Stalker Stationary Speed Sensor II

Technical Manual

011-0131-00 Rev. R

Applied Concepts, Inc.
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Regulatory Statement

Note: This equipment has been tested and found to comply with the limits for a Class A digital device, pursuant to part 15 of the FCC Rules. These limits are designed to provide reasonable protection against harmful interference when the equipment is operated in a commercial environment. This equipment generates, uses, and can radiate radio frequency energy and, if not installed and used in accordance with the instruction manual, may cause harmful interference to radio communications. Operation of this equipment in a residential area is likely to cause harmful interference in which case the user will be required to correct the interference at his own expense.

Changes or modifications not expressly approved by Applied Concepts, Inc. could void the user's authority to operate the equipment.

Not intended or approved for Law Enforcement use in the United States.

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1 Overview

The STALKER Stationary Speed Sensor II is a complete Doppler Radar in a small, rugged housing. Its direction sensing capabilities and its feature-rich configuration settings allow it to filter out undesired targets and focus on your targets of interest.

The Stationary Speed Sensor II connects to the serial port on a PC or other controller via an RS-232, an RS-485, or a USB link. This interface is used to configure the unit and to monitor the speed data it sends out. The Stationary Speed Sensor II can be configured to report the speeds of targets it acquires in many formats – from short ASCII character strings to larger data packets with speed and status information.

The RS-232 or USB port can stream speed data and monitor for commands from the controller at the same time. When configured for a four-wire connection, an RS-485 port can also send and receive data at the same time. When configured for a two-wire connection however, RS-485 ports only communicate one way at a time; they never stream data as a secondary node on the link. They only respond to commands and speed requests from the controller/primary node. RS-485 links have the benefit of operating over longer cable distances from the controller, and also multiple RS-485 units can be installed in a point-to-multipoint configuration and controlled from a single serial port on a controller.

The compact, waterproof unit can be mounted almost anywhere. Just supply 10-45 VDC power, and the Stationary Speed Sensor produces serial speed data configured for your application.

2 Specification

GENERAL SPECIFICATIONS

Product Type	Stationary Doppler Radar Speed Sensor
Processor	Digital Signal Processor
Operating Temperatures	-30°C to +70°C (-22°F to +158°F), 90% relative humidity
Storage Temperatures	-40°C to +85°C (-40°F to +185°F)

MICROWAVE SPECIFICATIONS

Operating Frequency	24.125 GHz (K-band)
Frequency Stability	±50 MHz
Antenna Type	Planar array
3 db Beam Width	30 by 32°
Power Output	18 dBm EIRP

ELECTRICAL SPECIFICATIONS

Supply Voltage	10 - 45 VDC 12 - 35 VAC
Current (at 12 VDC nominal)	Transmitter On: 85 mA Transmitter Off: 40 mA

PHYSICAL SPECIFICATIONS

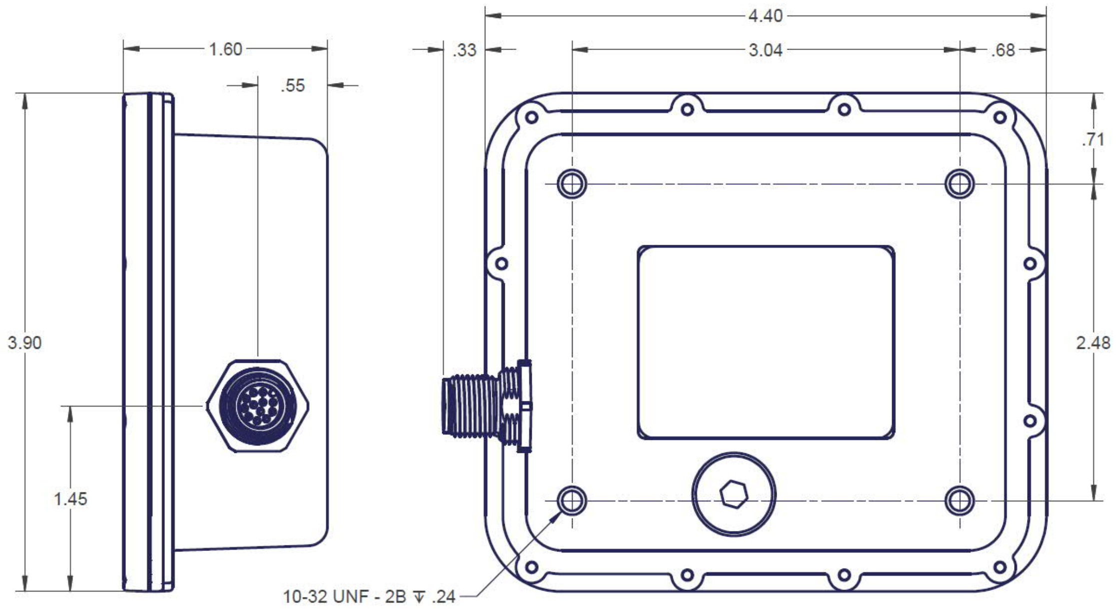
Weight	13 oz (0.35 kg)
Size (LxWxH)	4.4 x 3.9 x 1.6 inches 11.2 x 9.9 x 4 cm
Case Material	Aluminum die cast

PERFORMANCE SPECIFICATIONS

Stationary Speed Range	**For Low Speed Sensor II (200-0880-03 and 200-0880-60):** Min target speed: 0.1 in all units of measure Max target speed: 70 MPH (112 km/h, 60 knots, 31 meters/sec, 102 feet/sec, 3129 cm/sec) **For all others:** Min target speed: 1 MPH (1.6 km/h, 0.9 knots, 0.5 meters/sec, 1.5 feet/sec, 50 cm/sec) Max target speed: 200 MPH (322 km/h, 174 knots, 89 meters/sec, 293 feet/sec, 8941 cm/sec)
Accuracy	±.5 MPH ±0.3%, (±.8 KPH ±.3%) In ones resolution, speeds are rounded to nearest integer. In tenths resolution, speeds are rounded to nearest tenth.

3 Physical characteristics

3.1 Package dimensions

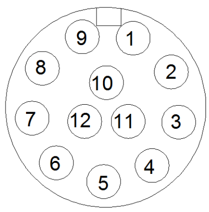


3.2 Electrical connections

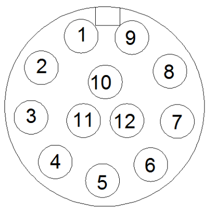
Use the table below to identify the electrical connections in the external connector.

Pin Number	Wire Color	Primary Function	Secondary Function
1	Brown	AC Power (factory only option)	USB D+
2	Red	AC Power (factory only option)	USB D-
3	Orange	COM B, RS-232 RX (From Computer)	
4	Yellow	COM A, RS-485 RX-, Full Duplex (From Computer)	COM C, RS-485 T/R-, Half Duplex
5	Dark Green	DC POWER	
6	Blue	AUX Relay	USB V
7	Violet	AUX Relay	
8	Gray	COM A, RS-485 TX+, Full Duplex (To Computer)	COM A, RS-485 T/R+, Half Duplex
9	Black	COM A, RS-485 TX-, Full Duplex (To Computer)	COM A, RS-485 T/R-, Half Duplex
10	White	COM A, RS-485 RX+, Full Duplex (From Computer)	COM C, RS-485 T/R+, Half Duplex
11	Pink	COM B, RS-232 TX (To Computer)	
12	Light Green	GROUND	

The diagrams below shows the pin out of the cable and sensor connectors as mated.



