



SPR-02

Intelligent Single Point Sensor

USER MANUAL



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Version A

This is an operational guide and technical manual that offers guidelines on how to install, configure and operate the DynaVision® SPR-02 Intelligent Single Point Sensor.

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1. Vision Sensor covering the general description, features and specifications.

1.1 DESCRIPTION OF THE DYNAVISON® SPR-02 Sensor

The DynaVision® S-Series Intelligent Vision Sensor is a laser source (Models 6-32, 16- 32, 16-168) non-contact optical displacement sensor for use in industrial applications. The sensor is assembled entirely from solid-state components housed in a rugged, gasketed enclosure. Scanning is accomplished by projecting a continuous light beam onto the surface to be measured and detecting the wave image of this beam on a Charged Coupled Device (CCD) array. The sensor measures the position of an object that is located between 6.0" (152.4 mm) and 168. + " (4267+ mm) from the front surface. The range varies according to the model. DynaVision® S-Series Sensors interface easily to automated systems. A single connector supplies power to the sensor and the communication link between itself and a host computer and 0 to 10 VDC and 4 to 20mA analog signal. Communication with the host computer is via a standard RS-485 serial interface. Commands are issued from the host computer to set parameters and control the sensor. Multiple sensors can be connected to the same serial communication line for a multi-drop configuration. Commands can be either broadcast to all sensors on a multi-drop configuration or sent as individual commands to specific sensors. The 0 to 10 VDC and 4 to 20mA analog range signal can be used by themselves or simultaneously with serial communications.

1.2 GENERAL FEATURES

- 16 bit Analog Devices DSP
- Flash memory for sensor parameters
- High speed RS-485 - serial interface to host
- Multiple Vision Sensors on one multi-drop line
- Rugged Industrial packaging
- Single Power Supply
- Internal Power Regulation
- Range Readings Available in Digital or Analog Formats
- Range readings are available in imperial or metric
- 0 to 10 VDC analog range output
- 4 to 20 mA analog range output

1.3 OPERATIONAL FEATURES AND SPECIFICATIONS

Range	6" to 168" (152.4 to 4267 mm) Actual range is determined by the sensor
Programmable Sample Rate	.60ms
Sample Buffer in	8192 samples (8 Kbytes)

1.3.1 POWER REQUIREMENTS

15-30 VOLTS DC	@500MA
Analog Output	0- 10 VOLTS DC (programmable) 4-20mA (programmable)

1.3.2 COMMUNICATIONS

TYPE	RS-485, FULL DUPLEX
Communications Rates	9600, 19200 , 38400, 57600 baud preset to 57600 baud
Configuration	8 Data Bits, 1 Stop Bit, No Parity

1.3.3 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	NEMA 4 Gasketed Aluminum Enclosure

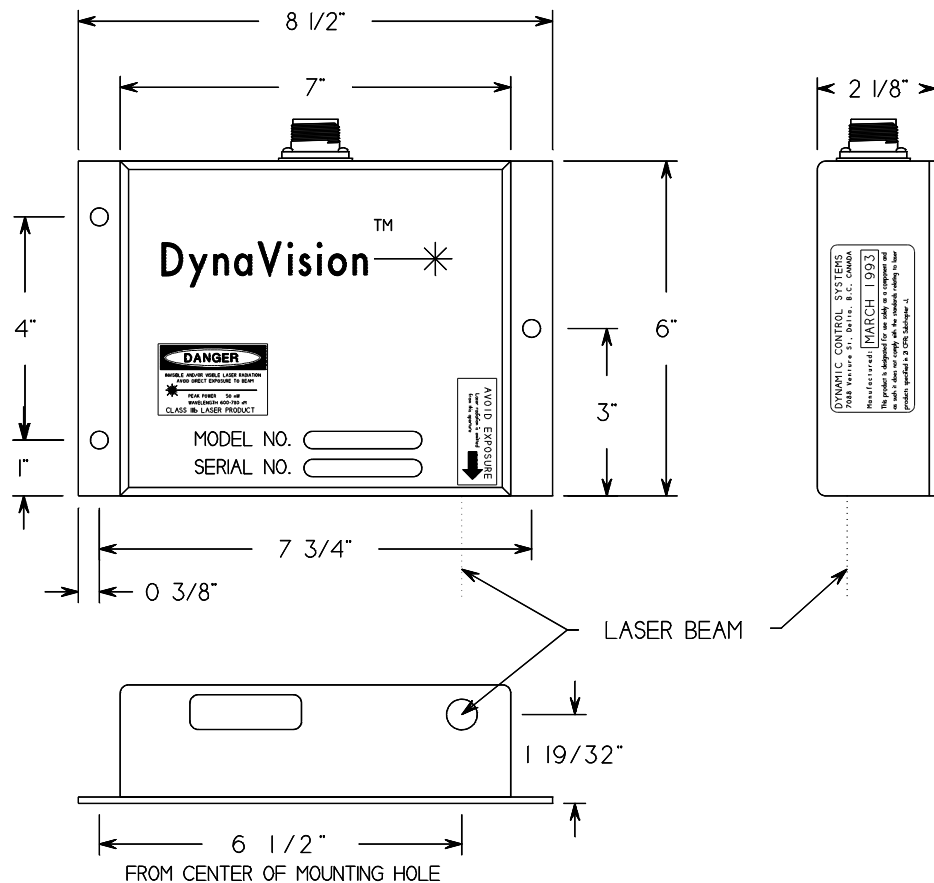
This chapter describes the requirements to install the sensor.

2.1 PACKAGING

Before installation of your sensor, please ensure that all components were shipped in your package. It should contain:

- Sensor
- Manual
- Software diskette
- Cable (cable supplied by LMI is “DEMO CABLE” for testing purposes only)

Visually inspect the sensor. The sensor is a single metal enclosure with a connector on one side and laser and sensor viewing windows on the opposite side. Ensure there is no damage to the enclosure, laser sensor viewing windows, connector or glass. If you notice significant flaws, please contact LMI Technologies Inc.

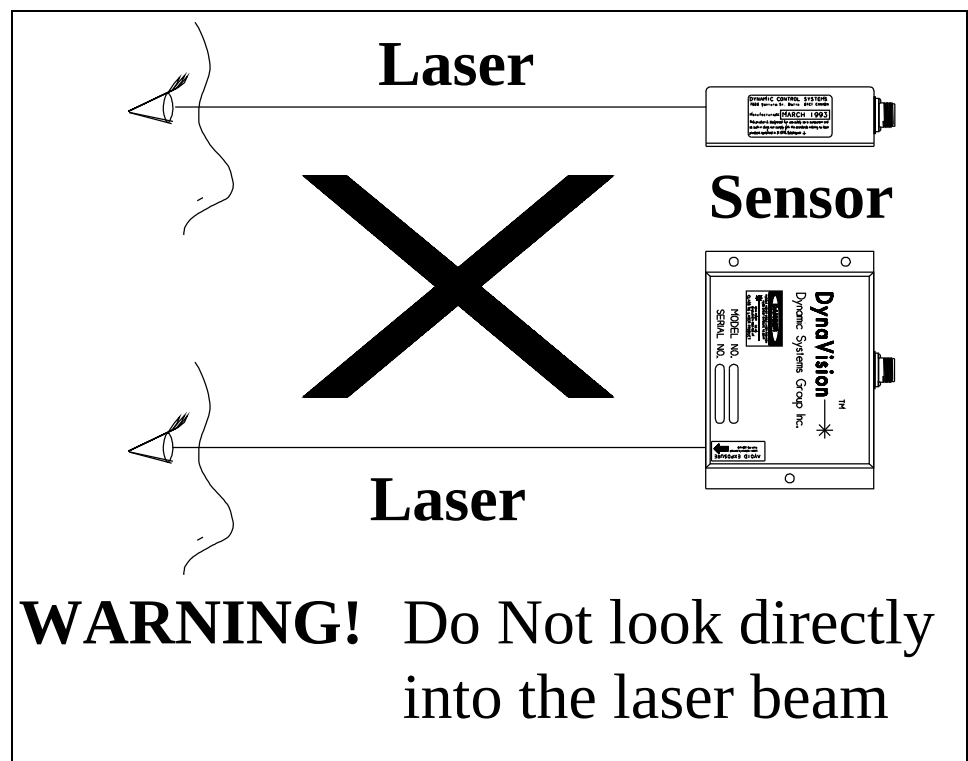


2.2 LASER SAFETY ISSUE

The DynaVision® scanner head uses lasers for measurement.
Specific safety precautions must be taken

Caution! Performance of procedures or controls other than those specified herein may result in hazardous radiation exposure.

