the DLS2000A_LR 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 Figure 2.).

***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.

**Mechanical Specifications**

| | |
|---|---|
| Dimensions | 410.4mm (16.15") x 117.48mm (4.62") x 38.4mm (1.51") |

**Electrical Specifications**

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

**Laser Specifications**

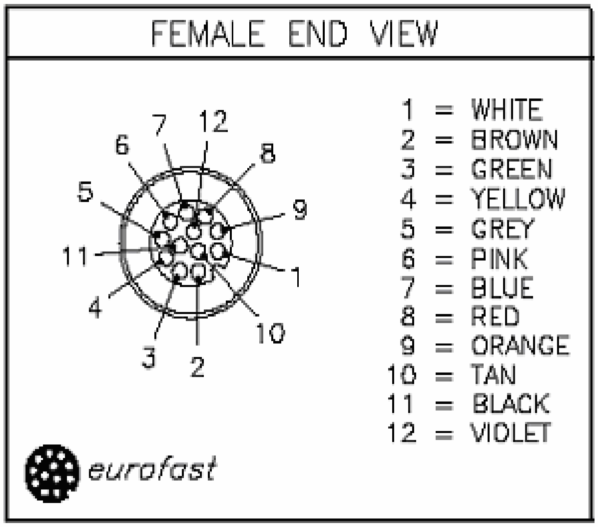
| | |
|---|---|
| Visible Laser | (RED) |
| Wave Length | 690 nm |
| Peak Power | 35 mW |

**Performance Specifications**

| | |
|---|---|
| Standoff | 495mm (19.5") |
| Range | 3000mm (118.2") |
| Resolution (Digital): | +/-0.03% up to 99" from sensor head, 0.1% from 99" to max. operating range. |
| Resolution (Analog): | +/-0.05% up to 99" from sensor head, 0.1% from 99" to max. operating range. |
| Scan Rate | 1667Hz |

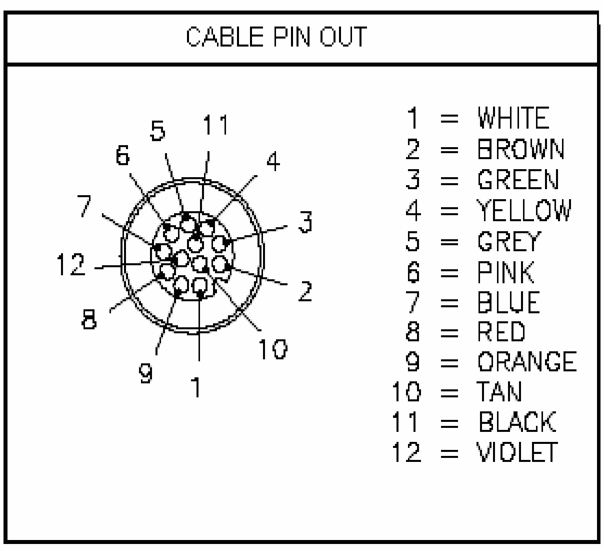
**Connector Pin Out**

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 Demo 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 |

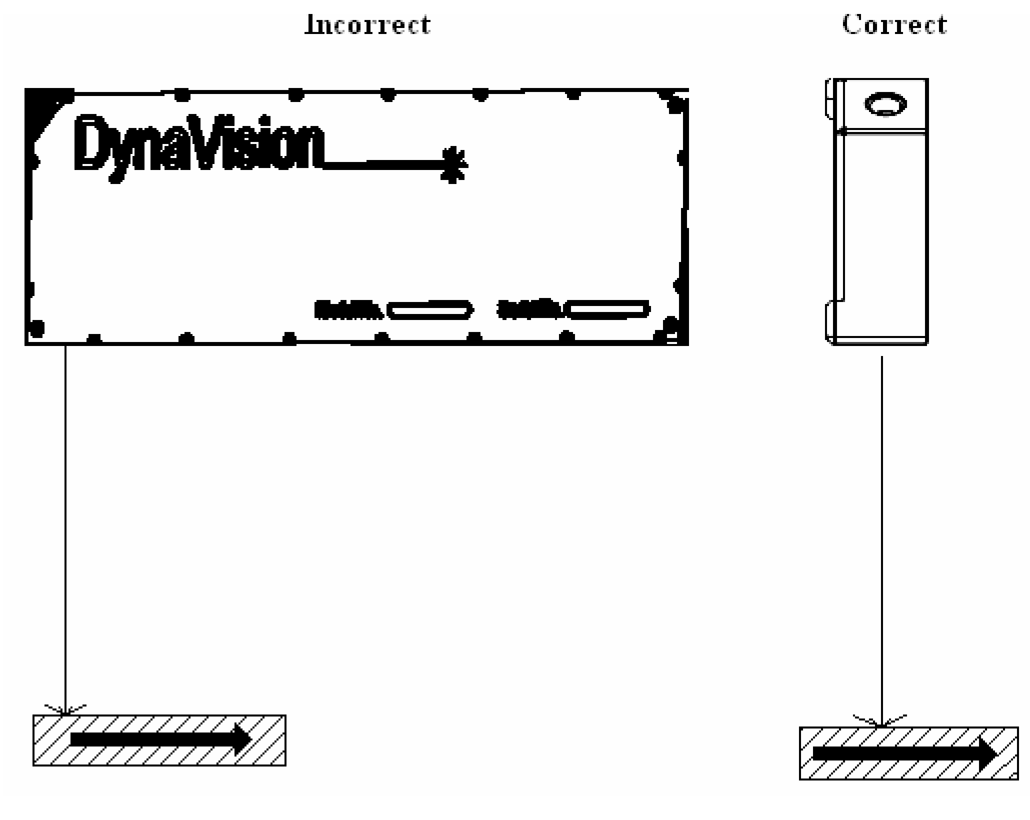
**Environmental**

| | | | | |
|---|---|---|---|---|
| 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

## 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. All range readings are perpendicular to the face of 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_LR 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 (SPUtil.exe) is supplied to allow you to set the address of each DLS2000A_LR unit.

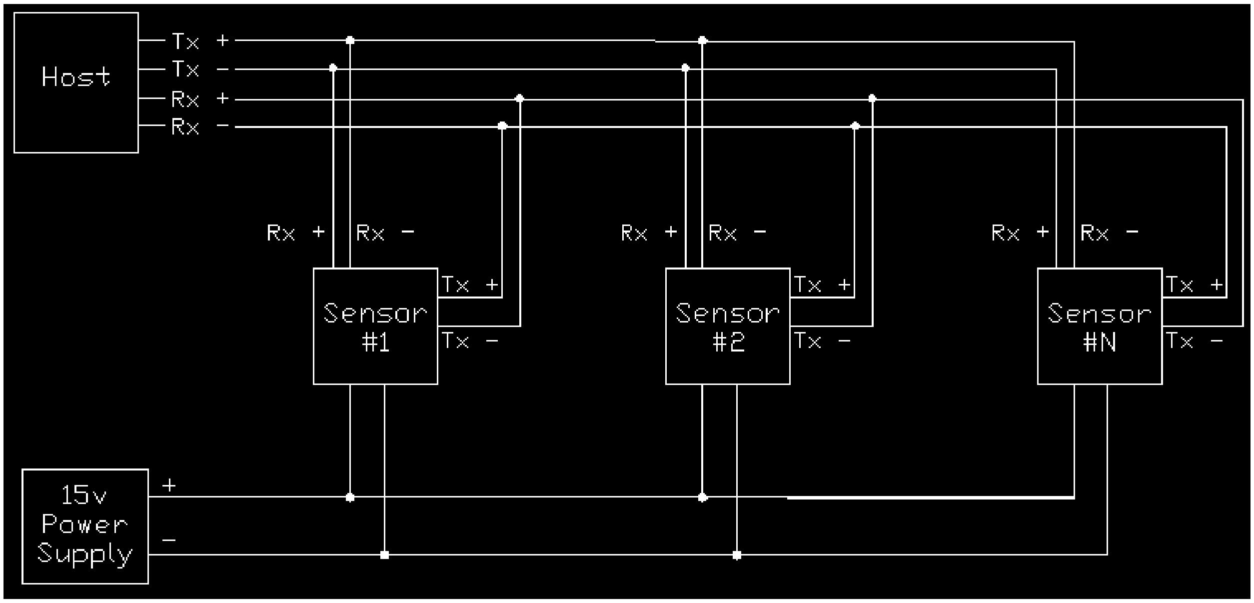
**Interconnect Specification**

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_LR 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_LR sensors are connected to the Rx-
- Tx- of all the DLS2000A_LR sensors are connected to the Rx+
- Rx+ of all the DLS2000A_LR sensors are connected to the Tx-
- Rx- of all the DLS2000A_LR 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.

**Warning**:
The multi-drop configurations wiring can vary depends of the RS-232/485 Converter box.

A utility is supplied (SPUtil.EXE), from which you can set the address of each DLS2000A_LR. **Remember this program only works in Microsoft® Windows® environments.**

<u>Cable Power Requirements</u>

The cable must be capable of handling +15 to 30VDC at 500 mA current.
The voltage must not drop below 14.5 VDC at the sensor.