CABLE CONNECTOR,
MATING END VIEW.



SENSOR CONNECTOR,
MATING END VIEW.

The columns in the table below show pins used for different connection options.

Pin Number	Wire Color	RS-485 Full Duplex	RS-485 Half Duplex	RS-232
1	Brown			
2	Red			
3	Orange			COM B, RX (from computer)
4	Yellow	COM A, RX-	COM C, T/R-	
5	Dark Green	DC Power	DC Power	DC Power
6	Blue	Relay (optional)	Relay (optional)	Relay (optional)
7	Violet	Relay (optional)	Relay (optional)	Relay (optional)
8	Gray	COM A, TX+	COM A, T/R+	
9	Black	COM A, TX-	COM A, T/R-	
10	White	COM A, RX+	COM C, T/R+	
11	Pink			COM B, TX (to computer)
12	Light Green	Ground	Ground	Ground

4 Connecting the Stationary Speed Sensor

4.1 Connecting to the COM Ports

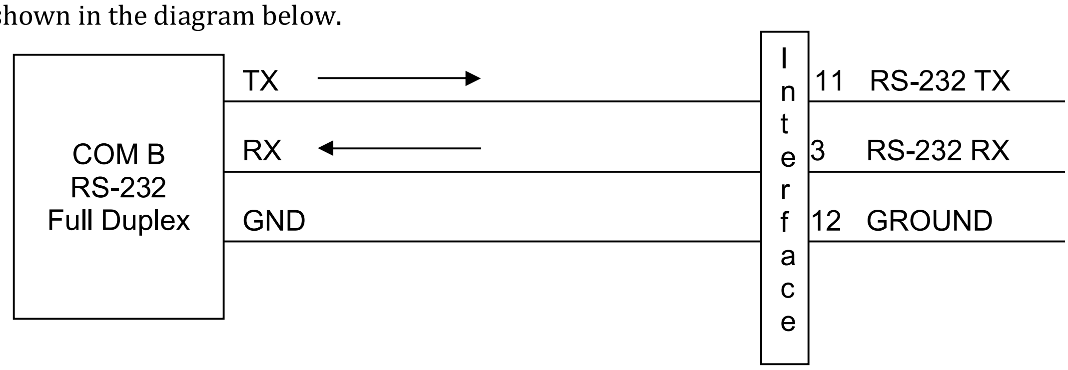
This section describes the ports on the 200-0880-00/-01 basic sensor. Ports for other sensor models are covered in Section 12 Sensor Variations.

There are four standard COM ports on the Stationary Speed Sensor II. Not all ports are available on all sensor models. COM A is an RS-485 port which can be either 4-wire full-duplex or 2-wire half-duplex. COM B is a 2-wire full-duplex RS-232 port. COM C is a 2-wire half-duplex RS-485 port. COM D is a full-duplex USB port which can have flow control enabled. Depending on the unit's configuration one, two, three or four COM ports may be used at the same time. The factory default configuration has COM A as a 4-wire full-duplex RS-485 port, COM B as a 2-wire full-duplex RS-232 port, COM C as disabled, and COM D as a USB port. This default configuration allows COM A, COM B, and COM D to be used simultaneously.

All Stationary Speed Sensor II COM ports are configured for 10 bit asynchronous serial communications with 1 start bit, 8 data bits, 1 stop bit and no parity (8N1). This is standard for PC serial ports, but a custom controller may need to be modified to match these settings. COM A and COM C, the RS-485 ports, have inter-dependencies, so COM B is discussed first below.

4.1.1 COM B – RS-232 Full Duplex Port

COM B is the simplest port to connect and configure. It provides a standard RS-232 port with Transmit Data (TX) and Receive Data (RX) signals relative to its ground (GND) as shown in the diagram below.



The sensor transmits data by changing the voltage level on the TX wire relative to GND. The TX wire should be connected to the receive signal on the PC/controller, and the GND should be connected to the controller's GND signal. The controller receives the data on its end by sensing the voltage changes relative to GND.

In a like manner, the controller's TX signal is connected to the sensor's RX, and the sensor receives controller data by sensing the voltage changes on that wire relative to the same ground. Because there are the two separate signals (TX and RX), the link is defined as **full-duplex** meaning that the data signals can flow in both directions at the same time without corrupting each other.

A limitation on RS-232 links is distance. The sensor and controller can communicate over cables – but only so far. Since received data is sensed as a voltage relative to the link's ground signal, as the cable gets longer, the received voltage changes get lower and noisier and become harder to detect reliably resulting in degraded communications. This distance can be affected by wire size in the cable, crosstalk between wires in the cable as well as routing the cable through noisy environments.

Most PCs are not configured with the older 9-pin D serial ports and have USB ports instead. In these cases, acquire a USB to serial port adapter to perform the necessary conversion. These products vary and may or may not work well. In some cases they provide undesirable buffering and delay, and a different brand should be used.

4.1.2 COM A and COM C – RS-485 Ports

RS-485 ports differ from RS-232 in that RS-485 uses a pair of wires with no ground for each direction of transmission instead of the RS-232 method of using one wire for each direction relative to a shared ground. Instead of generating or sensing a voltage level relative to ground like RS-232, RS-485 transmits data by changing the direction of current flow in the loop created by its two wires. Although still affected by noisy environments, RS-485 links can operate over longer distances than RS-232 because the receivers are not trying to measure smaller and smaller voltages relative to a noisier and noisier ground as the distances increase. They just have to measure the direction of the current flow on a closed loop.

RS-485 links can be implemented in a 4-wire or a 2-wire implementation. With four wires, the link is **full-duplex** because one pair of wires can be used to send data one way, and the other pair can be used to send data the other way permitting two-way simultaneous communication.