WARNING! All SPR-02 sensors (Models 6-32, 16-32, 16-168) are Class III type laser devices. Regardless of the power rating, or visibility of the laser do not view directly, or through a mirror, as it may result in severe damage to the eyes.



2.2.1 OEM SAFETY RESPONSIBILITIES

LMI Technologies Inc. works closely with Original Equipment Manufacturers (OEMs) in achieving certification of their own applications by referencing the report accession number. However, the following precautions should be addressed by the OEM to ensure safety in the operation of laser equipment.

LASER WARNING SIGN FORMAT

Laser warning signs, such as the sample below, must be located in the vicinity of the sensors and clearly visible to operators and other personnel



LASER EMISSION WARNING INDICATORS

As specified by the U.S. Department of Health and Human Services under the Radiation Control for Health and Safety Act of 1968, specifies that single point sensor controls incorporate a visible and 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. If the sensors are mounted some distance from the controls it is recommended that warning indicators are placed at each location. Warning indicators should not be located in areas where personnel could be exposed to laser emissions.

Additionally, U.S. Food and Drug Administration (FDA) standards require that the indicator be clearly visible through protective eyewear designed specifically for the wavelengths of the emitted laser radiation.

BEAM ATTENUATORS

CDRH standards 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.

POWER-ON DELAYS

For Class IIIB laser systems, a delay circuit is required which illuminates the warning indicators on the cabinet and frame for a short period of time (approximately 20 seconds) prior to supplying power to the lasers themselves.

KEYLOCK SWITCH

For Class IIIB laser systems delay circuit is required which illuminates warning indicators on the cabinet and frame for a short period of time (approximately 20 seconds) prior to supplying power to the lasers.

REMOTE INTERLOCK CONNECTOR

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

2.3 MECHANICAL MOUNTING

The sensor enclosure contains built in extensions with mounting holes 5/16" (7.9 mm) diameter – two on one side, one on the other. Refer to the diagram in section 2.1 Packaging, for placement and orientation of the mounting holes.

The sensor enclosure must be securely mounted to ensure measurement accuracy. Any movement or vibration of the sensor relative to the object being measured will result in measurement errors. The mounting surface must be flat to within 0.030" (0.76 mm) between the three mounting points. Standoff washers' 0.125" (3.16 mm) may be used between the mounting surface and the sensor enclosure to ensure proper alignment.

2.3.1 MEASUREMENT RANGE

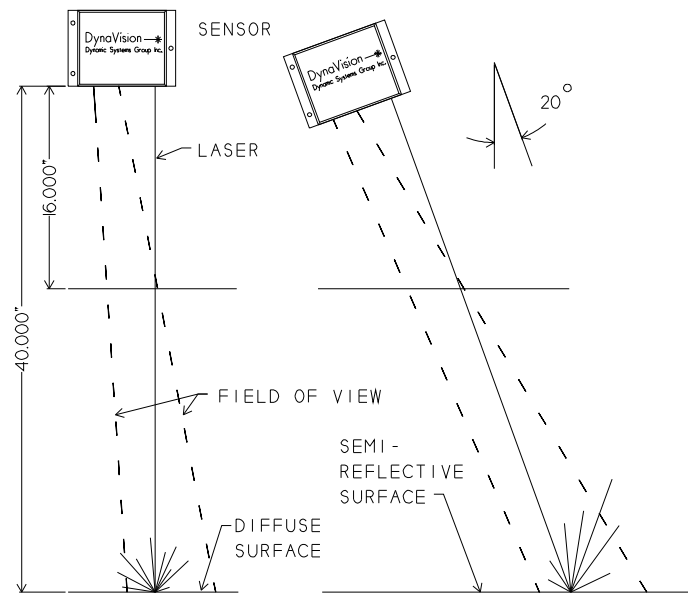
The various SPR-02 sensor units can measure surfaces within ranges from 6.0" (152.4 mm) to 168.0" (4673 mm) from the face of the unit depending on model number. The model number represents standoff and range, e.g. the Model 16-32 has a standoff (start of measurement) of 16" and range of 32". This represents a measurement zone of 16" to 48" from the face of the sensor.

The host can issue a command to set the zero reference point anywhere in the field of view (see 4.3.2. Set Offset/Cosine/Multiplier). For example, if the zero reference is set up for 23.0" (584 mm) from the face of sensor, material that is located 24.5" (622 mm) from the face of the sensor will have a measured distance of 1.5" (38 mm).

2.3.2

ORIENTATION RELATIVE TO OBJECT BEING VIEWED

The light beam is projected perpendicular to the face of the sensor. The reflectivity of the measurement surface affects whether the sensor should be mounted perpendicular to the surface or at an angle. Refer to the following diagram locating the light beam and viewing angles. Highly reflective surfaces may be difficult to measure with the SPR-02 sensors.



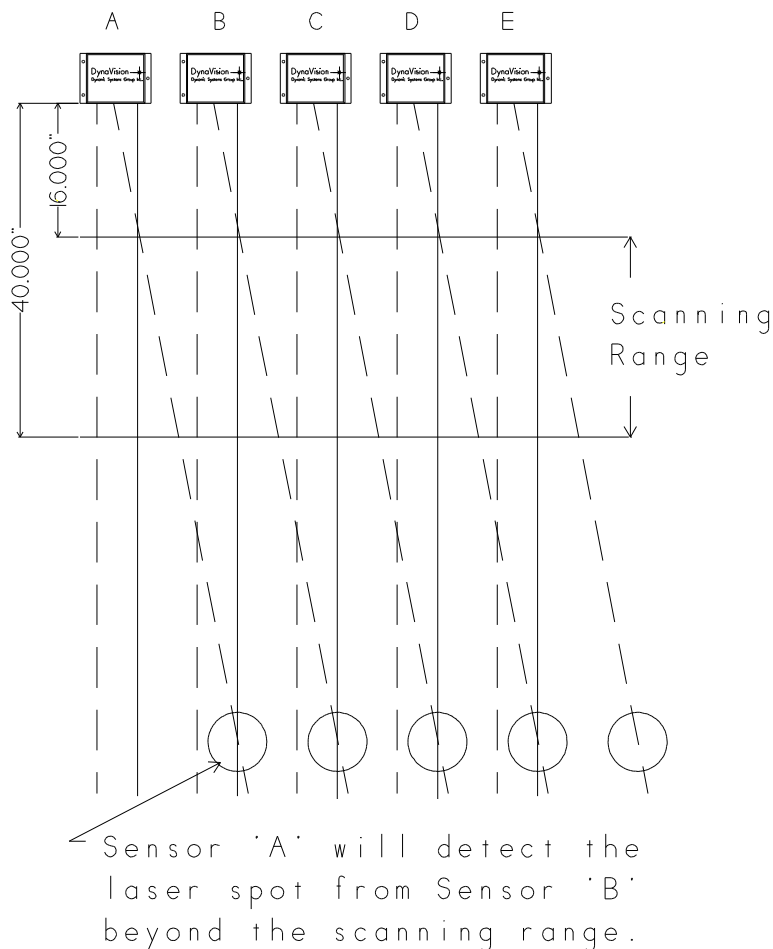
If the surface of the material being measured is **Diffused** the sensor should be mounted so the beam is projected **perpendicular** to the surface.