## 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.

**Do not immerse the unit in fluids and do not use a high-pressure spray to clean.**

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

**Mechanical**

The sensor surface attachment should be periodically checked (once per month or as required) to ensure that mechanical mounting is secure.

### Welding

The camera used inside DLS2000A_LR sensor 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. It is recommended that the sensor heads are shielded before any welding takes place in close proximity of the scanner.

## CLEANING

The glass surfaces must be kept clean from dirt and grease build up. It is recommended that the face of the sensor be inspected and cleaned with isopropyl alcohol on a regular basis. **Do Not use commercial glass cleaners;** many have chemicals that leave residue on the glass, which can affect optical performance.

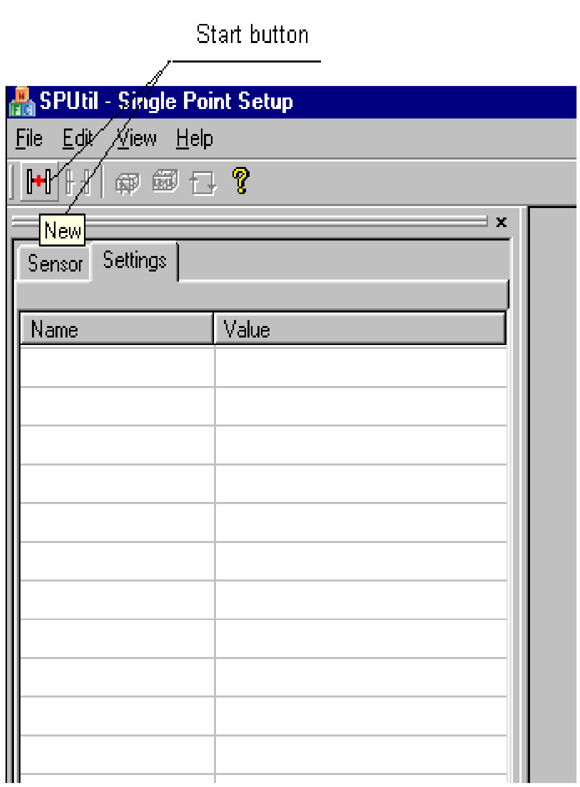
## AIR PURGE SYSTEMS

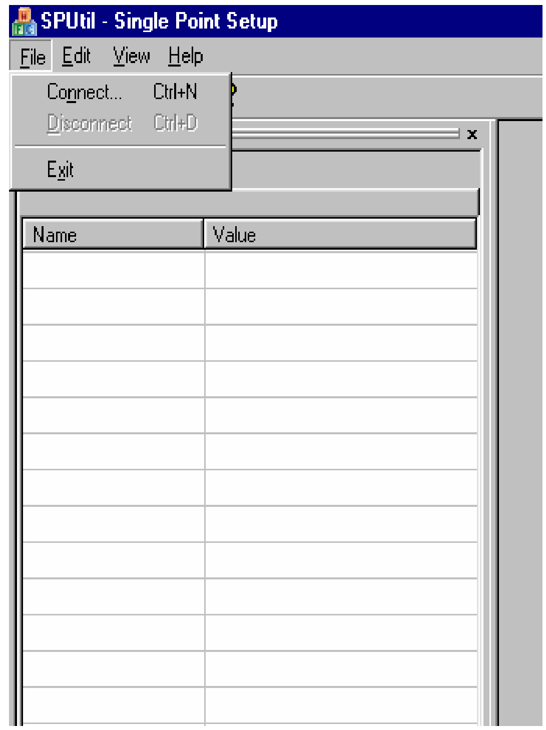
In very dirty environments, where free-floating particles are present, it is advised that a positive air pressure system be installed, such as an ‘air knife’ or ‘blower’ system. These systems blow air over the laser and sensor glass surfaces to prevent dust particles from settling**. It is important that the air be clean and free from oil and water.** The air purge system could be continuous or pulsed air operated from a timer.

## Using DLS2000A LR Setup Utility

### Connecting to the Sensor

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

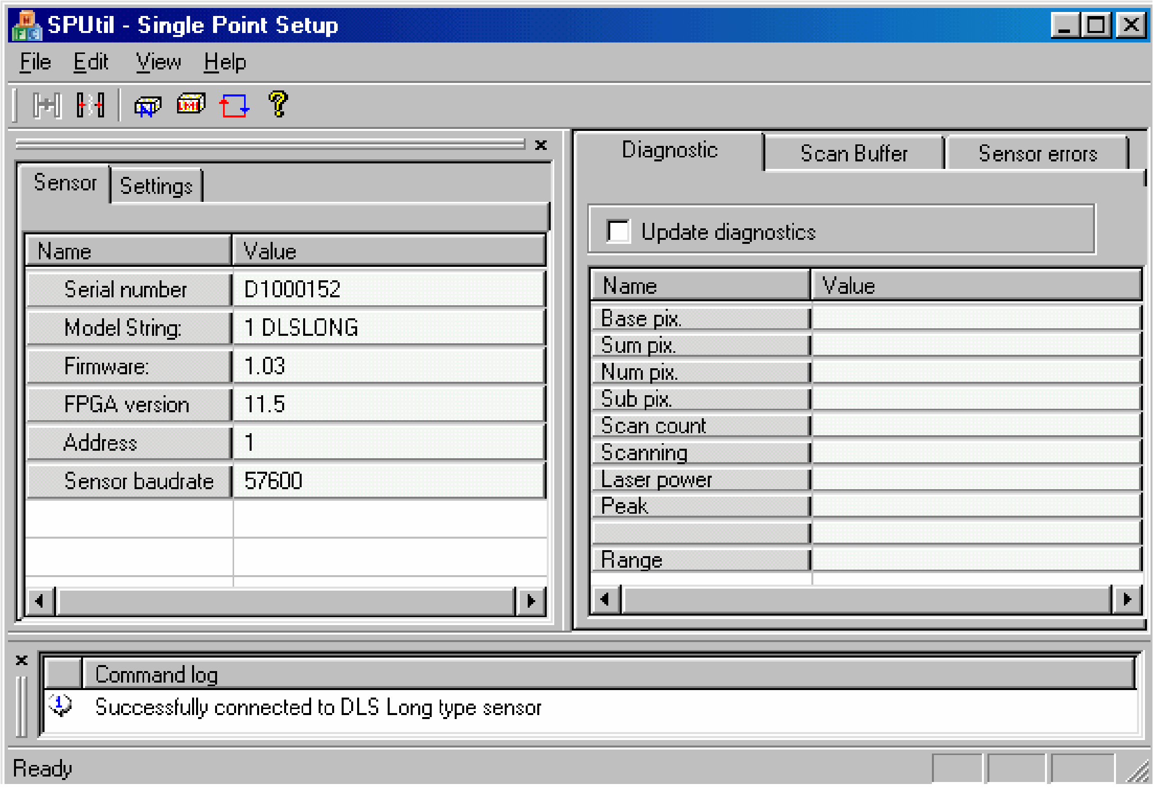



Select the proper COM Port, Baud Rate (57600 **-** Factory Default Rate), the unit address and click on "**OK"** button. If the unit address is not known, check the" **Use global address"** option.


**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.

## Connecting Successfully to the DLS2000A_LR Sensor




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

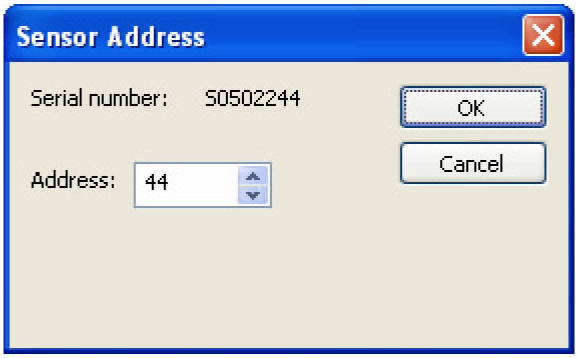
**Model String** This is the sensor's model number (Factory Programmed).

**Firmware** This is the firmware version of the sensor. It is factory programmed and cannot be changed (Factory Programmed).