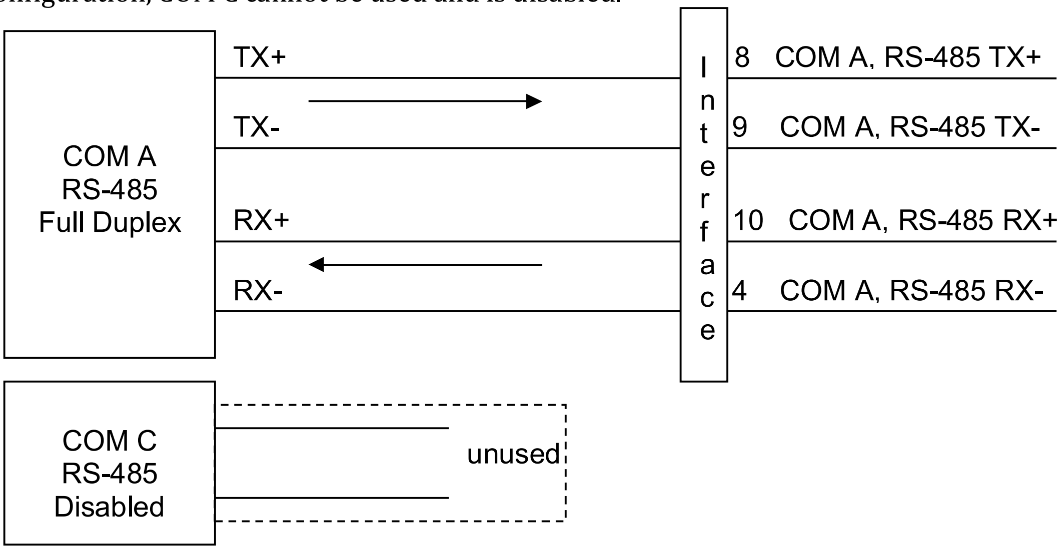
With only two wires, the two ends of the link must coordinate their sending of data so that only one end transmits at a time. On this **half-duplex** link, if both ends try to transmit at the same time, the communications will be garbled and neither end will be able to receive a clean signal.

To prevent messages in the two directions from colliding, the RS-485 half-duplex protocol requires that there be a primary node on one end of the link and secondary node(s) on the other. A Stationary Speed Sensor II always acts as a secondary node, and the controller is always the primary node. On a half-duplex link the Stationary Speed Sensor II only answers commands or requests for speeds from the controller. It never sends any data without receiving a request first, and it never streams speed data.

The Stationary Speed Sensor II has two RS-485 ports: COM A and COM C. COM A can be configured to be 4-wire full-duplex or 2-wire half-duplex. COM C is always a 2-wire half-duplex port. They share internal connections to only four pins on the main connector, so either COM A can be 4-wire while COM C is disabled, or they can both be 2-wire ports.

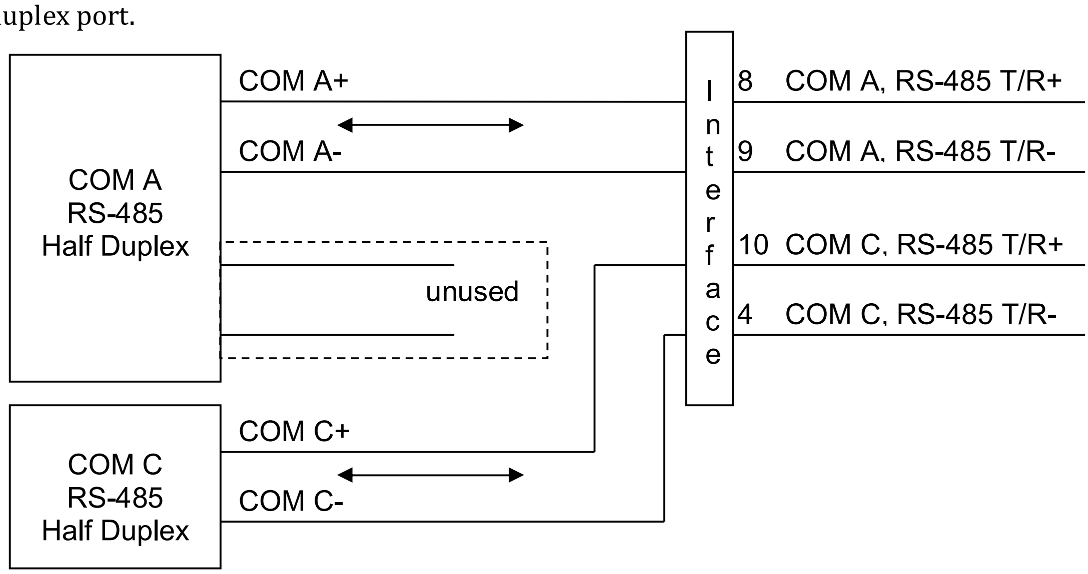
4.1.2.1 COM A – RS-485 Full Duplex Port

The default configuration for the COM A port is 4-wire as shown below. The two wires for the transmit data are TX+ and TX-, and the two wires for the receive data are RX+ and RX-. Notice that since there is a pair of wires for each direction, both the sensor and the controller can transmit and receive at the same time creating a **full-duplex** link. In this configuration, COM C cannot be used and is disabled.



4.1.2.2 COM A and COM C – RS-485 Half Duplex Ports

The 2-wire half-duplex implementation on COM A is shown below. In this configuration, there is only one pair of wires COM A+ and COM A- which is used for both directions of communication. Since the second pair of signals on COM A is unused, COM C may be enabled and connects to the other two pins on the connector as a second, independent half-duplex port.



4.2 Auxiliary Relay Connections

The AUX Relay Contacts, pins 6 and 7 of the interface connector, provide a contact closure interface. The sensor can internally short these pins together or leave them in their normal state of an open circuit. On some models, pin 6 is used for other purposes, so in those cases, pint 7 can be shorted internally to ground. This interface is used by the Stationary Speed Sensor II to implement an external status signal which is described in more detail in Section 9.8.

5 ASCII Sensor Control Using Standard PC Applications

The Stationary Speed Sensor IIs provide a serial command protocol based on ASCII characters. With a standard PC application like RealTerm, a user can control some of the sensor's settings and monitor speed data. Each command is represented by a single character, and some require a one or two character option selection. The options for these commands are described in this section.

One group of commands works in parallel with some of the sensor settings described in Section 9, and they are listed in the following table.

Command	Description
C	Dump configuration
D	Set direction mode
U	Set units
R	Set range
H	Set horizontal angle
V	Set vertical angle
Z	Reset sensor

The second group of commands are used to configure data streaming messages in the F0, F1, and F2 formats as described in Section 7.8, 7.9, and 7.10. They are as follows.

Command	Description
I	Get or Set ID
F	Set format of speed output
G	Get most recent speed data
S	Streaming output on/off
W	Set length of averaging window

Syntax notes for the commands:

- <*cr*> represents the carriage return character ASCII 13 decimal.
- <*lf*> represents the line feed character ASCII 10 decimal.
- Although the commands in the following tables are terminated with a <*cr*>, they may also be terminated with a <*lf*>.
- <*sp*> represents the space character ASCII 32 decimal.
- Optional parameters are enclosed in square brackets [...].
- All input commands may be upper or lower case.
- Commands can be issued at any time and do not affect streaming output.
- The only commands that return a response are the **C** dump configuration command and the **I** command for ID.