If the surface of the material being measured is **semi-reflective** then the sensor should be rotated **counter-clockwise** to reduce a direct reflection of the beam back to the sensor detector. A correction angle is then programmed to allow for the beam angle of the sensor. Any angle may be used, but 20° are recommended. If the sensor is mounted at an angle from the surface to be measured, the cosine of the angle is programmed to correct the reading (see 4.3.2 Set Offset/Cosine/Multiplier).

2.3.3

MULTIPLE SENSOR MOUNTING REQUIREMENTS

If more than one sensor is used, care must be taken to avoid projecting the laser spot from one sensor into the field of view of another sensor.

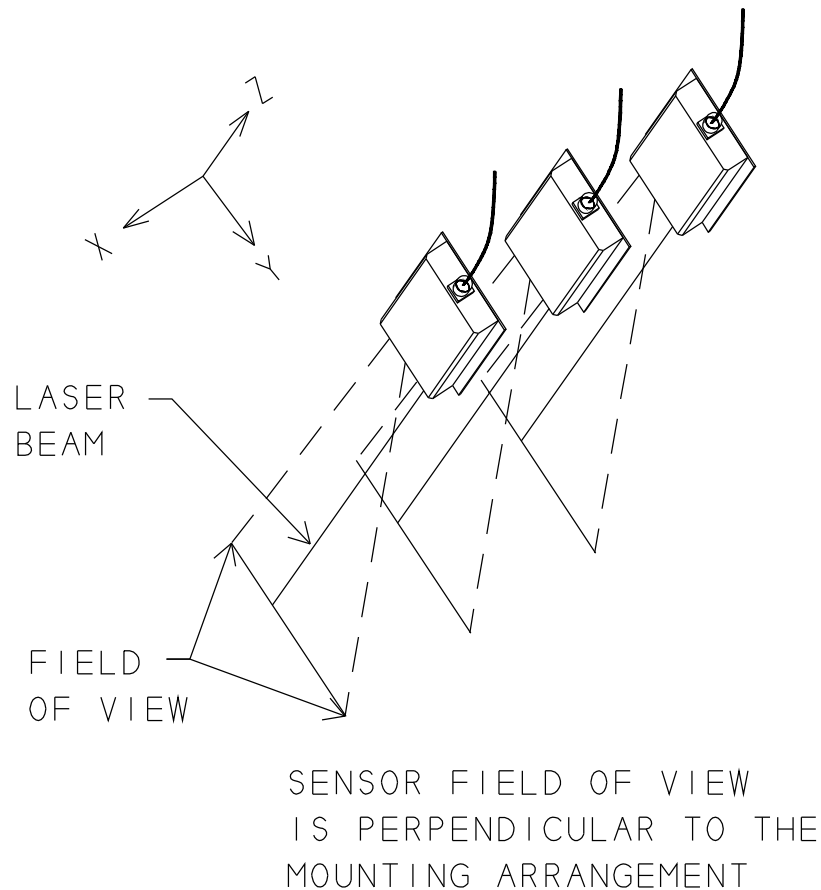


Note: The above illustration applies to the **Model 16-32-5** sensors and may not accurately indicate the overlap areas for sensors of different ranges.

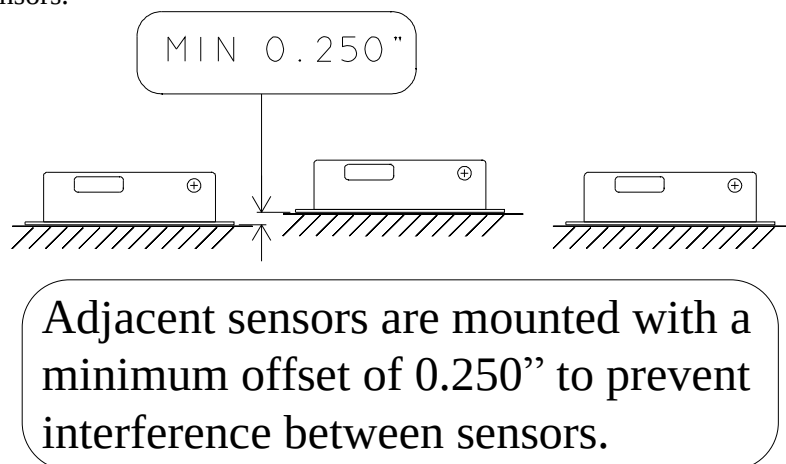
As the distance from the sensor increases the field of view increases. Sensors may detect a laser spot from another sensor beyond the measuring range of 48" (1,210 mm), but due to the angle of detection appear to be within the field of view. Refer to the diagram above.

Two different mounting schemes are recommended to eliminate interference from other lasers:

- Option #1** The plane of the field of view should be perpendicular to the plane of the sensors. Refer to the following diagram:



- Option #2** The vertical mounting position of the adjacent sensors could be offset to alter the field of view. Adjacent sensors should be offset from each other by 0.250" (6.4mm) or greater, according to the diagram below. The host system should align the data from the sensors.



2.4 CONNECTOR AND INTERFACE REQUIREMENTS

The connector contains the power, power ground analog signal, analog ground, RS-485 serial input and RS-485 serial output signals for the sensor.

WARNING: Always turn the power OFF before installing or removing the connector, otherwise damage may occur.

2.4.1 CONNECTOR TYPE AND MANUFACTURERS

The sensor has a 10-pin male connector manufactured by Amphenol, ITT Cannon, (Part Number MS-3102E18-IP). The mating 10-pin female cable connector is manufactured by Amphenol, ITT Cannon, (Part MS-3106E18-IS) with cable clamp, (Part number 97-3057-1010).

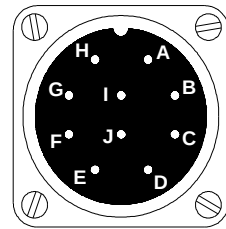
2.4.2

SENSOR CONNECTOR

PIN OUT

There is an alignment tab in the connector housing to ensure correct orientation of the mating ends of the connectors. No other connector configuration or type should be used with this sensor. 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
A	Rx- (Receive)
B	Rx+ (Receive)
C	Gnd (Signal)
D	Tx- (Transmit)
E	Tx+ (Transmit)
F	Gnd (Power)
G	Analog Out (Gnd)
H	Analog Out (0-10 VDC)
I	Analog Out (4-20mA)
J	+15 to 30 VDC @ 500 mA



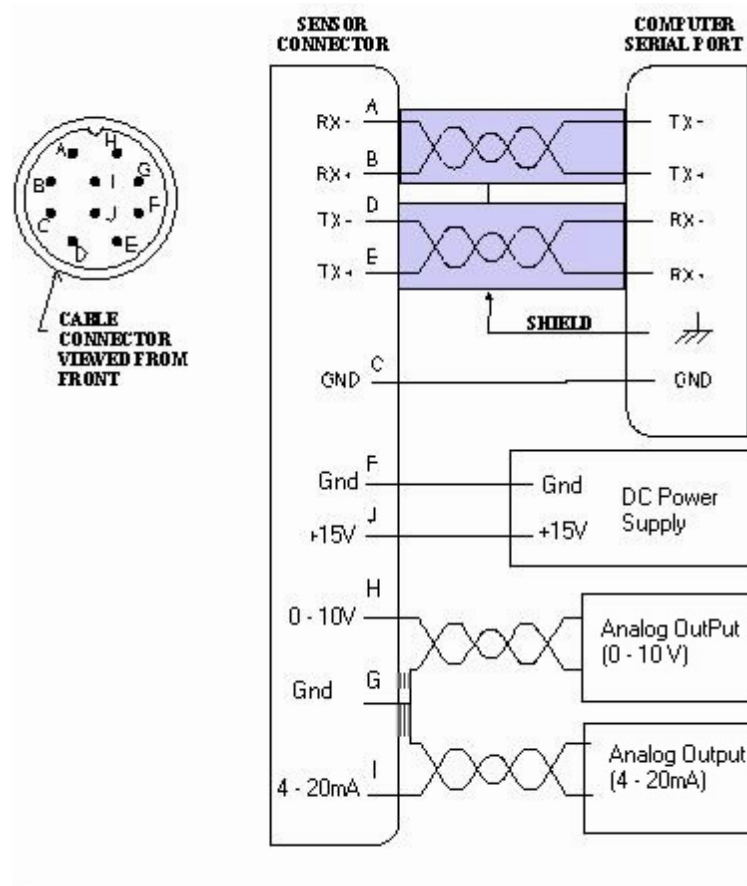
2.4.3

CABLE FOR RS-485

It is recommended that Belden Cable type 8777 (or equivalent) be used as the RS-485 connection to the host.