**FPGA** This is the FPGA version of the sensor. It is factory programmed and cannot be changed (Factory Programmed).

**Sensor Address**

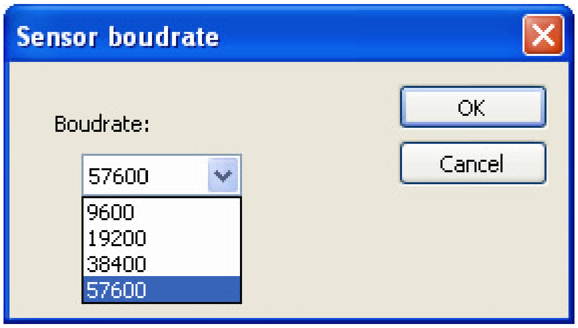
The sensor address may range from 1 to 255, the maximum number of sensors that can be placed on a single multi drop line. Each sensor must have a different address. To change the address of the sensor, double click on the current address. New window will appeared, enter new address and click on "OK"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




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

**Baud Rate**

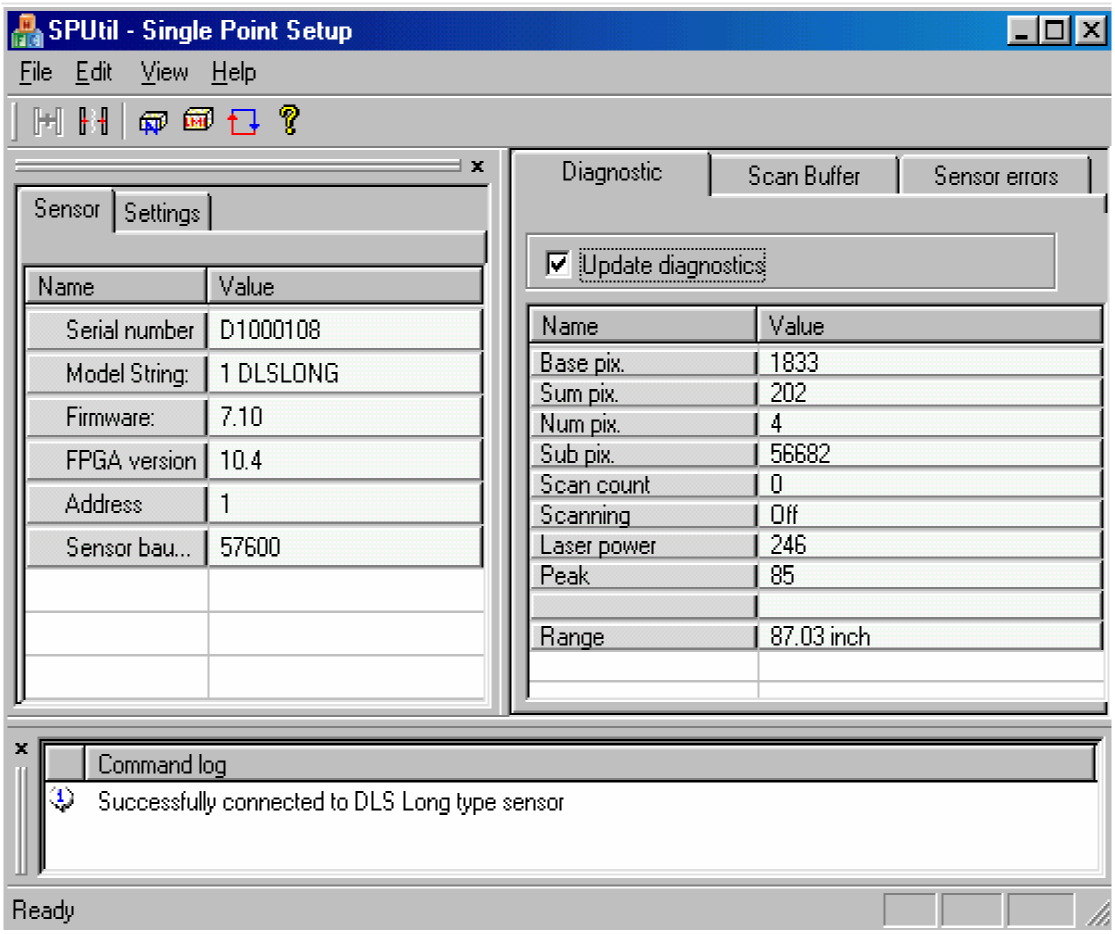
This is the sensor's Baud Rate that it uses to communicate to the Host. To change Baud Rate of the sensor, double click on the current Baud Rate. New window will appeared select the Baud Rate from the list and click on "OK" button. The available rates are 9600, 19200, 39400, and 57600.