Syntax	Description

Syntax	Description
c<*cr*>	Dump configuration Output: **i***aannnnnn*<*sp*>**f***n*<*sp*>**s***n*<*sp*>**d***n*<*sp*>**r***n*<*sp*>**h***n* <*sp*>**v***n*<*sp*>**u***n*<*sp*>**w***nn*<*cr*> Notes: 1. All values of *n* are defined by the parameter values for each respective input command. Example: **c**<*cr*> **iSD004007 f1 s0 d1 r1 h00 v30 u1 w40**<*cr*> **u2**<*cr*> **c**<*cr*> **iSD004007 f1 s0 d1 r1 h00 v30 u2 w40**<*cr*>
d*n*<*cr*>	Set direction mode *n*: **0**=both **1**=inbound **2**=outbound Note: When both is selected, an “i” for inbound or an “o” for outbound is appended to the average speeds in the F1 and F2 streaming output messages.
u*n*<*cr*>	Set units *n*: **0**=mph **1**=km/h **2**=m/s **3**=ft/s **4**=knots **5**=cm/s
r*n*<*cr*>	Set range *n*: **1-4** Notes: 1. 4 is most sensitive setting (farthest range), 1 is the least sensitive setting. 2. This command can only be used to set the sensor to the ranges as shown above. The Sensitivity setting as described in Section 9.3 can configure the sensor for a sensitivity from 0 to 16. • Sensitivity settings 0-4 map to Range setting 1 • Sensitivity settings 6-8 map to Range setting 2 • Sensitivity settings 9-12 map to Range setting 3 • Sensitivity settings 13-16 map to Range setting 4 • Range setting 1 maps to Sensitivity setting 4

Syntax	Description
	• Range setting 2 maps to Sensitivity setting 8 • Range setting 3 maps to Sensitivity setting 12 • Range setting 4 maps to Sensitivity setting 16
h*nn<cr>*	Set horizontal angle *nn*: **00-70** (0° - 70°) <u>Notes:</u> 1. *nn* must be a 2-digit numeric.
v*nn<cr>*	Set vertical angle *nn*: **00-70** (0° - 70°) <u>Notes:</u> 1. *nn* must be a 2-digit numeric.
z*<cr>*	Reset sensor <u>Notes:</u> 1. Resets the sensor as if it has been powered off and back on. 2. Process takes about ten seconds. 3. Sensor sends out its version information after reset.
i*[aannnnnn]<cr>*	Get or set ID *aannnnnn*: *ID (2-alpha + 6-numeric = 8-digit ASCII string)* <u>Notes:</u> 1. When ID is not specified or incorrect length, current ID is output. 2. When ID is specified, new ID is set to *aannnnnn*. <u>Example:</u> **i***<cr>* **SD004001***<cr>* **iSD004007***<cr>* **i***<cr>* **SD004007***<cr>*

Syntax	Description
f*n<cr>*	Set format of speed output *n*: **0**=*current (instantaneous) speed* **1**=*ID-strength-avgTime-currSpeed-currAvgSpeed-prevAvgSpeed* **2**=*ID-strength-currSpeed-currWindowAvgSpeed* <u>Notes:</u> 1. *ID* is as specified by the **i** command. 2. *currSpeed* is the current (instantaneous) speed. 3. *currAvgSpeed* is the running average from 0.0 seconds until *avgTime.* 4. *currWindowAvgSpeed* is the average of all valid speed readings from the last n seconds. (n set by W command) 5. *prevAvgSpeed* is the average over the previous measurement period. 6. *strength* is 0 to 9, where 0 means no speed. 7. *avgTime* resolution is tenths of a second and is in the range 00.0 to 99.9 seconds. 8. Speed resolution is in hundredths (xx.xx) 9. Refer to Section 0 for descriptions of all of the streaming protocols available on the sensors. Format 0 above correlates to sensor format F0 (Section 7.8), 1 above to F1 (Section 7.9), and 2 to F2 (Section 7.10). 10. If the sensor is configured for a format other than these three, the **f***n* portion of the **c** dump configuration string shows "**f**?".
g*<cr>*	Get most recent speed output data <u>Example:</u> **f1***<cr>* **g***<cr>* SD004001-7-02.4-11.32-11.32-11.14*<cr>* **g***<cr>* SD004001-8-16.2-11.95-11.43-11.14*<cr>* **g***<cr>* SD004001-7-37.1-11.63-11.51-11.14*<cr>* **f2***<cr>* **g***<cr>* SD004001-8-11.32-11.44*<cr>* **f0***<cr>* **g**<cr> 11.87*<cr>* **g**<cr> 11.92*<cr>* <u>Notes:</u> 1. If a streaming output mode (**s1,s2**) is selected, then this command is ignored. 2. This command only applies to sensor formats F0, F1, and F2.

Syntax	Description
s*n<cr>*	Streaming output mode *n*: **0**=*off* **1**=*every averaging period* **2**=*every measurement period* Notes: 1. Averaging period for format F1 is fixed at 100 seconds. 2. Averaging period for format F2 depends on the averaging window set using the **w***nn* command. 3. Measurement period depends on the model of sensor in use. 4. This command only applies to sensor formats F0, F1, and F2. Example: **f1***<cr>* **s1***<cr>* SD004001-7-00.0-11.88-11.79-11.16*<cr>* SD004001-8-00.0-11.89-11.80-11.16*<cr>* SD004001-7-00.0-11.90-11.80-11.16*<cr>* **s2***<cr>* SD004001-7-32.1-11.88-11.79-11.16*<cr>* SD004001-8-32.3-11.87-11.80-11.16*<cr>* SD004001-7-32.5-11.90-11.81-11.16*<cr>* SD004001-7-32.8-11.89-11.79-11.16*<cr>* SD004001-8-33.0-11.87-11.80-11.16*<cr>* SD004001-7-33.2-11.92-11.81-11.16*<cr>* **s0***<cr>*
w*nn<cr>*	Set window size for moving window averaging *nn*: **00-60**=window size in seconds Notes: 1. *nn* must be a 2-digit number. 2. Applies to speed format F2 only.

RS-485 Extensions:
Units equipped with RS-485 serial ports can be used in multi-point links. For these ports, a prefix must be included with all commands and will be included with every response. The command prefix consists of an exclamation point character “!” (ASCII=33 decimal) followed by the destination device's address and a dash “-” (ASCII=45 decimal). The address is a two-digit number represented as an ASCII string equal to the last two digits of the device ID (as set by the “i” command). A broadcast address is also defined to which all devices will respond, regardless of ID. This is useful for initial configuration where only one sensor/secondary node is attached to the PC or controller/primary node. The broadcast address is “A” (must be upper-case). Certain restrictions are imposed on the use of the broadcast address to prevent erroneous input from producing an unrecoverable state. Streaming cannot be enabled with a broadcast command. Also, the unit's ID cannot be set this way. To set the ID without knowing the old one, send the set ID command as though the unit were equipped with RS-232 (that is, send a command like **iSD004007***<cr>*).

The response prefix is similar to command prefix except that the first character is a back tick “`” (ASCII=96 decimal). The address of the device is sent here also. This time, it is a message source address rather than a destination address.