2.4.4 CABLE CONNECTOR PIN OUT

The signals use shielded twisted pairs as follows:



NOTE: A terminating resistor (220 ohm) should be installed on the end unit across TX-, TX+ and across RX-, RX+ to reduce noise.

WARNING: DEMO Cable supplied by LMI communicates via RS232 protocol and has to be used for testing purposes only.

It is not recommended this cable to be used for final operation, because it is not manufactured to communicate via RS 485 protocol.

2.4.5 CABLE POWER REQUIREMENTS

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.

2.5 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 or use a high pressure spray to clean.

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

2.5.1 MECHANICAL

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

2.5.2 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.

Commercial glass cleaners should not be used; many have chemicals that leave a residue on the glass, which can affect optical performance.

2.5.3 AIR PURGE SYSTEMS

In very dirty environments, where free-floating particles are present, it is advised that a positive air pressure systems 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.

3.1 GENERAL OVERVIEW

All communication between the host computer and the sensor is via an RS-485 serial interface. This interface is designed to be utilized with a single sensor or with multiple sensors. All commands are initiated from the host computer to the sensor, with the sensor responding to the commands. Command 35 is an exception. It puts the sensor in a special mode which allows a high speed data transfer. Refer to chapter 4.5.

3.2 RS-485 HARDWARE SPECIFICATIONS

This section describes the operation of the RS-485 serial interface.

3.2.1 INTERCONNECT SPECIFICATION

Serial communication is accomplished using RS-485 differential drivers with one input and one output port.

The RS-485 serial input and output ports must be configured as followed:

- Asynchronous
- 9600, 19200, 38400, 57600 baud to match the sensors.
- 8 Data Bits
- One Stop Bit
- No Parity

3.2.2 MULTIDROP SPECIFICATION

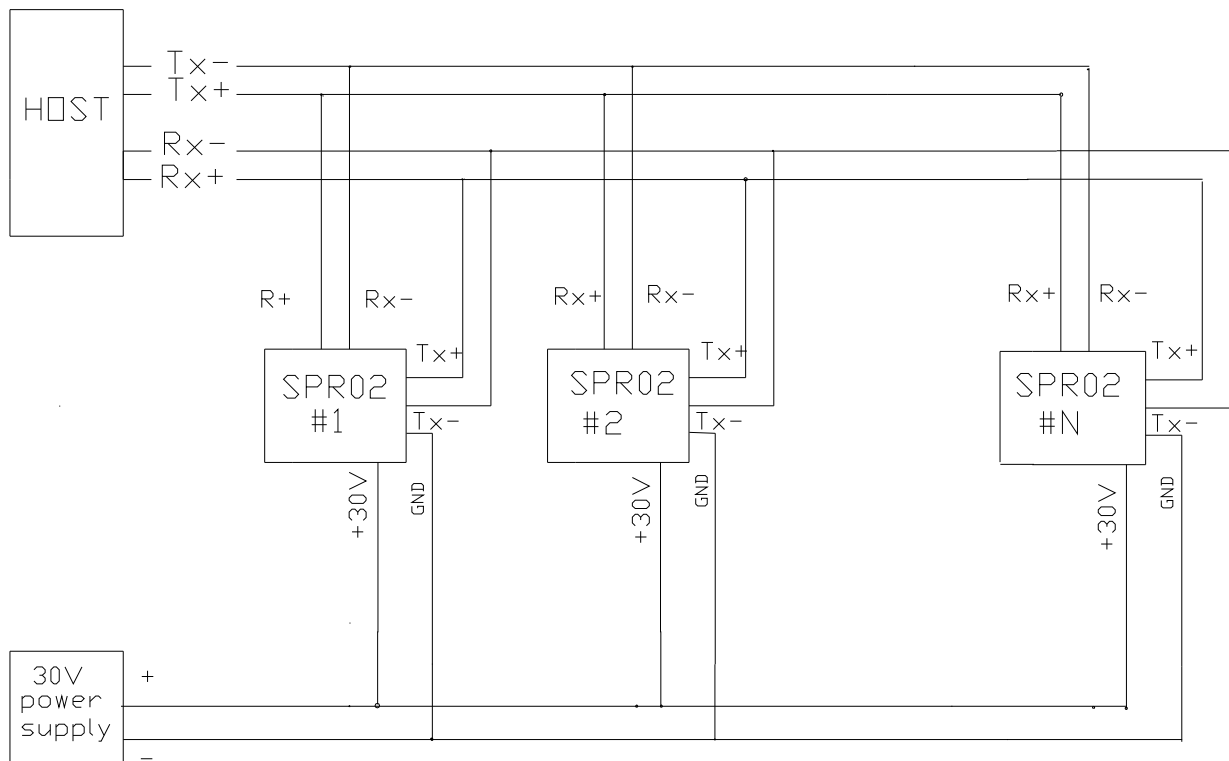
Up to 255 sensors can be addressed on one serial interface from the host.

The serial transmitters from the sensor to the host are tri-stated and are normally off (high impedance) until the host requests data from the sensor.

Some commands to the sensor are **broadcast** to all sensors connected to a serial line. A broadcast command does not require a response from any of the sensors and therefore all sensor transmitters will remain tri-stated.

Some commands are addressed to a specific sensor which will cause only that sensor to respond. The sensor addressed will remain on-line (output driver on) until either a broadcast command has been issued from the host or another sensor has been addressed at which time the new sensor will become active and the previous one will be tri-stated.

The following is a wiring diagram example for multidrop sensors.



Notes: Ensure voltage at sensors are maintained between 15V and 30V. Use sense wires on power supplies if long distances are involved.

A terminating resistor (120 ohm) should be installed on the end unit across TX-, TX+ and across RX-, RX+ to reduce noise.

3.3 **PROTOCOL**

This section describes the contents of the packet used to transmit commands and data from the host to the sensor and from the sensor to the host.

3.3.1 **GENERAL PACKET PROTOCOL**

The software protocol that occurs via the asynchronous RS-485 serial communication link describes the packet or group of information that is transmitted and generally will consist of an address, command, optional data and checksum or CRC.

3.3.2 **PACKET DESCRIPTION**

The packet consists of a contiguous series of bytes with the same format being used to transmit from the host to the sensor and from the sensor to the host.

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]

<i>[STX]</i>	1 byte	Start transmission character (02h)
<i>[Address]</i>	1 byte	0 broadcast to all sensors. 1..255 addressing a specific sensor.
Note: This byte identifies the sender when received by the host.		
<i>[CommandSize]</i>	1 byte	Number of bytes from command to the last data byte. Maximum 255.
<i>[Command]</i>	1 byte	1..255 See command descriptions.
<i>[Data..Data]</i>	N byte	Number of bytes is command dependent.
<i>[Checksum]</i>	1 byte	2s Complement sum of all bytes inclusive of STX and last data byte.

OR

<i>[CRC]</i>	2 byte	16 bit CRC of all bytes inclusive of STX and last data byte
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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)	

Lets 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 t 15 (\$000F);

Smooth to 75 (\$004B) and Order to 5 (\$0005)

SENSOR COMMANDS AND RESPONSES

$\$02 + \$01 + \$07 + \$0E + \$0F + \$00 + \$4B + \$00 + \$05 + \$00 + \$89$

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 46 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 send first.

Decimal points are assumed, depending on data content and mode in which sensor is set. I.e. if the data expected were in inches then 12345 would represent 12.345". If the data expected is in millimeters then 12345 would represent 1234.5 mm.