<u>The factory default Baud Rate is 57600.</u>

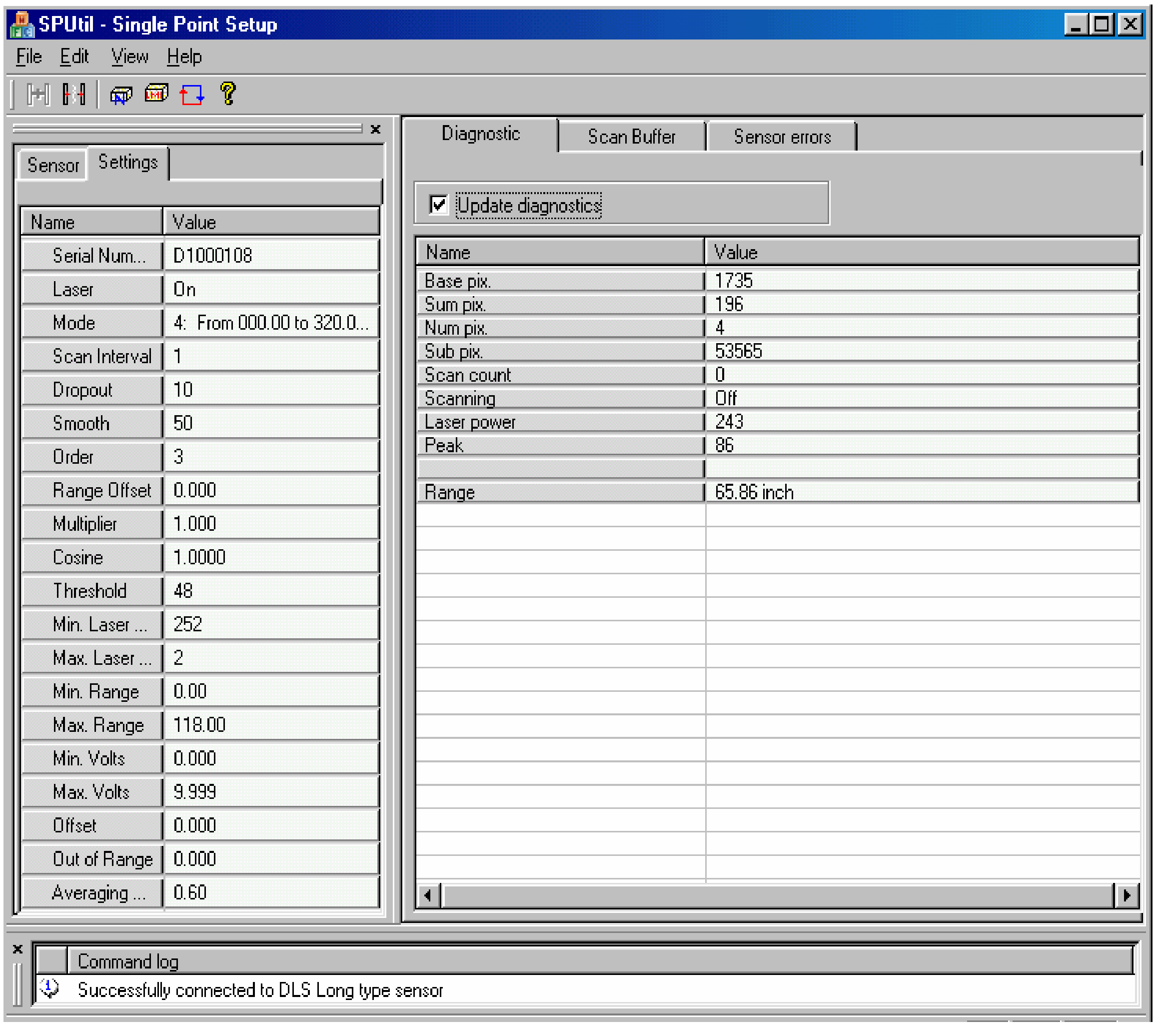
### Setup Sensor Parameters

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

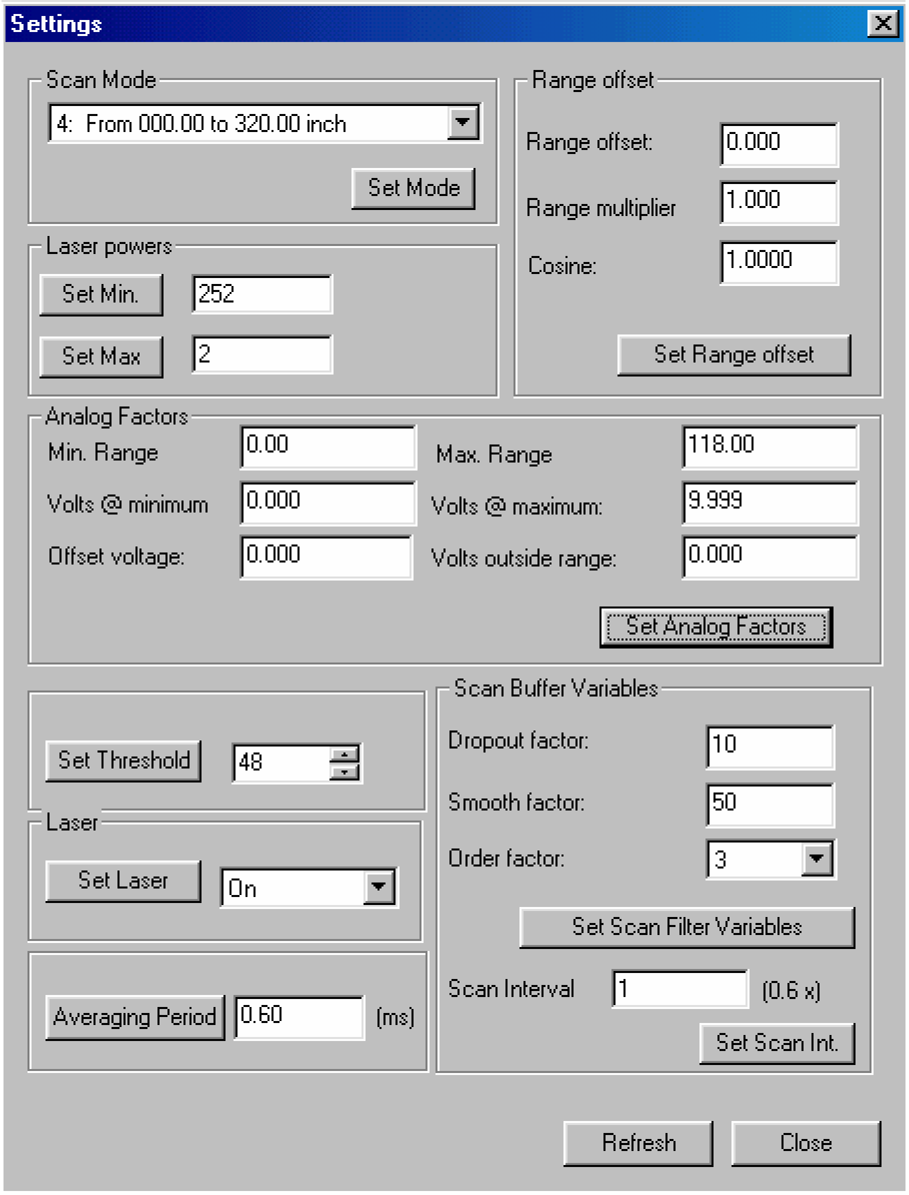


## Sensor Settings/Diagnostic

**Settings** In the “Settings” window all sensor settings can be changed accordingly. Double click on any setting will open SPUtil.exe “Settings” display.



## DLS2000A_LR Sensor Settings




**Scan Mode** The sensor mode refers to the format of the measurements (Imperial or Metric), range and its accuracy. The sensor will "see" targets only within its range defined by "MODE".
Note that all other parameters concerning range will be interpreted having the same unit as defined by" MODE". To change the mode, select the desired mode from the drop list and click on "Set Mode" button.

**Range Offset** This item sets an offer value which is added to the sensor range result, to change its relative position. To change this value, enter the new value in the edit box and click on the "Set Range offset" button. This value is metric or inches, depending on the mode. This setting is very useful when mounting requires an adjusted zero point.

**Range Multiplier** This item sets a multiplier from 1.000 to 10.000 to the sensor output. In this manner, you can insert 3.142 or π to give a circumference output. The multiplier will be applied, after the range offset has been added. To change this value, enter the new value in the edit box and click on the "Set Range offset" button.

**Cosine** "Cosine" is the cosine of the mounting angle of the sensor. This value is always set to 1.0000 if the sensor is mounted perpendicular to the surface being measured.

<u>Laser Powers</u>

**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 to ensure the optimal sensor's performance. To change the minimum laser power, enter the new power setting and click on "Set Min". The recommended value for Min Laser Power is 240.

**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 to ensure the optimal sensor's performance. To change the maximum laser power, enter the new power setting and click on "Set Max". The recommended value for Max Laser Power is 2.

<u>Analog Factors</u>

**Min Range** Sets the sensor's range at which the analog output is at the "volt@min". The "Minimum voltage" will be output at exactly this range. 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".

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

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

**Offset Voltage** This item allows for a voltage offset in the output data.

**Volts outside range** This voltage is output when the range is outside the minimum and maximum range values. This feature allows absolute recognition of out of range readings. The settings are from 0 to 9.999V.

**Note:** Generally the voltage range defined from 'Volt @ Min 'to 'Volt @ Max" is spread over the range defined from 'Min Out'. If the standard (metric/Imperial) is changed, it is important to pay attention to the D/A range values, and to redefine them.

**All "Analog Factors" parameters can be set using "Set Analog Factors" button.**

**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 the camera becomes to laser light but also becomes more sensitive to background ambient light. Recommended value for threshold is 48.

**Laser On/Off**

Turns Laser ON – turns laser ON with -1 option (see command 01) and OFF. To turn laser ON or OFF: select the desired option from the drop list and click on “Set Laser” button.

**Averaging Period**

This interval is the rate which the sensor updates the readings for the output taking readings at its sample rate and averaging them. For example, a value of ‘150.00’ means that 250 readings (each 0.6ms in duration) are taken and averaged before the output will be updated. To change this value, enter the new value in the edit box and click on the “Averaging Period” button.

**Set Buffer Variables**

Filter Parameters, Dropout, Smooth and Order, are used to filter the data in the scan buffer. Reasonable values for ‘‘DROPOUT’ count are (50.0%, 3, 10), ORDER’ factor, and ‘SMOOTH’ factor, respectively.

**Dropout Factor**

To change the dropout factor, edit the value and Click on “Set Scan Filter Variables”. This specifies the number of bad readings to fill in with the last good reading if the sensor does not obtain valid readings. Dropout filter is applied to the scan buffer before the moving average filter. Results are as follows:

| Dropout Count | Result |
|---|---|
| 1 | No dropouts removed. |
| 10 | Any bad laser reading < 10 samples wide are filled in with previous valid data. |

**Smooth Factor**

This item modifies the smooth factor used by the scan buffer filter programs. This factor, along with the order factor is used to apply a moving average filter to the current scan buffer. Results of the smooth are as follows:

| Smooth | Order | Results |
|---|---|---|
| 0 | X | Moving average filter is off |
| 30.0% | 5 | Filtered Value = (70% current value) + (30%* [Average of 5 samples]) |

A ‘SMOOTH’ factor near 100% means the data buffer elements will be averaged heavily with adjacent elements in the buffer. To change the smooth factor, edit the value and Click on “Set”.

**Order Factor**

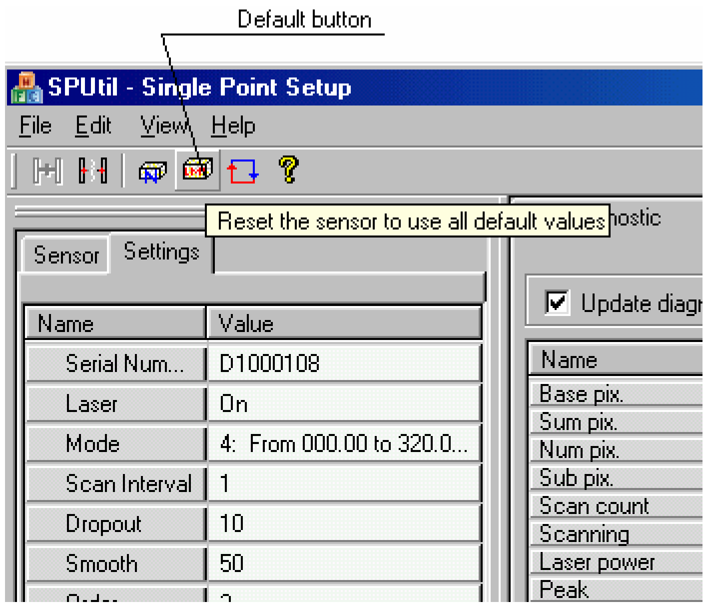
To change the order factor, edit the value and Click on “Set”. This item is used by the moving average filter and the smooth factor. This number is the number of samples that are averaged, centered on the sample being filtered. It must be odd and between 1 and 19. (i.e. An ‘ORDER’ factor of 3 uses 3 elements to calculate the average value. An ‘ORDER’ factor of 19 causes 9 elements before and 9 elements after the element are being filtered to be used in the average calculation.)

**Scan Interval**

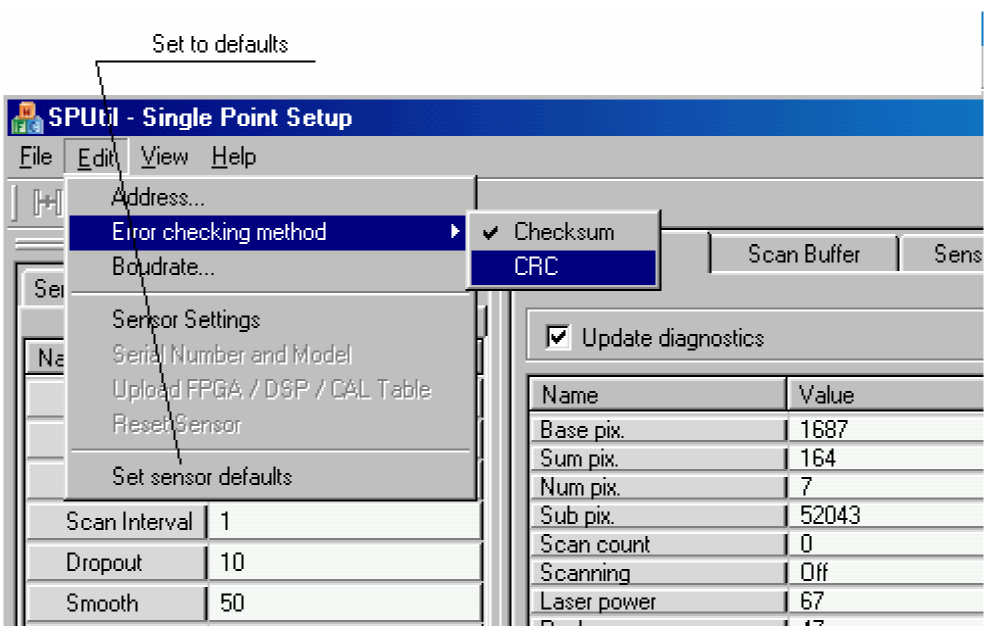
This refers to the sensor’s scan interval, i.e. the rate at which sensor stores scanned samples in the scan buffer. To change the scan factor, edit the value and Click on “Set”.