Example:

command: !38-i<cr>	effect: query ID on unit with ID ending in “38”
response: <none>	because there is no unit with ID ending in “38”
command: !96-g<cr>	effect: request speed from unit with ID ending “96”
response: `96-12.34<cr>	meaning: speed from unit with ID ending “96” is 12.34
command: !A-g<cr>	effect: request most recent speed from all connected units
response: `65-23.45<cr>	meaning: most recent speed from all units, in this case, only unit with ID ending in “65” is attached and has speed 23.45

Streaming in Multi-Drop Systems:
Streaming should be enabled only on one unit at a time. A unit with streaming enabled will pause its output when it reads a “!” on the serial port between transmissions. This enables it to receive a command from the controller on the half-duplex bus. Exclamation point “!” characters may be sent repeatedly until the streaming unit is interrupted. If the command that follows is addressed to the streaming unit, it will cancel streaming mode and respond to the command. If the command is invalid or addressed elsewhere, streaming mode will resume on receipt of a carriage return <cr> character and after a short delay.

6 Custom Applications to Control the Stationary Speed Sensor II

This section discusses in detail the advanced protocol used to communicate with the Stationary Speed Sensor IIs. It is the protocol used by STALKER demo applications such as Stalker Sensor Wizard and can be used by designers to develop custom applications to control Stationary Speed Sensor IIs. A basic knowledge of hexadecimal math is required, but the protocol fields are basically “fill in the blank”.

Using the configuration protocol described in Section 11, a designer can “get” the current value of a setting from the unit, “set” the setting to a new value or “change” (increment) the value. When a PC or other controller sends a configuration command packet to the Stationary Speed Sensor II, the Stationary Speed Sensor II responds immediately with a packet in the same format. The only values changed in the returned packet are the Destination ID, Source ID, Configuration Value and the Checksum bytes. The Payload Length may also change depending on the length of the returned Configuration Value.

The PC/controller is always defined to be the primary node (ID = 0x01) so commands from the controller will always have 0x01 as the Source ID, and responses from Stationary Speed Sensor IIs will always have 0x01 as the Destination ID.

The default Unit ID for Stationary Speed Sensor IIs is 0x02 and need not be changed on point-to-point links between a sensor and a PC/controller – whether on an RS-232 or RS-485 port.

Multiple units using RS-485 ports can work simultaneously on a single link to the controller in a point-to-multipoint configuration. The ID of each one must be unique and in the range of 2-254 (0x02 – 0xFE). ID 0 is undefined and should not be used. ID 255 (0xFF) is the broadcast address. Every unit on the link acts on commands sent to ID 255, so a controller can, for example, turn all the radar transmitters on or off with a single command. Be aware that each unit also sends a response packet to a broadcast command, and that the responses are likely to be garbled on the shared link. For this reason, always disregard responses to broadcast commands unless there is only one Stationary Speed Sensor II on the link. If the response from a single unit on a multipoint link is desired, always address that unit in the command.

Another good use for a broadcast command is to find out the ID of a Stationary Speed Sensor II that may not be responding to its expected address. Make sure the unit is the only one on the link, and send the Get Stationary Speed Sensor II Address command (1/116) to the broadcast Destination ID 255 (0xFF). As long as the baud rate is correct, the unit will respond back using its ID as the Source ID in the response packet.

All of the configuration methods (get, change and set) use the same packet format defined in Section 11. The differences are in the use of the Command ID and the Configuration Value fields.

- The “change” command and the “get” command are similar in that the Command ID field is set equal to the Setting ID (in hex) from the list of settings in Section 10.
    - For a “change” command, the Configuration Value is set to 1 to instruct the Stationary Speed Sensor II to increment the value by 1 and return the

resulting value: change(1). If the incremented value exceeds the legal range for the setting, the value rolls around to the lowest value in the range.
    - For a “get” command, the Configuration Value is set to 0 basically instructing the Stationary Speed Sensor II not to increment the current value but to simply return it. This is essentially a change(0) command.
- For a “set” command, the Command ID field is set equal to 0x80 plus the Setting ID value (in hex) from the list in Section 10 (essentially turning on the high-order bit). The Configuration Value field is set to the new desired value.

In the response packet, the Stationary Speed Sensor II inserts the value of the requested setting in the Configuration Value field. Once the Destination and Source IDs and the Configuration Value are correct, the sensor calculates a new checksum and inserts it into the packet before sending off the response.

7 Streaming Speed Data Protocols

When a streaming protocol is selected on a full-duplex port, the Stationary Speed Sensor II sends continuous speed updates in the selected output format at a specified message period. When one of these protocols is selected on a half-duplex port, the unit sends only a single message in the selected output format in response to each EA Poll from the controller. Refer to Section 9.2 for settings that affect the content and timing of these messages.

The following streaming protocol message formats are supported.

A – ASCII single visual speed only
B – ASCII all visual speeds + status
D0 – ASCII strong visual speed only, optional direction byte
D1 – ASCII strong visual speed only, optional direction byte, checksum
D2 – ASCII strong visual speed only, optional direction byte, tenths
D3 – ASCII strong visual speed only, optional direction byte, relative amplitude, tenths
D4 – HEX strong visual speed only
F0 – ASCII strong visual speed only
F1 – ASCII strong visual speed, average speed
F2 – ASCII strong visual speed, windowed average speed
G – ASCII single visual speed with count indicator – AGD compatible
GS – ASCII single visual speed with count and strength indicators
Enhanced Output – Hex all visual speeds + status
S – ASCII visual speeds + status
BT – ASCII Timestamp from the unit's internal real-time clock
DT – ASCII Date and Timestamp from the unit's internal real-time clock
DBG1 – ASCII information for all tracked statistics targets (stats unit only)
LOG – ASCII information for statistics targets as they are lost (stats unit only)

7.1 A Format – Single Visual Speed Only

Byte #	Description	Value
1	Speed hundreds digit (ASCII)	
2	Speed tens digit (ASCII)	
3	Speed ones digit (ASCII)	
4	Carriage Return	0x0D

A Format messages are 4 bytes in length. The baud rate setting must be 1200 or greater to ensure that a complete message is sent before the radar processes a new message to send.

Use the Format A Speed setting for the desired port to select the Strong visual target or the Fast visual target to be sent in this message.

When the Unit Resolution (Setting 1/21) is set for tenths, the speed reported is multiplied by ten: 58.5 MPH is reported as 585. The decimal point is assumed. An A Format message can carry a maximum speed in tenths of 99.9.

When the Unit Resolution (Setting 1/21) is set for hundredths, the speed reported is multiplied by one hundred: 8.72 MPH is reported as 872. The decimal point is assumed. An A Format message can carry a maximum speed in hundredths of 9.99.