Some of the commands also require ASCII characters:

Byte: 8 bit ASCII

3.4 ERROR HANDLING

This section describes the error handling of the serial communications at both the sensor and the host.

3.4.1 SENSOR AND HOST ERROR HANDLING

Sensor Error Handling

All packets transmitted to the sensor contains a Checksum or CRC as the last bytes.

The checksum is the 2s complement of the sum of all previous bytes sent in the packet starting with the "STX" character and ending with the last data byte. As the sensor receives the packet it sums all the bytes. The last operation of summing the checksum will result in a zero value. If a non-zero result is obtained the data packet received was incorrect and will not be used.

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.

Host Error Handling

The host utilized checksum or CRC values in the same manner as the sensor, following the same time out sequences.

3.5

RE-SYNCHRONIZING

TIMING

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

The "STX", Start Transmission Character, which initiates transmission of a data packet, can occur a second time within the packet as part of the command or data set. To prevent the host or sensor from misinterpreting a duplicated STX character, a mechanism has been devised to differentiate between a genuine start of transmission and STX binary value within the data packet.

3.5.1 **SENSOR**

Upon receipt of a legitimate "STX" start transmission character the sensor will allow a maximum of 50ms for the next byte to be transmitted from the host. Any STX character received before a legitimate end of command, will be considered part of the command data set. If the transmission time between two bytes exceeds 50ms the sensor will abort the command and start looking for another STX character.

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

3.5.2 **HOST**

The host allows a 200ms transmission time for the data packet from the sensor. Similarly, if this time is exceeded, the host will abort the command and await a further STX character.

Resynchronization is achieved after a 200ms delay as noted above.

4. SENSOR COMMANDS AND RESPONSE

4.1 GENERAL OVERVIEW

The SPR-02 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 consists of a 1 byte command value 1..255 and a number of bytes or words.

4.1.1	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.

4.1.2

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.

4.2

SCANNING COMMANDS

4.2.1

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

4.2.2

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

SENSOR COMMANDS AND RESPONSES

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 Succes
0 Fail

If using ChkSum: None

NOTE: The maximum number of samples that can be stored is 8192 (8 Kbytes), The buffer wold 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.

4.2.3 Command 04 Stop Scan

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

Command Format: [*command*]

command (1 byte) 04

Response: None

4.2.4 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 Succes
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.:

$$\text{Newsample} = (\text{average} * \text{smooth}\%) + (\text{original sample} * (100\% - \text{smooth}\%))$$

If smooth is 0 then no smoothing takes place.

4.2.5	Command PURPOSE	15 Filter Scan Buffer 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 Succes 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.

4.2.6	COMMAND	10	READ HIGH / LOW / AVERAGE OF SCAN
	PURPOSE	Obtain the High/Low and Average values of the readings contained in the scan buffer.	
	Command Format	[COMMAND]	
		<i>command</i>	(1 byte) 10
	Response Format	[<i>response</i>][<i>high value</i>][<i>high scan #</i>][<i>low value</i>][<i>low scan #</i>][<i>average</i>]	
		<i>response</i>	(1 byte) 10
		<i>high value</i>	(1 word) $\pm$ $\langle$ sensor range $\rangle$
		<i>high scan#</i>	(1 word) 1..8192
		<i>low value</i>	(1 word) $\pm$ $\langle$ sensor range $\rangle$
		<i>low scan#</i>	(1 word) 1..8192
		<i>average</i>	(1 word) $\pm$ $\langle$ sensor range $\rangle$
	NOTE: $\langle$ Sensor Range $\rangle$ is dependent on the actual mode of operation. Refer to chapter 4.3.1. 'SET MODE'.		

4.2.7	COMMAND	11	READ SCAN BUFFER
	PURPOSE	Obtains the contents of a specified portion, or the entire scan buffer. Between 1..66 packets are sent containing scan data. Each packet contains up to 126 samples.	
	Command Format	[<i>command</i>] [<i>start scan index</i>][<i>scans to read</i>]	

<i>command</i>	(1 byte)	11
<i>start scan index</i>	(1 word)	1..8192
<i>scans to read</i>	(1 word)	1..8192

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

<i>response</i>	(1 byte)	11
<i>sequence #</i>	(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.
<i>scan data</i>	(1..126 Words)	Always 126 except for last packet (sequence# = 1).

NOTE: The (see section 4.4.3 Read Current Sensor Status) command should be issued by the host to determine how many samples are in the buffer before reading it. 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.

SENSOR COMMANDS AND RESPONSES

4.3 SET MODE/OPERATION COMMANDS

4.3.1 COMMAND 09 SET MODE

PURPOSE

Set 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]

<i>command</i>	(1 byte)	09		
<i>mode</i>	(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

4.3.2 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]

<i>command</i>	(1 byte)	08
<i>offset</i>	(1 word)	± <sensor range>
<i>cosine</i>	(1 word)	0.0000 - 1.0000 cosine of mounting angle
<i>multiplier</i>	(1 word)	0.0000- 10.000
<i>cosoffset2</i>	(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 chapter 4.3.1. 'SET MODE'.

4.3.3 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 (see section 2.1 Packaging).

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

4.3.4

COMMAND PURPOSE

26

SET ANALOG OUTPUT FACTORS

Set 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*]

<i>command</i>	(1 byte)	26
<i>minvolt</i>	(1 word)	0..9.999 Volts
<i>minrange</i>	(1 word)	±(sensor range)
<i>maxvolt</i>	(1 word)	0..9.999 Volts
<i>maxrange</i>	(1 word)	±(sensor range)
<i>offset</i>	(1 word)	0..9.999 Volts
<i>out of range</i>	(1 word)	0..9.999 Volts
<i>reserved</i>	(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 section 4.3.1. SET MODE. For further explanation of each parameter see chapter 7.3.2. Change Sensor Parameters.

4.3.5

COMMAND

33

SET CONFIGURATION VARIABLES

PURPOSE

Sets laser power and sample interval.

Command Format

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

<i>command</i>	(1 byte)	33
<i>lasercfg</i>	(1 word)	Reserved
<i>laserpwr</i>	(1 word)	0...31744
<i>period</i>	(2 words)	low word, high word [60, 120,180] (x 0.01ms)
<i>reserved</i>	(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 section 7.3.2. Change Sensor Parameters.

4.3.6 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)

4.3.7 Command 77 SET ERROR CHENGING 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

4.3.8 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

4.3.9 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)

4.3.10 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)	

4.3.11 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 sensor to streaming data mode, sensor is continuously sends out range values until host sends any character (byte) to the sensor to end the streaming 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	Stop the sensor from streaming data mode.
----------------	---

Command Format:	[command]
------------------------	------------------

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

4.4 **READ CURRENT
VALUES**

4.4.1 **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 chapter 4.3.1. SET MODE.

4.4.2 **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]**

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

NOTE: <Sensor Range> is dependent on the actual mode of operation. Refer to section 4.3.1. SET MODE.

4.4.3

COMMAND Purpose

21 READ CURRENT SENSOR STATUS
Returns a variety of values relatins to current sensor status.

Command Format

[command]

[command] 1 byte 21

ResponseFormat

[response][basepix][sumpix][numpix][subpix][current][scancnt][scanflg]

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

NOTE: <sensor range> is dependent on the actual mode of operation. Refer to chapter 4.3.1. 'SET MODE'. Also see section 7.3.2.5 for description of [base pix], ext.