**Set to Defaults** Sets all sensor parameters to factory defaults:

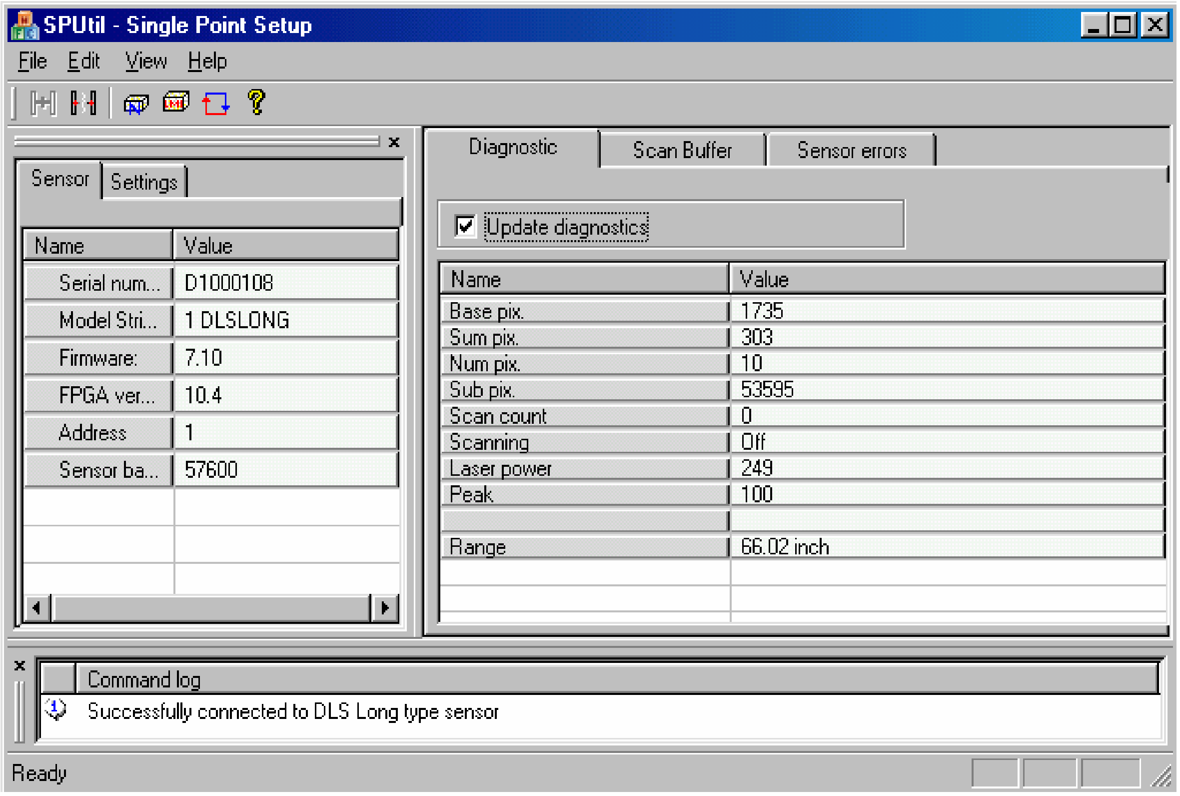
- use Default button
- use Edit/ Set sensor defaults options




**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".



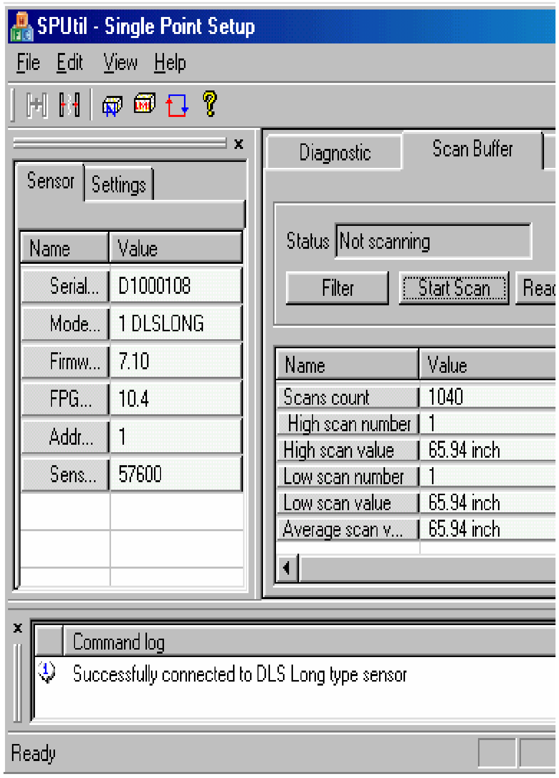
## Diagnostics

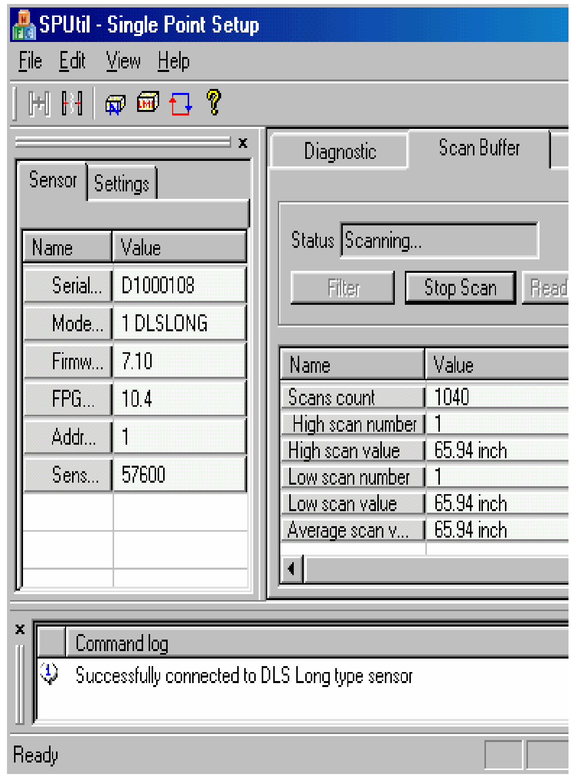



All of the items in the "Diagnostic" window is used for diagnostic purposes, and serve to alert technicians to the operation status of the sensor. For the sensor to start displaying all diagnostics informations "Update diagnostics" button need to be checked.

- **'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.
- **'Scan Count'** refers to the number of samples in the scan buffer.
- **'Scanning'** indicates if the internal scan buffer is On or OFF.
- **'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.

## Scan Buffer

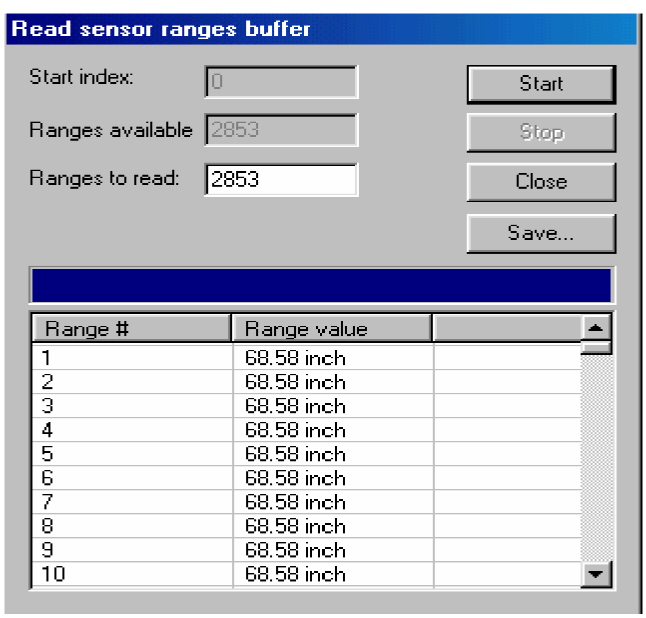



**Start Scan/**
**Stop Scan** Starts filling the scan buffer with range readings at rate specified by "Interval". Stop filling the scan buffer.