7.2 B Format – All Visual Speeds + Status

Byte #	Description	Value
1	Message Type	0x81
2	Status 1	*(see detail below)*
3	Status 2	*(see detail below)*
4	unused	0x20 (space) or 0x30 (ASCII 0)
5	unused	0x20 (space) or 0x30 (ASCII 0)
6	unused	0x20 (space) or 0x30 (ASCII 0)
7	Locked speed hundreds digit (ASCII)	
8	Locked speed tens digit (ASCII)	
9	Locked speed ones digit (ASCII)	
10	Fast speed hundreds digit (ASCII)	
11	Fast speed tens digit (ASCII)	
12	Fast speed ones digit (ASCII)	
13	Target speed hundreds digit (ASCII)	
14	Target speed tens digit (ASCII)	
15	Target speed ones digit (ASCII)	
16	Carriage Return	0x0D

Status 1 byte
Bit 7-6: always = 01 (to force displayable ASCII characters)
Bit 5: lock status (0=no speed locked, 1=speed locked)
Bit 4: zone (0=closing, 1=away/both)
Bit 3: always = 0
Bit 2: always = 0
Bit 1: always = 1
Bit 0: transmitter status (0=off, 1=on)

Status 2 byte
Bit 7-6: always = 01 (to force displayable ASCII characters)
Bit 5-4: always = 00
Bit 3: fast lock status (0=no fast speed locked, 1=fast speed locked)
Bit 2: fast status (0=faster disabled, 1=faster enabled)
Bit 1: always = 0
Bit 0: always = 0

B Format messages are 16 bytes in length. The baud rate setting must be 4800 or greater to ensure that a complete message is sent before the radar processes a new message to send.

When the Unit Resolution (Setting 1/21) is set for tenths, the speeds reported are multiplied by ten: 58.5 MPH is reported as 585. The decimal point is assumed. A B Format message can carry a maximum speed in tenths of 99.9.

When the Unit Resolution (Setting 1/21) is set for hundredths, the speed reported is multiplied by one hundred: 8.72 MPH is reported as 872. The decimal point is assumed. A B Format message can carry a maximum speed in hundredths of 9.99.

7.3 D0 Format – Strong Visual Speed Only, Optional Direction Byte

Byte #	Description	Value
1	Optional direction byte	
2	Target speed hundreds digit (ASCII)	
3	Target speed tens digit (ASCII)	
4	Target speed ones digit (ASCII)	
5	Carriage Return	0x0D

D0 Format messages are up to 5 bytes in length. The baud rate setting must be 1200 or greater to ensure that a complete message is sent before the radar processes a new message to send.

If the direction byte is not enabled for the desired port, it is not sent, and the message will be a 4 byte message. When enabled, the direction byte is '+' for approaching, '-' for receding, and '?' for unknown.

When the Unit Resolution (Setting 1/21) is set for tenths, the speed reported is multiplied by ten: 58.5 MPH is reported as 585. The decimal point is assumed. A D0 Format message can carry a maximum speed in tenths of 99.9.

When the Unit Resolution (Setting 1/21) is set for hundredths, the speed reported is multiplied by one hundred: 8.72 MPH is reported as 872. The decimal point is assumed. A D0 Format message can carry a maximum speed in hundredths of 9.99.

7.4 D1 Format – Strong Visual Speed Only, Optional Direction Byte, Checksum

Byte #	Description	Value
1	Optional direction byte	
2	'S'	The letter 'S' (0x53)
3	Target speed tens digit (ASCII)	
4	Target speed ones digit (ASCII)	
5	Carriage Return	0x0D
6	Checksum	

D1 Format messages are up to 6 bytes in length. The baud rate setting must be 2400 or greater to ensure that a complete message is sent before the radar processes a new message to send.

If the direction byte is not enabled for the desired port, it is not sent, and the message will be a 5 byte message. When enabled, the direction byte is '+' for approaching, '-' for receding, and '?' for unknown.

The checksum is the sum of the preceding bytes truncated to the low order 7 bits.

When the Unit Resolution (Setting 1/21) is set for tenths, the speed reported is multiplied by ten: 8.2 MPH is reported as 82. The decimal point is assumed. A D1 Format message can carry a maximum speed in tenths of 9.9. Due to this limited speed range, the tenths setting is not recommended for this format.

When the Unit Resolution (Setting 1/21) is set for hundredths, the speed reported is multiplied by one hundred: 0.82 MPH is reported as 82. The decimal point is assumed. A D1 Format message can carry a maximum speed in hundredths of 0.99.

7.5 D2 Format – Strong Visual Speed Only, Optional Direction Byte, Tenths

Byte #	Description	Value
1	Optional direction byte	
2	Target speed hundreds digit (ASCII)	
3	Target speed tens digit (ASCII)	
4	Target speed ones digit (ASCII)	
5	Decimal Point	0x2E
6	Target speed tenths digit (ASCII)	
7	Carriage Return	0x0D

D2 Format messages are up to 7 bytes in length. The baud rate setting must be 2400 or greater to ensure that a complete message is sent before the radar processes a new message to send.

If the direction byte is not enabled for the desired port, it is not sent, and the message will be a 6 byte message. If enabled, the direction byte is '+' for approaching, '-' for receding, and '?' for unknown.

The Unit Resolution (Setting 1/21) should be set to tenths for this format to report speeds properly.

7.6 D3 Format – Strong Visual Speed Only, Optional Direction Byte, Relative Amplitude, Tenths

Byte #	Description	Value
1	'*'	Asterisk (0x2A)
2	Optional direction byte	
3	Target speed hundreds digit (ASCII)	
4	Target speed tens digit (ASCII)	
5	Target speed ones digit (ASCII)	
6	Decimal Point	0x2E
7	Target speed tenths digit (ASCII)	
8	','	Comma (0x2C)
9	Relative Amplitude hundreds digit (ASCII)	
10	Relative Amplitude tens digit (ASCII)	
11	Relative Amplitude ones digit (ASCII)	
12	Carriage Return	0x0D

D3 Format messages are up to 12 bytes in length. The baud rate setting must be 4800 or greater to ensure that a complete message is sent before the radar processes a new message to send.

If the direction byte is not enabled for the desired port, it is not sent, and the message will be an 11 byte message. If enabled, the direction byte is '+' for approaching, '-' for receding, and '?' for unknown.

Amplitude values are relative and in the range 0-160.

The Unit Resolution (Setting 1/21) should be set to tenths for this format to report speeds properly.

7.7 D4 Format – Strong Visual Speed Only

Byte #	Description	
1	0x02 (HEX)	
2	0x84 (HEX)	
3	0x01 (HEX)	
4	Target Speed (HEX)	
5	0x01 (HEX)	
6	0xAA (HEX)	
7	0x03 (HEX)	

The bytes are sent just as above, in HEX format. The only variable is speed, which is the strong target speed expressed in HEX format, e.g. 30 MPH would be sent as 0x1E. The maximum speed that can be reported in this format is 255

D4 Format messages are 7 bytes in length. The baud rate setting must be 2400 or greater to ensure that a complete message is sent before the radar processes a new message to send.

When the Unit Resolution (Setting 1/21) is set for tenths, the speed reported is multiplied by ten: 25.5 MPH is reported as 255. The decimal point is assumed. A D4 Format message can carry a maximum speed in tenths of 25.5.

When the Unit Resolution (Setting 1/21) is set for hundredths, the speed reported is multiplied by one hundred: 2.13 MPH is reported as 213. The decimal point is assumed. A D4 Format message can carry a maximum speed in hundredths of 2.55.