SENSOR COMMANDS AND RESPONSES

4.4.4	COMMAND	20	READ CURRENT ERROR STATUS
	Purpose	Returns various error and statistic counts.	
	Command Format	[command]	
		Command	1 byte 20
	Response Format	[response][power][reset][chkerr][cmderr][calbrat][illopc]	
	<i>response</i>	(1 byte)	20
	<i>power</i>	(1 word)	# of power up restarts
	<i>reset</i>	(1 word)	# of restarts excluding power up
	<i>chkerr</i>	(1 word)	# of checksum errors
	<i>cmderr</i>	(1 word)	# of command errors from host
	<i>calbrat</i>	(1 word)	5555 Hex = Calibration OK
	<i>illopc</i>	(1 word)	# of illegal opcodes

4.4.5	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]	
	<i>response</i>	(1 byte)	27
	<i>minvolt</i>	(1 word)	0..9.999 Volts
	<i>minrange</i>	(1 word)	±(sensor range)
	<i>maxvolt</i>	(1 word)	0..9.999 Volts
	<i>maxrange</i>	(1 word)	±(sensor range)
	<i>offset</i>	(1 word)	0..9.999 Volts
	<i>out of range</i>	(1 word)	0..9.999 Volts
	<i>reserved</i>	(4 words)	0
	<i>d/aoutput</i>	(1 word)	0..4095

NOTE: (Sensor Range) is dependent on the actual mode of operation.
Refer to Section 4.3.1 Set Mode

4.4.6

COMMAND	30	READ VERSION NUMBER	
Purpose	Returns internal software version number.		
Command Format	[command]		
	<i>command</i>	(1 byte)	30
Response Format	[response][version][model][reserved]		
	<i>response</i>	(1 byte)	30
	<i>version</i>	(1 word)	0...255
	<i>model</i>	(1 word)	0...255
	<i>reserved</i>	(2 words)	0

4.4.7

COMMAND	32	READ CONFIGURATION VARIABLES	
Purpose	Returns laser configuration parameters.		
Command Format	[command]		
	<i>command</i>	(1 byte)	32
Response Format	[response][lasercfg][laserpwr][interval][reserved]		
	<i>response</i>	(1 byte)	32
	<i>lasercfg</i>	(1 word)	ignore
	<i>laserpwr</i>	(1 word)	0...31744
	<i>period</i>	(2 words)	low word,high word
	<i>reserved</i>	(1 word)	0

NOTE: For further explanation of each parameter see chapter 7.3.2. 'Change Sensor Parameters'.

4.5 HIGH SPEED POLLING MODE

4.5.1 GENERAL DESCRIPTION

The SPR-02 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 potocol 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.

SENSOR COMMANDS AND RESPONSES

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.

4.5.2	COMMAND	35	PUT SENSOR IN HIGH SPEED MODE		
	Purpose	Puts the sensor in high speed polling mode and changes the data transfer protocol.			
	Command	<i>[command]</i>			
		<i>command</i>	(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

Command	Descripton
01	Laser On
02	Laser Off
03	Start Scan
04	Stop Scan
05	Set Scan Interval
08	Set Offset
09	Set Mode
10	Read/Low/Average of Scan
11	Read Scan Buffer
12	Read Current Position
14	Set Scan Filter Factors
15	Filter Scan Buffer
18	Set Address
19	Read Current Sensor Setup
20	Read Current Error Status
21	Read Current Sensor Status
26	Set Analog Output Factors
27	Read Analog Output Factors
30	Read Version Number
32	Read Configuration Variables
33	Set Configuration Variables
35	Put Sensor in High Speed Mode
66	Set To Defaults
77	CRC/Checksum mode
82	Write Threshold
83	Set Maximum Laser Power
84	Set Minimum Laser Power
92	Set Sensors Baud Rate
129	Get Maaximum Laser Power
130	Get Minimum Laser Power
131	Get Threshold
134	Start Streaming
135	Get Baud Rate of the sensor
147	End Streaming

5. TROUBLESHOOTING

This section will help you with any difficulties you may have in operating the SPR-04 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)

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

1. Connect the offending sensor by itself (see previous) to see if it operates correctly in a non multi-drop environment.
2. Check the analogue output with an instrument capable of measuring DC voltage from 0 to 10.
3. 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 or cabling is incorrect.
4. If the sensor behaves correctly in Step #1 and #3, the problem may be that the sensor address is not unique, or it is set to 0.
5. Be sure you are using an RS-232 to RS-485 converter.
6. Check that the wiring of the multi-drop configuration is correct (See Serial Connections).
7. Check that the sensor addresses you are sending are correct. Use the utility program SETUPSP2.EXE to reset any invalid sensor addresses.

5.2 **Data appears erratic or jumpy**

- Check for long runs of wire to sensor (excessive wire length can induce electronic noise).
- Check for unshielded wires to sensor.
- Check for 'voltage' or 'noise' generators near wiring to sensor.

**5.3 Data is not as accurate
 as expected**

- Check for sources of electronic noise (see above).
- Average data in head or in software.
- Make sure target is not highly reflective or black. Optical sensors require diffused light to reflect back to the sensor, too much or too little can cause sensor to be unable to read surfaces correctly.

6. PSEUDO CODE

6.1 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
```

6.1.1 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
                ENDIF
            ENDIF
        ENDIF
    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
        CRCErrror = 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
```


7 PC DEMO HARDWARE AND SOFTWARE

7.1 Purpose To test/demonstrate a single DynaVision® S-Series Sensor.

7.2 Interface Cable	Connector on SPR-02	Connector on IBM-AT Serial (9 pin connector)	DB25-FEM (25 Pin connector)
Cable B			
	RX-A white	3 TX	3
	GND C black	5 GND	7
	TX-D green	2 RX	2
		4	4
		6	5
		8	
		9	6
			8
			20

Cable A

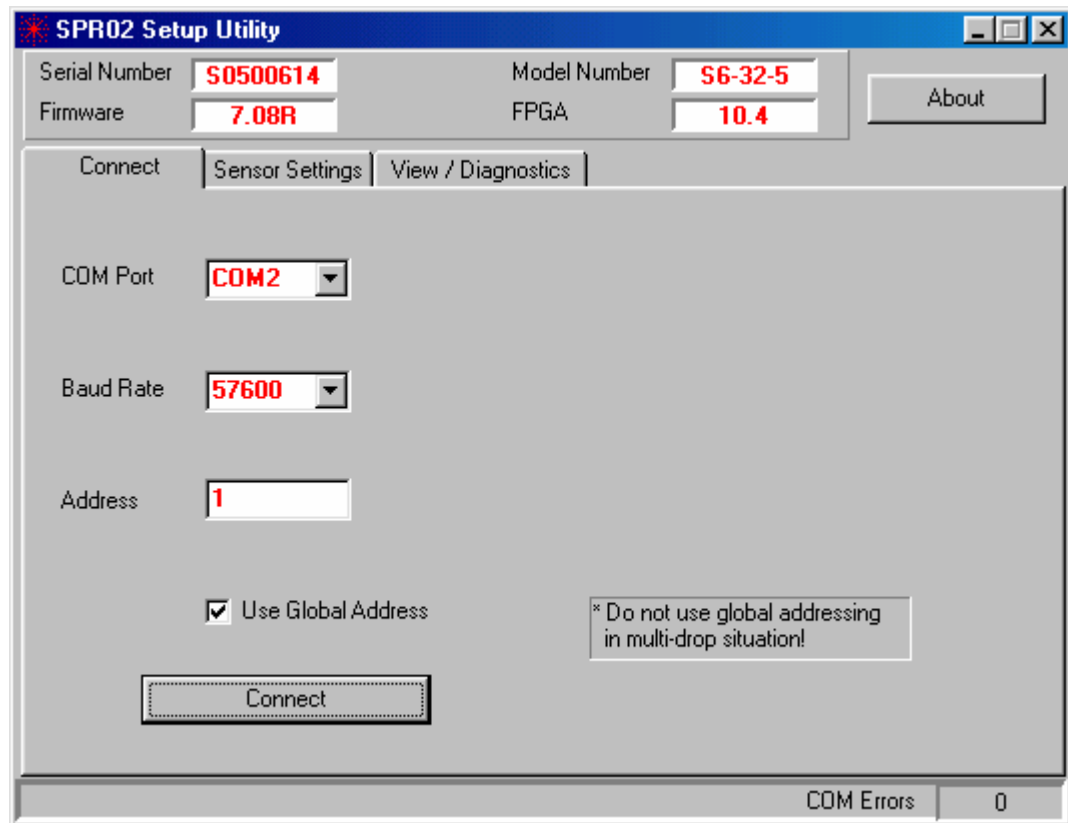
F	Black	Power GND
J	red	+ 15V ÷ +30V

Cable C

H	white	Analog 0-10 VDC Output
G	black	Analog GND
I		Analog 4 – 20 mA Output

7.3 USING SPR02 SETUP UTILITY Setup software is provided as a convenient method to test/setup the sensor using an IBM/PC/AT or equivalent, with Windows95/98 or Windows NT

7.3.1 Connecting To The Sensor



Select the proper Comm Port, Baud Rate and the unit address and click on “**Connect**”. If the unit address is not known, check the “**Use Global Address**” option.