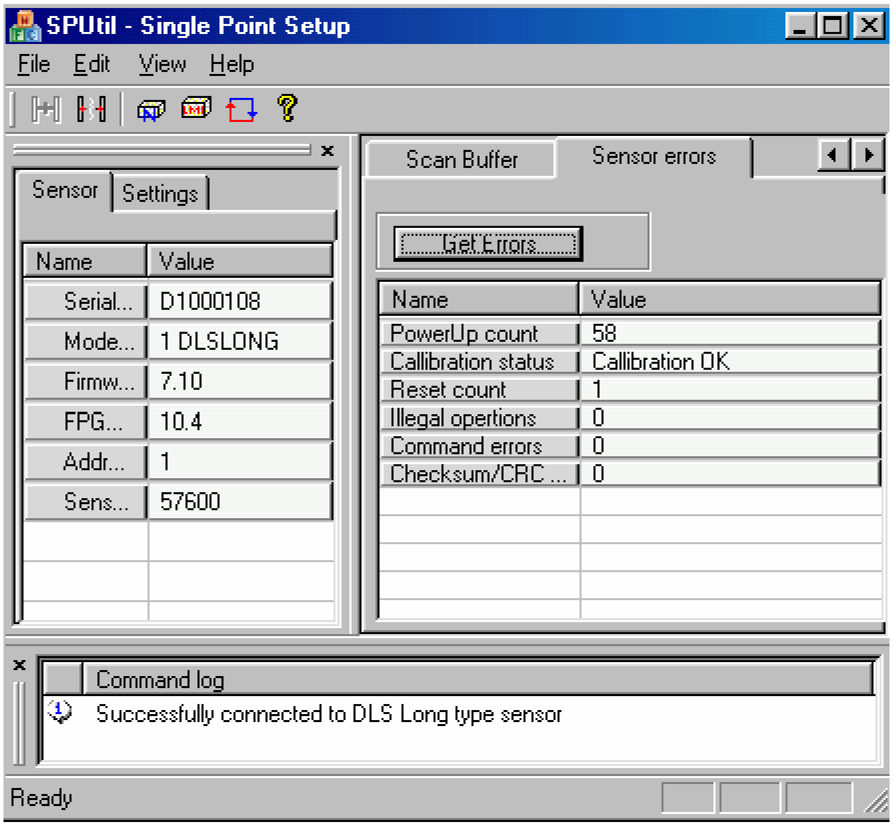
**Filter** Filters the scan buffer using specified filter factors, and display high, low, and average sample reading from the scan buffer.

**Read Scan Buffer** Reads the scan buffer and store it in a file (specified by user).



## Sensor Errors

Click on the "Get Errors" button to update the display.




| | |
|---|---|
| **Power-up Count** | This count refers to the number of times the sensor has been powered up over the life span. |
| **Calibration** | This refers to the internal checking of the sensor to ensure its calibration tables have not been corrupted. |
| **Reset count** | This count refers to number of internal restarts the sensor has gone through caused by something other than the power going off and on… |
| **Command Errors** | This count indicates the number of illegal commands the sensor has received from the Host. This could indicate poor host software or a poor communications link. |
| **Checksum/CRC Error** | This count indicates the number of times the sensor had received bad data packets. If Checksum count keeps increasing, further investigation of the communications link is required. |

## COMMUNICATIONS PROTOCOL

This section describes the contents of the packet used to transmit commands and data between a host computer and a DLS2000A_LR 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
- Checksum or 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][CommandSize][Command][Data..Data] [Checksum] or [CRC]

| | | |
|---|---|---|
| [STX] | 1 byte | Start transmission character (02 hex) |
| [Address] | 1 byte | 0 broadcast to all sensors.<br>1..255 addressing a specific sensor.<br>Note: This byte identifies the sender when received by the host. |
| [Command Size] | 1 byte | Number of bytes from command to the last data byte. Maximum 255. |
| [Command] | 1 byte | 1..255 See command descriptions. |
| [Data..Data] | 1 byte | 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 bytes | 16 bit CRC of all bytes inclusive of STX and last data byte |

PACKET EXAMPLE:

To request the current range value from the sensor, the host computer program should send the following message packet:

## Packet example

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

<u>If using Checksum</u>

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

Lets assume that sensor has serial address of 1;
<u>**Example 1**</u>

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

<u>**Example 2**</u>

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

<u>**Example 3**</u>

Set Scan Filters ( command 14 ($0E )) : Let set Dropout factor t 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 Two bytes sent with a range of 0 to 65535, the least significant byte is sent first.

Decimal points are assumed depending on data content.
Example: If the data is 12345 would represent 1234.5 mm.

## 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)**

"STX" (Start of Transmission) character initiates packets' transmission.

**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 complete command packet 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_LR 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

## General Overview

The DLS2000A_LR sensor is initialized, configured and controlled by commands it receives over a high speed RS-485 serial communications interface. The command may be a **broadcast** type that will be received and acted upon by all sensors connected to that serial line, or may be addressed to a specific sensor. The command number will dictate the response.

All commands consist of a 1 byte command value 1..255 and a number of bytes or words.

### COMMAND 01 TURN LASER ON

**Purpose** Sets time-out value for laser in 4 msec increments. Host must send this command before timer expires or laser will turn off. Value is always truncated to next closest multiple of 4 m sec

If a zero is sent then laser is turned on with no time-out.

If a –1 is sent then laser comes on at power up and there is no timeout. This is the factory setting.

| | | |
|---|---|---|
| HOST COMMAND SIZE | - | 3 BYTES |
| COMMAND | - | 01 |
| DATA | - | 2 BYTES |

LASER TIME-OUT VALUE:

| | | |
|---|---|---|
| DATA TYPE | - | 16 BIT WORD |
| Range | - | 0..32000 (x4 msec) |

**RESULT** Turns Laser On with optional time-out

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

| | | | |
|---|---|---|---|
| Command | (Byte) | 01 | Success |
| | | 0 | Fail |

**If using ChkSum**: None.

### COMMAND 02 TURN LASER OFF

HOST COMMAND SIZE 1 BYTE

COMMAND 02

DATA None

RESULT Turns laser off

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

| | | | |
|---|---|---|---|
| Command | (Byte) | 02 | Success |
| | | 0 | Fail |

**If using ChkSum**: None.

# Scanning Commands

## Command 05 Set Scan Interval

**Purpose** Sets the rate the sensor fills the internal sample buffer. Scan interval indicates the number of internal clock ticks (.60 ms), which elapse between updates. To store samples in the scan buffer use the commands 'START SCAN' and 'STOP SCAN'. (see following command descriptions).

**Command Format** **[command] [scan interval]**

| | | |
|---|---|---|
| ***Command*** | (1 byte) | 05 |
| ***scan interval*** | (1 word) | 1 ... 32000 (x .60ms) |

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

| | | | |
|---|---|---|---|
| Command | (Byte) | 05 | Success |
| | | 0 | Fail |

**If using ChkSum**: None

## Command 03 Start Scan

**Purpose** Clears the scan buffer and begins sampling at the rate specified by [Scan Interval], adding each sample in the scan buffer. Upon receipt of the START Scan command, the sensor will begin sampling after the time set in the SET SCAN INTERVAL command. For example, if the scan interval was set to 1,000 (x .60ms) or 6.0 seconds, the first sample would be entered after 6.00 seconds and every 6.0 seconds afterwards.

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

| | | |
|---|---|---|
| ***command*** | (1 byte) | 03 |

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

| | | | |
|---|---|---|---|
| Command | (Byte) | 03 | Success |
| | | 0 | Fail |

**If using ChkSum**: None

**NOTE:** The maximum number of samples that can be stored is 8192 (8 Kbytes), The buffer would be full in 163.84 seconds at a sample rate of 20 ms. When the buffer reaches capacity, samples will wrap around and begin storing new values at the beginning of the scan buffer, overwriting samples.

## Command 04 Stop Scan

**PURPOSE** Stops sampling and preserves the contents of the Scan buffer.

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

***command*** (1 byte) 04

**Response:** None

## Command 14 Set Scan Filter Factors

**Purpose** Sets up the filtering factors for the samples in the scan buffer.

**Command Format:** **[*command*][*dropout factor*][*smooth factor*][*order factor*]**

| | | |
|---|---|---|
| ***command*** | (1 byte) | 14 |
| ***dropout factor*** | (1 word) | 1..50 |
| ***smooth factor*** | (1 word) | 0..100 |
| ***order factor*** | (1 word) | 1,3,5,7,9,11,13,15,17,19 (must be odd) |

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

| | | | |
|---|---|---|---|
| Command | (Byte) | 14 | Success |
| | | 0 | Fail |

**If using ChkSum**: None

**NOTE:** The filters are applied in the following order:

1st - Drop Out Filter.
2nd - Moving Average Filter
3rd - High / Low Sampling

### Drop Out Filter

When the laser sensor returns a dropout (no value) a 32768 (8000h) sample will be put in the buffer. The dropout filter replaces all 32768 sample scan areas with the value preceding the dropout where the **number** of contiguous 32768 samples is less than the [Dropout Factor]. If the [Dropout Factor] is set to 1 then no dropouts are filtered. For example:

With the [Dropout Factor] = 3,

**Buffer** before = ..101, 102, 32768, 32768, 104, 0, 0, 0, 103...
after = ..101,102, 102, 102, 104, 0, 0, 0,103...

The [Dropout Factor] is set in the SET SCAN FILTER FACTOR command.