7.8 F0 Format – Strong Visual Speed Only

Byte #	Description	
1	Target speed tens digit (ASCII)	
2	Target speed ones digit (ASCII)	
3	Decimal Point	0x2E
4	Target speed tenths digit (ASCII)	
5	Target speed hundredths digit (ASCII)	
6	Carriage Return	0x0D

F0 Format messages are 6 bytes in length. The baud rate setting must be 2400 or greater to ensure that a complete message is sent before the radar processes a new message to send.

The sensor's resolution setting has no effect on this format; speeds are always reported in hundredths resolution. An F0 Format message can carry a maximum speed of 99.99.

This format is dependent on the ASCII sensor controls described in Section 5. Use the **s**n command to control the streaming frequency of these messages: s0 for no streaming, s1 for a message every 100 seconds, s2 for a message every measurement period.

7.9 F1 Format – Strong Visual Speed, Average Speed

Byte #	Description	
1-8	8-byte ASCII ID Number	e.g. "SD004001"
9	'-'	Dash (0x2D)
10	Target Strength	0 – 9
11	'-'	Dash (0x2D)
12	Average time tens digit (ASCII)	00.0 – 99.9
13	Average time ones digit (ASCII)	
14	Decimal Point	0x2E
15	Average time tenths digit (ASCII)	
16	'-'	Dash (0x2D)
17	Current speed tens digit (ASCII)	
18	Current speed ones digit (ASCII)	
19	Decimal Point	0x2E
20	Current speed tenths digit (ASCII)	
21	Current speed hundredths digit (ASCII)	
22	'-'	Dash (0x2D)
23	Current avg speed tens digit (ASCII)	
24	Current avg speed ones digit (ASCII)	
25	Decimal Point	0x2E
26	Current avg speed tenths digit (ASCII)	
27	Current avg speed hundredths digit (ASCII)	
*	Target Direction 'i' or 'o'	*See note below
28	'-'	Dash (0x2D)
29	Previous avg speed tens digit (ASCII)	
30	Previous avg speed ones digit (ASCII)	
31	Decimal Point	
32	Previous avg speed tenths digit (ASCII)	
33	Previous avg speed hundredths digit (ASCII)	
*	Target Direction 'i' or 'o'	*See note below
34	Carriage Return	0x0D

F1 Format messages are a maximum of 36 bytes in length. The baud rate setting must be 9600 or greater to ensure that a complete message is sent before the radar processes a new message to send.

The sensor's resolution setting has no effect on this format; speeds are always reported in hundredths resolution. An F1 Format message can carry a maximum speed value of 99.99.

This format is dependent on the ASCII sensor controls described in Section 5. Use the **s**n command to control the streaming frequency of these messages: s0 for no streaming, s1 for a message every 100 second averaging period, or s2 for a message every measurement period.

The averaging period for F1 is always 100 seconds. At that time the current average moves to the previous average field, and a new average is started. See the sample messages below:
SD004001-5-99.7-40.38-40.40-40.36o<cr>
SD004001-5-99.8-40.38-40.40-40.36o<cr>
SD004001-5-99.8-40.38-40.40-40.36o<cr>
SD004001-5-99.9-40.39-40.39-40.36o<cr>
SD004001-5-99.9-40.39-40.39-40.36o<cr>
SD004001-5-00.0-40.39-40.39-40.39o<cr>

SD004001-5-00.0-40.39-40.39-40.39o<cr>

*When the sensor's direction setting is Both, an "i" or an "o" is appended after the average speeds to denote inbound or outbound.

7.10 F2 Format – Strong Visual Speed, Windowed Average Speed

Byte #	Description	
1-8	8-byte ASCII ID Number	e.g. "SD004001"
9	'-'	Dash (0x2D)
10	Target Strength	0 – 9
11	'-'	Dash (0x2D)
12	Current speed tens digit (ASCII)	
13	Current speed ones digit (ASCII)	
14	Decimal Point	0x2E
15	Current speed tenths digit (ASCII)	
16	Current speed hundredths digit (ASCII)	
17	'-'	Dash (0x2D)
18	Current avg speed tens digit (ASCII)	
19	Current avg speed ones digit (ASCII)	
20	Decimal Point	0x2E
21	Current avg speed tenths digit (ASCII)	
22	Current avg speed hundredths digit (ASCII)	
*	Target Direction 'i' or 'o'	*See note below
**	'W'	**See note below
23	Carriage Return	0x0D

F2 Format messages are a maximum of 25 bytes in length. The baud rate setting must be 9600 or greater to ensure that a complete message is sent before the radar processes a new message to send.

The sensor's resolution setting has no effect on this format; speeds are always reported in hundredths resolution. An F2 Format message can carry a maximum speed value of 99.99.

This format is dependent on the ASCII sensor controls described in Section 5. Use the **s**n command to control the streaming frequency of these messages: s0 for no streaming, s1 for a message every averaging period, or s2 for a message every measurement period.

The averaging period for F2 is a user-settable window in the range of 0-60 seconds. Use the **wnn command as described in Section 0 to set the windowing period. A "W" is appended to the first message in the windowing period. See the sample messages below:
SD004001-5-40.43-40.33i<cr>
SD004001-5-40.45-40.33i<cr>
SD004001-5-40.45-40.45iW<cr>
SD004001-5-40.39-40.41i<cr>

*When the sensor's direction setting is Both, an "i" or an "o" is appended at the end of the message before the carriage return to denote inbound or outbound.

7.11 G Format – Single Visual Speed with Count Indicator

Byte #	Description of speed message	
1	'*'	Asterisk (0x2A)
2	'S'	The letter 'S' (0x53)
3	Target speed hundreds digit (ASCII)	
4	Target speed tens digit (ASCII)	
5	Target speed ones digit (ASCII)	
6	Carriage Return	0x0D

Byte #	Description of count indicator message	
1	'*'	Asterisk (0x2A)
2	'C'	The letter 'C' (0x43)
3	Carriage Return	0x0D

G format messages are intended to be compatible with equipment that monitors AGD335 sensors with the following differences.

- AGD sensors can be configured to send the *C message when a target reaches a certain distance from the sensor. The ACI Speed Sensor II family cannot determine distance, so the *C message is sent when the target disappears from tracking. For targets moving toward the sensor (closing), the *C message is sent when the target passes by the sensor. For targets moving away, the *C is sent when they get too far in the distance to track. No holdover is applied to targets for this streaming format.
- The ACI Speed Sensor II family tracks speeds of all targets in their view – they are not limited to one lane unless they are aimed to limit their view to one lane.