Note: Do not use “Use Global Address” option in multidrop configuration. All sensors have default address of 1. In case of multidrop configuration, ensure that each sensor has been assigned a unique address before being placed on single multidrop line.

7.3.2 Changing/Viewing Sensor Parameters

7.3.2.1. View/Edit Sensor Settings:

Serial Number The serial number shown in this box is the same as stamped (or attached) on the top of the sensor enclosure. It is used for identification purposes and cannot be changed.

Firmware This is the Firmware version of the sensor. It is 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 multidrop line. Each sensor must have a different address.

To change the address of the sensor, enter new address and click on “Address” button.

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

Model Number	This is the sensor's model number (Factory Programmed).
FPGA	This is the FPGA version of the sensors. It is factory programmed and cannot be changed.
Baud Rate	This is the sensor's Baud Rate that it uses to communicate to the Host. To change Baud rate select the Baud Rate from the list and click on "Baud" button. The available rates are 9600, 19200, 38400 and 57600.
Set Sensor 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 Sensor Mode" button.
Cosine Offset	'Cosine' is the cosine of the mounting angle of the sensor. To change the cosine of the mounting angle, enter the new value in the edit box and click on the "Set Offsets" button. This value is always set to 1.0000 if the sensor is mounted perpendicular to the surface being measured. If the surface is more reflective, better results are achieved if the sensor is mounted 20° from perpendicular. Any angle can be used, but 20° is recommended. To compensate for ranging at an angle, the cosine of the mounting angle must be entered here. It is always a number less than 1. For example, the cosine of 20° is 0.9397. Incorrect settings may cause sensor to give false readings, or no readings.
Range offset	This item sets an offset 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 Offsets" button. This value is metric or inches, depending on the mode. This setting is very useful when mounting requires an adjusted zero point.

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 Offsets” button.
Min/Max Laser Power	Min/Max Laser Power settings refer to the Off time for the laser. Higher these values are lower the laser power will be. For example, if Min laser power is set to 200 and Max laser power is set to 20, the laser power will be auto-adjusted between $21.6\%[(255-200/255)*100\%]$ and $92.1\%[(255-20)/255*100\%]$ depending on the target. To change these value, enter the new values in the edit box and click on the proper “Min or Max ” button.
Threshold	The THRESHOLD is used to subtract the background light from the CCD array output. Recommended value is 48. If the THRESHOLD is too small ambient light will be interpreted as a laser spot and will cause erroneous readings by the sensor. To change this value, enter the new value in the edit box and click on the “Threshold”button.
Edit Offset Voltage	This item allows for a voltage offset in the output data.
Min Range	Editing this item changes the digital to analog minimum range, which affects two things. First, any reading less than this value, will output the “out of range” voltage (‘Out @ O/R’). Second, the “minimum voltage” (‘Volt @ Min’) will be output at exactly this range.
Maximum Range	Editing this item changes the digital to analog maximum range which affects two things. First, any readings greater than this value, will output the “out of range” voltage (‘Out @ O/R’). Second, the maximum voltage (‘Volt @ Max’) will be output at this range.
Voltage @ Minimum	This item specifies the voltage to be output at the analog terminal when a reading is made by the sensor. This allows “digital to analog minimum voltage” to be changed. This is the output voltage when the range is at the D/A minimum range. The settings are from 0 to 9.999 V.
Voltage @ Maximum	Editing this item changes the digital to analog maximum voltage. This is the output voltage when the range is at the D/A maximum range. The settings are from 0 to 9.999 V
Out Of Range Voltage	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 9.999 V.

Note: Generally the voltage range defined from ‘Volt @ Min’ to ‘Volt @ Max’ is spread over the range defined from ‘Min Out’ to ‘Max Out’. If the standard(metric/Imperial) is

changed, it is important to pay attention to the D/A range values, and to redefine them.

Error Checking Error checking method used by sensor to communicate with the Host: Checksum(Default) or CRC.
To change select the method from the list and click on “Error Checking” button.

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

Dropout Factor To change the dropout factor, edit the value and Click on “Set Scan 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.

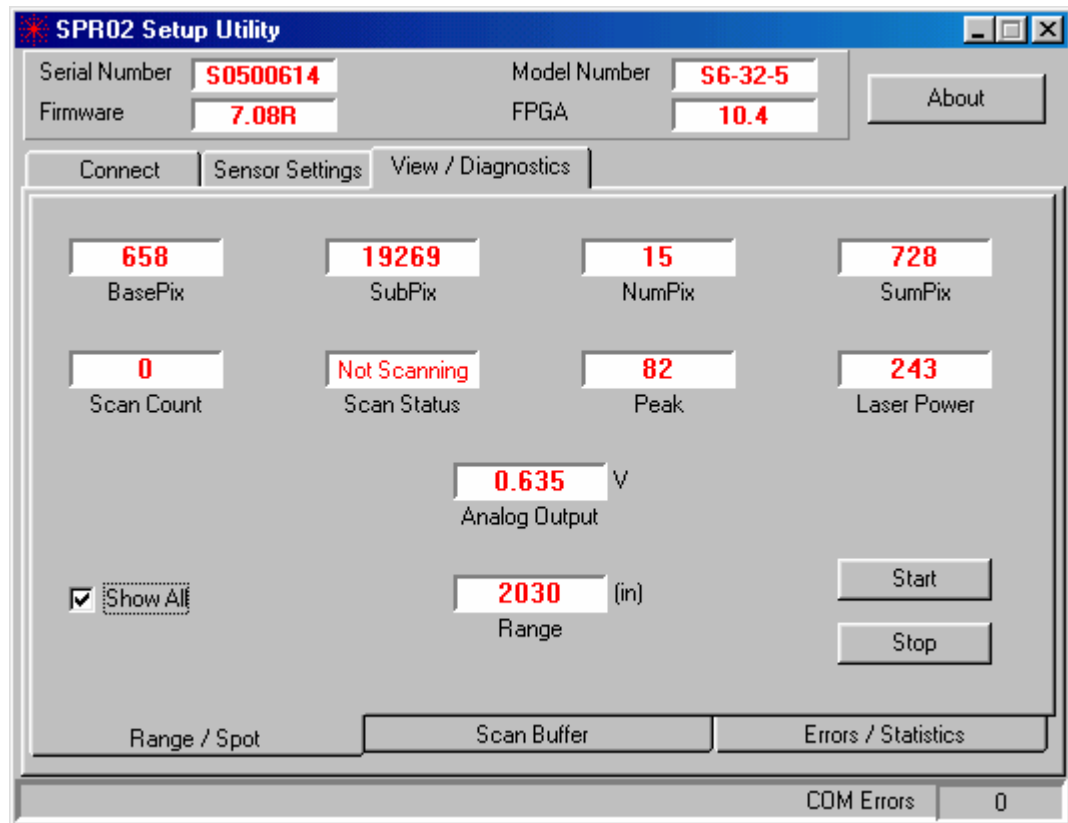
Order Factor	To change the order factor, edit the value and Click on “Set Scan Variables”. This item is used by the moving average filter and the smooth factor. This number is the number of samples that are averaged, centered around the sample being filtered. It must be odd and between 1 and 19. (i.e. 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 being filtered to be used in the average calculation.)
Smooth Factor	This item modifies the smooth factor used by the scan buffer filter programs. This factor, along with the order factor are 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 Scan Variables”.