### Moving Average (Smooth) Filter

This filter takes an average of an odd number of samples on either side of the original sample and creates a new value by adding percentage of the average to a percentage of the original. The filter will smooth the scan with no phase shift. Two filter factors control these filters:

(a) Order Factor - The number of samples to average. It must be an odd number between 3..19. A value of 5 will cause two readings before and two readings after to be averaged.

(b) Smooth Factor - The percentage of the average to add to the opposite percentage of the original sample is a percentage 0 to 100 %, e.g.:

Newsample = (average*smooth%) + (original sample*(100%-smooth%)

If smooth is 0 then no smoothing takes place.

## Command 15 Filter Scan Buffer

**PURPOSE** Causes the contents of the scan buffer to be processed and modified using the parameters defined by the SET SCAN FILTER FACTORS command. This command should only be sent after the STOP SCAN command and not while the buffer is still being filled.

**Command Format** **[command]**

**[command]** **1 byte 15**

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

| | | | |
|---|---|---|---|
| Command | (Byte) | 15 | Success |
| | | 0 | Fail |

**If using ChkSum**: None

High Low (order) Sampling

After applying the Dropout and Moving Average Filters, the scan buffer is processed to find the location and value of the Highest sample, Lowest sample and the Average of all samples.

## Command 10 Read High / Low / Average of Scan

**Purpose** Obtains the High/Low and Average values of the readings contained in the scan buffer.

**Command Format** [command]

| | | |
|---|---|---|
| ***command*** | (1 byte) | 10 |

**Response Format** **[*response*][*high value*][*high scan #*][*low value*][*low scan #*][*average*]**

| | | |
|---|---|---|
| ***response*** | (1 byte) | 10 |
| ***high value*** | (1 word) | ± ⟨sensor range⟩ |
| ***high scan#*** | (1 word) | 1..8192 |
| ***low value*** | (1 word) | ± ⟨sensor range⟩ |
| ***low scan#*** | (1 word) | 1..8192 |
| ***average*** | (1 word) | ± ⟨sensor range⟩ |

**NOTE**: ⟨Sensor Range⟩ is dependent on the actual mode of operation. Refer to 'SET MODE' on page 39.

## Command 11 Read Scan Buffer

**PURPOSE** Obtains the contents of a specified portion, or the entire scan buffer. Between 1 and 66 packets is sent containing scan data. Each packet contains up to 126 samples.

**Command Format** ***[command] [start scan index][scans to read]***

| | | |
|---|---|---|
| ***command*** | (1 byte) | 11 |
| ***start scan index*** | (1 word) | 1..8192 |
| ***scans to read*** | (1 word) | 1..8192 |

**Response Format** **[*response*][*sequence #*][*scan data*]** (4-254 bytes)

| | | |
|---|---|---|
| ***response*** | (1 byte) | 11 |
| ***sequence #*** | (1 byte) | 66..1 – Highest sequence number (maximum 66) to 1. [sequence #] starts at the high value and decrements to 1 for last packet of scan. |
| ***scan data*** | (1..126 Words) | Always 126 except for last packet (sequence# = 1). |

**NOTE:** The command should be issued by the host to determine how many samples are in the buffer before reading it. (see page 46 "Read Current Sensor Status-21") If a large buffer is requested the host must be capable of accepting up to 16,384 bytes into its own buffer without losing data. If this buffer size is unavailable, smaller packets should be requested. The scan buffer can be read as many times, as the host requires. If unfiltered scans are required the host should read the scan buffer before requesting that the scan buffer be filtered.

## SET MODE/OPERATION COMMANDS

## Command 09 Set Mode

**Purpose**

Sets the sensor's range and units of measurement. The accuracy of the sensor's measurement depends on this range setting. Once the [MODE] is set all measurement values are in inch or metric units, accordingly**.**

**Command Format**

[command] [mode]

| | | | |
|---|---|---|---|
| ***command*** | (1 byte) | 09 | |
| ***mode*** | (1 word) | 0 | = 00.000"... 32.000 " |
| | | 1 | = 00.000"..-32.000 " |
| | | 2 | = 0000.0... 3200.0 mm |
| | | 3 | = 0000.0... -3200.0 mm |
| | | 4 | = 000.00"... 320.00 " |
| | | 5 | = 000.00"... -320.00 " |
| | | 6 | = 00.000... 32.000 m |
| | | 7 | = 00.000... -32.000 |
| | | 8 | = 0.0000"... 3.2000 " |
| | | 9 | = 0.0000"... -3.2000 " |
| | | 10 | = 000.00... 320.00 mm |
| | | 11 | = 000.00... -320.00 mm |
| | | 12 | = 000.00... 266.00 ft |
| | | 13 | = 000.00... -266.00 ft |
| | | 14 | = 000.00... 320.00 m |
| | | 15 | = 000.00... -320.00 m |

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

| | | | |
|---|---|---|---|
| Command | (Byte) | 09 | Success |
| | | 0 | Fail |

**If using ChkSum**: None

## Command 08 Set Offset/Cosine/Multiplier

**Purpose**

Defines a base offset value to add to the sensor's range readings. This value is added before the reading is stored in the scan buffer. It is assumed to be within a certain range and accuracy depending on the sensor mode. Sets the cosine of the angle the sensor is mounted relative to the measurement surface. For a sensor mounted with the laser beam perpendicular (90°) to the surface, the value of 1.000 is entered.
Set the multiplier of the output. The range reading is multiplied by this value before output. Do not use >>as this would result in >> output.

**COMMAND FORMAT** [command] [offset] [cosine] [multiplier] [cosoffset2]

| | | |
|---|---|---|
| ***command*** | (1 byte) | 08 |
| ***offset*** | (1 word) | ± ⟨sensor range⟩ |
| ***cosine*** | (1 word) | 0.0000 **-** 1.0000 cosine of mounting angle |
| ***multiplier*** | (1 word) | 0.0000- 10.000 |
| ***cosoffset2*** | (1 word) | reserved |

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

| | | | |
|---|---|---|---|
| Command | (Byte) | 08 | Success |
| | | 0 | Fail |

**If using ChkSum**: None

**NOTE**: ⟨sensor range⟩ is dependent on the actual mode of operation. Refer to 'SET MODE' on page 39.

## COMMAND 18 Set Address

**PURPOSE**

Assigns a specific address to the sensor identified by the serial number. This command is always sent as a **broadcast** to all sensors (packet Address is zero). Each sensor checks the [serial #] and if it matches the serial # stamped on the face of the sensor, the [address] is set. This address is then used to send commands to a specific sensor.

**Command Format** **[command] [serial #] [address]**

| | |
|---|---|
| ***command*** | (1 byte) 18 |
| ***serial #*** | (8 ASCII bytes) |
| ***address*** | (1 byte) 1..255 |

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

| | | | |
|---|---|---|---|
| Command | (Byte) | 18 | Success |
| | | 0 | Fail |

**If using ChkSum**: None

## COMMAND 26 Set Analog Output Factors

**PURPOSE** Sets new values for analog output, including minimum and maximum voltage, minimum and maximum range, offset and out of range values.

**Command Format** **[*command*][*Minvolt*][**Minrange**][** ***Maxvolt*][*Maxrange*][*offset*]** **[**Out of ***Range*][*reserved*][**d/aoutput**]**

| | | |
|---|---|---|
| ***command*** | (1 byte) | 26 |
| ***minvolt*** | (1 word) | 0..9.999 Volts |
| ***minrange*** | (1 word) | ±⟨sensor range⟩ |
| ***maxvolt*** | (1 word) | 0..9.999 Volts |
| ***maxrange*** | (1 word) | ±⟨sensor range⟩ |
| ***offset*** | (1 word) | 0..9.999 Volts |
| ***out of range*** | (1 word) | 0..9.999 Volts |
| ***reserved*** | (4 words) | 0 |

**ResponseFormat:** **if using CRC**: [Command]

| | | | |
|---|---|---|---|
| Command | (Byte) | 26 | Success |
| | | 0 | Fail |

**If using ChkSum**: None

**NOTE**: ⟨Sensor Range⟩ is dependent on the actual mode of operation. Refer to 'SET MODE' on page 39. For further explanation of each parameter see page 22 , DLS2000A_LR Sensor Settings .

## Command 33 Set Configuration Variables

**Purpose** Sets laser power and sample interval.

**Command Format**

[command][lasercfg][laserpwr][lointerval][hiinterval][reserved]

| | | |
|---|---|---|
| ***command*** | (1 byte) | 33 |
| ***lasercfg*** | (1 word) | Reserved |
| ***laserpwr*** | (1 word) | 0...31744 |
| ***period*** | (2 words) | low word, high word [60, 120,180] (x 0.01ms) |
| ***reserved*** | (1 word) | 0 |

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

| | | | |
|---|---|---|---|
| Command | (Byte) | 33 | Success |
| | | 0 | Fail |

**If using ChkSum**: None

**NOTE**: For further explanation of each parameter see page 22, DLS2000A_LR Sensor Settings.

.

## Command 92 Set Baud Rate of the Sensor

**Purpose** Puts 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** Reads Sensors Baud setting

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

| | | |
|---|---|---|
| Command | (1 Byte) | 135 |
| Baud | (1 Byte) | |

## Command 77 Set Error Changing to CRC / Checksum

**Purpose** Changes 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 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, sensor is continuously sending out range values until host sends any character (byte) to the sensor to end the steaming mode.
Sensor start to send out 16 bit data of the following format:
MSB and LSB

**Command Format:**

**[command]**

| | | |
|---|---|---|
| Command | (1 Byte) | 134 |

## Command 147 End Streaming

**Purpose**

Stops the sensor from streaming data mode.

**Command Format:**

**[command]**

| | | |
|---|---|---|
| Command | (1 Byte) | 147 |

# Read Current Values Commands

## Command 12 Read Current Position

**Purpose**
Returns the current reading in standard or metric depending on the sensor mode with offset added.

**Command Format**
[command]

| | | |
|---|---|---|
| ***command*** | (1 byte) | 12 |

**Response Format**
**[*response*][*position*]**

| | | |
|---|---|---|
| ***response*** | (1 byte) | 12 |
| ***position*** | (1 word) | ± 〈sensor range〉 |

**NOTE**: 〈Sensor Range〉 is dependent on the actual mode of operation. Refer to 'SET MODE' on page 39.

## Command 19 Read Current Sensor Setup

**Purpose**
Returns Various setup parameters.

**Command Format**
**[command]**

| | | |
|---|---|---|
| [command] | 1 byte | 19 |

**Response Format**

**[*response*][*serial#*][*address*][*mode*][*aperture*][*threshold*][*scantime*][*dropout*][*smooth*][*order*][*offset*][*cosine*][*cosoff1*][*cosoff2*][*laser*]**

| | | |
|---|---|---|
| ***response*** | (1 byte) | 19 |
| ***serial#*** | (8 ASCII bytes) | |
| ***address*** | (1 byte) | 1..255 |
| ***mode*** | (1 byte) | 0..3 |
| ***aperture*** | (1 word) | |
| ***threshold*** | (1 byte) | 1..255 - ignore |
| ***scantime*** | (1 word) | 1..32000 (x 0.6 ms) |
| ***dropout*** | (1 word) | 1..50 |
| ***smooth*** | (1 word) | 0..100 % |
| ***order*** | (1 word) | 1..19 (odd) |
| ***offset*** | (1 word) | ± 〈sensor range〉 |
| ***cosine*** | (1 word) | 0.0 - 1.0000 |
| ***cosoff1*** | (1 word) | Reserved |
| ***cosoff2*** | (1 word) | Reserved |
| ***laser*** | (1 word) | 0 = laser off, 1 = laser on |

**NOTE**: 〈Sensor Range〉 is dependent on the actual mode of operation. Refer to 'SET MODE' on page 39.

## COMMAND 21 Read Current Sensor Status

**Purpose** Returns a variety of values relating to current sensor status.

**Command Format** [command]

| | | |
|---|---|---|
| ***[command]*** | 1 byte | 21 |

**Response Format**

***sepix*][*sumpix*][*numpix*][*subpix*][*current*][*scancnt*][*scanflg*]**

| | | |
|---|---|---|
| ***response*** | (1 byte) | 21 |
| ***basepix*** | (1 word) | 0..2047 - base pixel address (ignore) |
| ***sumpix*** | (1 word) | sum of pixels (ignore) |
| ***numpix*** | (1 word) | width of laser spot pixels (ignore) |
| ***subpix*** | (1 word) | sub pixel value (ignore) |
| ***current*** | (1 word) | ±⟨sensor range⟩ - position |
| ***scancnt*** | (1 word) | 1..8192 - number of samples |
| ***scanflg*** | (1 word) | 0 = not scanning, 1 = scanning |

**NOTE**: ⟨sensor range⟩ is dependent on the actual mode of operation Refer to 'SET MODE' on page 39. Also see page 26 for description of [base pix], ext.

## Command 20 Read Current Error Status

**Propose** Returns various error and statistic counts.

**Command Format** [command]

| | | |
|---|---|---|
| Command | 1 byte | 20 |

**Response Format** **[*response*][*power*][*reset*][*chkerr*][*cmderr*][*calbrat*][*illopc*]**

| | | |
|---|---|---|
| ***response*** | (1 byte) | 20 |
| ***power*** | (1 word) | # of power up restarts |
| ***reset*** | (1 word) | # of restarts excluding power up |
| ***chkerr*** | (1 word) | # of checksum errors |
| ***cmderr*** | (1 word) | # of command errors from host |
| ***calbrat*** | (1 word) | 5555 Hex = Calibration OK |
| ***illopc*** | (1 word) | # of illegal opcodes |

## Command 27 Read Analog Output Factors

**Purpose** Returns various new factors for analog output.

**Command Format** [command]

| | | |
|---|---|---|
| [command] | 1 byte | 27 |

**Response Format** **[*response*][*Minvolt*][*Minrange*][*Maxvolt*][*Maxrange*][*offset*] [*Out of Range*] [*reserved*][*d/aoutput*]**

| | | |
|---|---|---|
| ***response*** | (1 byte) | 27 |
| ***minvolt*** | (1 word) | 0..9.999 Volts |
| ***minrange*** | (1 word) | ±⟨sensor range⟩ |
| ***maxvolt*** | (1 word) | 0..9.999 Volts |
| ***maxrange*** | (1 word) | ±⟨sensor range⟩ |
| ***offset*** | (1 word) | 0..9.999 Volts |
| ***out of range*** | (1 word) | 0..9.999 Volts |
| ***reserved*** | (4 words) | 0 |
| ***d/aoutput*** | (1 word ) | 0..4095 |

**NOTE**:⟨Sensor Range⟩ is dependent on the actual mode of operation. Refer to 'SET MODE' on page 39.

## Command 30 Read Version Number

**Purpose** Returns internal software version number.

**Command Format** [**command**]

| | | |
|---|---|---|
| ***command*** | (1 byte) | 30 |

**Response Format** **[*response*][*version*][*model*][*reserved*]**

| | | |
|---|---|---|
| ***response*** | (1 byte) | 30 |
| ***version*** | (1 word ) | 0...255 |
| ***model*** | ( 1 word ) | 0...255 |
| ***reserved*** | (2 words ) | 0 |

## Command 32 Read Configuration Variables

**Purpose** Returns laser configuration parameters.

**Command Format** [command]

| | | |
|---|---|---|
| ***command*** | (1 byte) | 32 |

**Response Format** **[*response*][*lasercfg*][*laserpwr*][*interval*][*reserved*]**

| | | |
|---|---|---|
| ***response*** | (1 byte) | 32 |
| ***lasercfg*** | (1 word) | ignore |
| ***laserpwr*** | (1 word) | 0...31744 |
| ***period*** | (2 words) | low word, high word |
| ***reserved*** | (1 word) | 0 |

**NOTE**: For further explanation of each parameter see page 22 "DLS2000A_LR Sensor Settings".

## HIGH SPEED POLLING MODE

### General Description

The DLS2000A_LR sensor is capable of a special mode, which utilizes a high speed transfer protocol enabling range measurement in real time. When the high speed polling command is issued, the sensor changes data transfer protocols. The protocol is a simple one. The sensor expects one of two possible ASCII characters:

| | |
|---|---|
| **P** (50h) | Software encoder pulse. Each time the sensor receives command 50h it responds by sending a range reading (1 word - LSB,MSB) back. The sensor will ignore all other commands until it receives an F (46h). |
| **F** (46h) | Finish high speed poll mode. The sensor changes back to its normal data transfer protocol. |

Using the high speed polling mode the data transfer can maintain the highest sample rate possible (667 Hz) if the baud rate has been changed to 57600 baud.

## Command 35 Put Sensor In High Speed Mode

**PURPOSE** Puts the sensor in high speed polling mode and changes the data transfer protocol.

**Command** ***[command]***

| | | |
|---|---|---|
| ***command*** | (1 byte) | 35 |

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

| | | | |
|---|---|---|---|
| Command | (Byte) | 35 | Success |
| | | 0 | Fail |

**If using ChkSum : None**

**NOTE**: The sensor will stay in the high speed polling mode even if the sensor gets powered down and up again unless the **F** character has been sent.

## 4.6 Command Summary Ordered by Command Number

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
```

## TROUBLESHOOTING

This section will help you with any difficulties you may have in operating the DLS2000A_LR sensor.

The general rule when you encounter any problems with the sensor's performance is to make sure that you have:

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

Make sure the windows are clean, and cables and connectors are checked.

**Behavior**
Laser off. (When the laser is on, a red light appears in the small circular window.)

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

**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_LR uses a visible (red) laser.

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

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 a 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 your 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_LR uses a visible (red) laser.

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

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_LR 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

### List of Agents
### Canada and the United States

Call our offices at 1-604-636-1011 for the agent nearest you, or visit our web site at www.lmint.com

| | | |
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