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 Scan Variables”.
Set 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 200 readings 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 “Set Averaging Period” button.
Laser On	Turns Laser ON – turns laser ON with –1 option (see command 01)
Laser Off	Turns Laser OFF.
Set Sensor To Defaults	Sets all sensor parameters to defaults.

7.3.2.2. View/Diagnostics_Range/Spot



All of the items in this display used for diagnostic purposes, and serve to alert technicians to the operation status of the sensor.

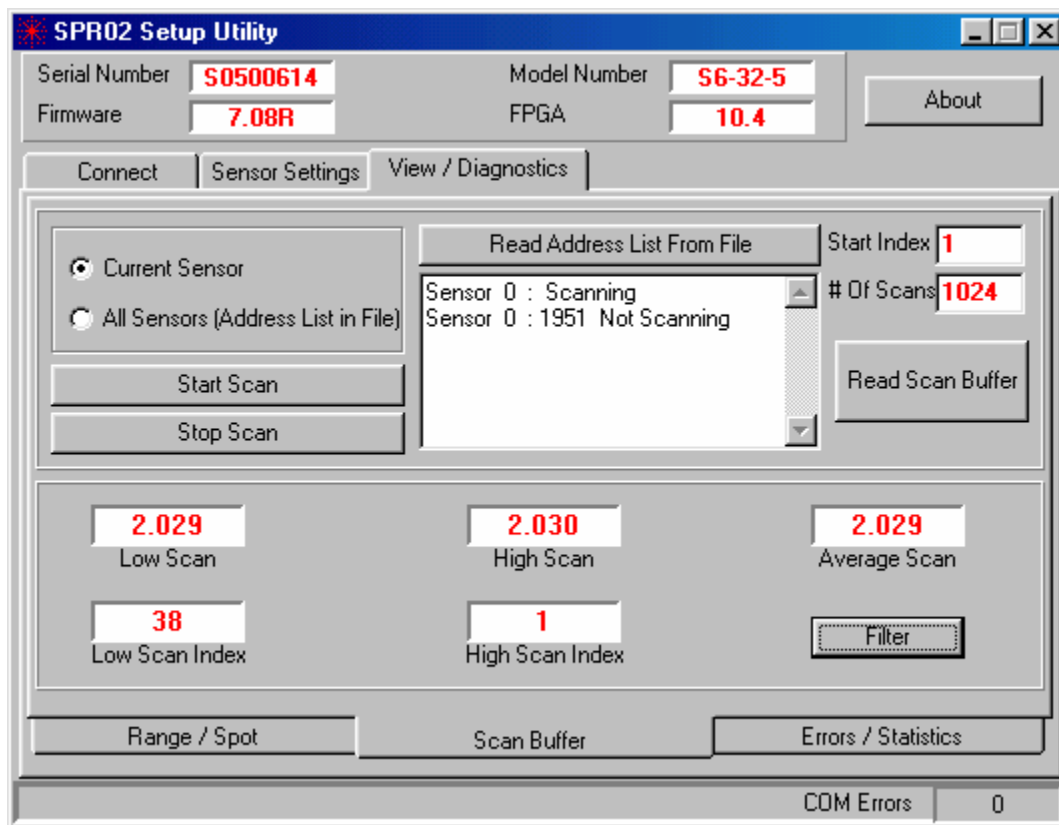
- ‘**BasePix**’ references where on the camera array the spot is falling.
- ‘**NumPix**’ is the number of pixels wide the light spot is on the camera.
- ‘**SumPix**’ is the total area covered by the spot, showing technicians the shape of the light spot.
- ‘**SubPix**’ is the number of pixels seen by the camera, broken up into sub divisions.
- ‘**PeakPix**’ is the highest pixel of the spot.
- ‘**Laser Power**’ is the actual(current) laser power of the sensor.
- ‘**Scan Status**’ indicates if the internal scan buffer is On or Off.

- **‘Scan Count’** refers to the number of samples in the scan buffer.

Continuous range reading (both Analog and Digital) can be viewed by clicking on **”Start”** button. **“Stop”** button will stop the Continuous display.

If **“ Show All ”** is not ‘Checked’ then only “Range” reading is displayed.

7.3.2.3. View/Diagnostics_Scan Buffer



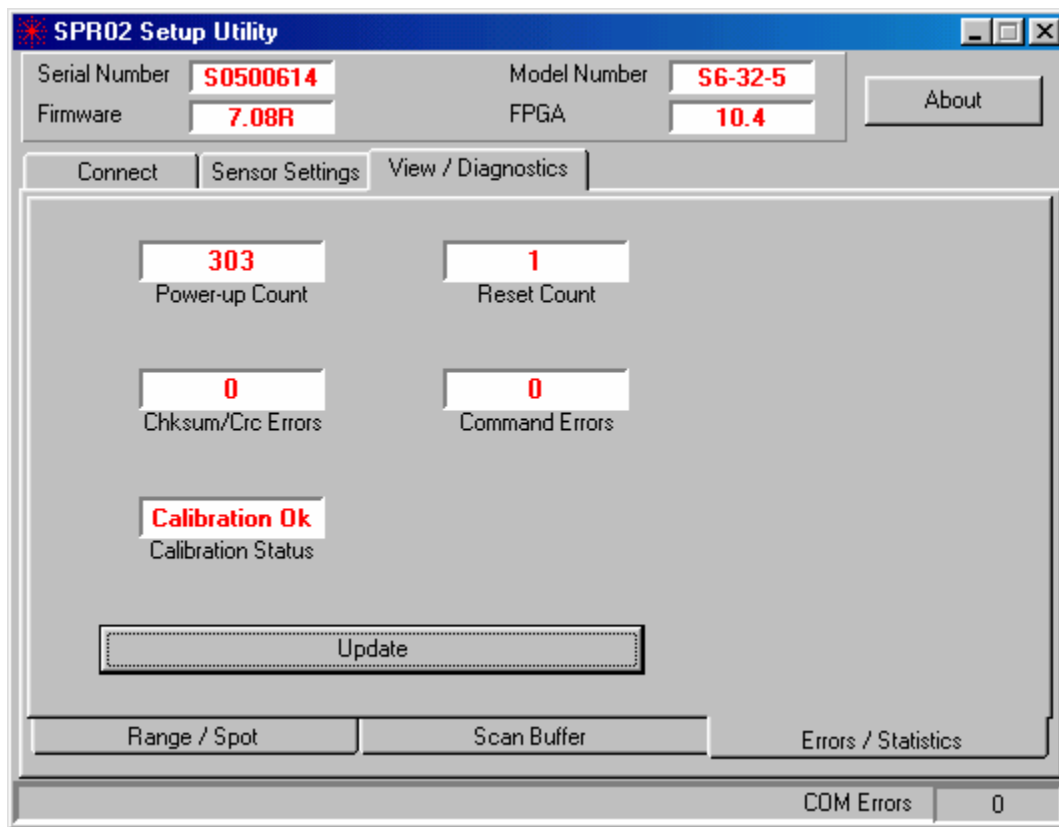
Start Scan Starts filling the scan buffer with range readings at rate specified by “Interval”.

Stop Scan Stops 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 Address list From File Reads the scan buffer and store is in a file(specified by user).

7.3.2.4 View/Diagnostics_Errors/Statistics



Power-up Count	This count refers to the number of times the sensor has been powered up over its life span.
Checksum/CRC Errors	This count indicates the number of times the sensor has received bad data packets. If Checksum count keeps increasing, further investigation of the communications link is required.
Reset Count	This count refers to the 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.
Calibration	This refers to the internal checking of the sensor to ensure its calibration tables have not been corrupted.

Click on the “Update” button to update the display.

**8. GETTING FURTHER
HELP**

If you wish further help on the SPR-02 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

8.1 LIST OF AGENTS

**CANADA AND
THE UNITED
STATES**

Call our offices at 1-604-940-0141 for the agent nearest you, or visit
our web site at www.lmint.com

INTERNATIONAL

EUROPE

LMI Selcom Inc. (Sweden)
Box 250, S-433 25
Ogardesvagen 19 A
Partille, Sweden

ph 46-31-36-25-24
fax 46-31-44-61-79