Examples of the streamed data follow (where <cr> signifies a carriage return character 0x0D).
In the example on the left, a vehicle moving at 32 appears in the radar's view, speeds up to 33, and is then lost from view. The *C message denotes that it could be counted as a statistic at that time.
In the right-hand example, a vehicle moving at 32 appears, it disappears and can be counted, a vehicle at 47 follows the 32 vehicle, and it also disappears and can be counted. The *S000 messages signify no target in view.

```
*S000<cr>          *S000<cr>
*S000<cr>          *S032<cr>
*S032<cr>          *S032<cr>
*S032<cr>          *C<cr>
*S033<cr>          *S047<cr>
*C<cr>             *S047<cr>
*S000<cr>          *C<cr>
*S000<cr>          *S000<cr>
```

G Format messages are a maximum of 6 bytes in length. The baud rate setting must be 2400 or greater to ensure that a complete message is sent before the radar processes a new message to send.

Use the Format A Speed setting for the desired port to select the Strong visual target or the Fast visual target to be sent in this message.

When the Unit Resolution (Setting 1/21) is set for tenths, the speed reported is multiplied by ten: 58.5 MPH is reported as 585. The decimal point is assumed. A G Format message can carry a maximum speed in tenths of 99.9.

When the Unit Resolution (Setting 1/21) is set for hundredths, the speed reported is multiplied by one hundred: 8.72 MPH is reported as 872. The decimal point is assumed. A G Format message can carry a maximum speed in hundredths of 9.99.

7.12 GS Format – Single Visual Speed with Count and Strength Indicators

Byte #	**Description of strength indicator message**	
1	'*'	Asterisk (0x2A)
2	Target strength tens digit (ASCII)	
3	Target strength ones digit (ASCII)	
4	Carriage Return	0x0D

GS format messages are the same as G format except a two-digit target strength value is sent after each *C message. The examples above for G format would appear as below in GS format.

```
*S000<cr>          *S000<cr>
*S000<cr>          *S032<cr>
*S032<cr>          *S032<cr>
*S032<cr>          *C<cr>
*S033<cr>          *64<cr>
*C<cr>             *S047<cr>
*64<cr>            *S047<cr>
*S000<cr>          *C<cr>
*S000<cr>          *83<cr>
*S000<cr>          *S000<cr>
```

The target strength values are relative and in the range 01-99. They reflect the average target strength during the period the target is tracked.

7.13 Enhanced Output Format – Hex All Visual Speeds, Status

Byte #	Description	Value
1	Start ID	0xEF
2	Destination ID	0xFF (broadcast address)
3	Source ID	0x02
4	Packet Type	0x01
5	Payload Length (LSB)	0x0D
6	Payload Length (MSB)	0x00 (length = 0x000D = 13 bytes) (bytes 7-19)
7	Command ID	0x00
8	Antenna Number	0x01
9	Target Speed (LSB)	Speed of strongest target is 16-bit number
10	Target Speed (MSB)	*(see above)*
11	Faster Speed (LSB)	Speed of faster target is 16-bit number
12	Faster Speed (MSB)	*(see above)*
13	Locked Speed (LSB)	Locked speed (strong or fast) is 16-bit number
14	Locked Speed (MSB)	*(see above)*
15	unused	0x00
16	unused	0x00
17	Direction	*(see detail below)*
18	Status	*(see detail below)*
19	Configuration	*(see detail below)*
20	Checksum (LSB)	The checksum should equal the 16-bit sum of pairs of bytes in LSB, MSB order starting with byte #1 as the first LSB through and including the last byte before the Checksum (in this case, byte #19). In the case of an odd number of bytes, 0x00 is used as the last MSB value. (See example packet below.)
21	Checksum (MSB)	*(see above)*

<u>Direction byte</u>

Bits 7-6:	always = 00
Bits 5-4:	locked speed direction (0=unknown, 1=closing, 3(-1)=away)
Bits 3-2:	fast speed direction (0=unknown, 1=closing, 3(-1)=away)
Bits 1-0:	target speed direction (0=unknown, 1=closing, 3(-1)=away)

<u>Status byte</u>

Bit 7:	always = 0
Bit 6:	always = 0
Bits 5-3:	units (000=MPH, 001=km/h, 010 = knots, 011 = meters/sec, 100 = ft/sec)
Bit 2:	transmitter status (0=off, 1=on)
Bit 1:	strong lock (1=locked speed is strongest target)
Bit 0:	fast lock (1=locked speed is faster target)

<u>Configuration byte</u>

Bits 7-3:	always = 00000
Bits 2-1:	zone (00=away, 01=closing,10=both closing and away)
Bit 0:	always = 0

Enhanced Output Format messages are 21 bytes in length. The baud rate setting must be 4800 or greater to ensure that a complete message is sent before the radar processes a new message to send.

When the Unit Resolution (Setting 1/21) is set for tenths, the speeds reported are multiplied by ten: 58.5 MPH is reported as 585. The decimal point is assumed. An Enhanced Output Format message can carry a maximum speed in tenths of 6553.5.

When the Unit Resolution (Setting 1/21) is set for hundredths, the speeds reported are multiplied by one hundred: 5.85 MPH is reported as 585. The decimal point is assumed. An Enhanced Output Format message can carry a maximum speed in hundredths of 655.35.

EXAMPLE PACKET (Enhanced Output Format)

Byte #	Description	Example Values
1	Start ID	0xEF
2	Destination ID	0xFF
3	Source ID	0x02
4	Packet Type	0x01
5	Payload Length (LSB)	0x0D
6	Payload Length (MSB)	0x00
7	Command ID	0x00
8	Antenna Number	0x01
9	Target Speed (LSB)	0x37 (55 MPH)
10	Target Speed (MSB)	0x00
11	Fast Speed (LSB)	0x4B (75 MPH)
12	Fast Speed (MSB)	0x00
13	Locked Speed (LSB)	0x37 (55 MPH)
14	Locked Speed (MSB)	0x00
15	unused	0x00
16	unused	0x00
17	Direction	0x1D
18	Status	0x06
19	Configuration	0x00
20	Checksum (LSB)	0xD4
21	Checksum (MSB)	0x08

Checksum = 0x08D4 (truncated to the low order 2 bytes) = 0xFFEF + 0x0102 + 0x000D + 0x0100 + 0x0037 + 0x004B + 0x0037 + 0x0000 + 0x061D + 0x00

7.14 S Format – ASCII Visual Speeds + Status

Byte #	Description	Value	
1	Message type	0x83	
2	Faster target direction	'A' = "away", 'C' = "closing"	
3	Faster target speed	Hundreds (100)	'0' – '9' (ASCII)
4	*(same)*	Tens (10)	'0' – '9' (ASCII)
5	*(same)*	Ones (1)	'0' – '9' (ASCII)
6	*(same)*	Tenths (0.1)	'0' – '9' (ASCII)
7	Strongest target direction	'A' = "away", 'C' = "closing"	
8	Strongest target speed	Hundreds (100)	'0' – '9' (ASCII)
9	*(same)*	Tens (10)	'0' – '9' (ASCII)
10	*(same)*	Ones (1)	'0' – '9' (ASCII)
11	*(same)*	Tenths (0.1)	'0' – '9' (ASCII)
12	Strongest target strength	Hundreds (100)	'0' – '9' (ASCII)
13	*(same)*	Tens (10)	'0' – '9' (ASCII)
14	*(same)*	Ones (1)	'0' – '9' (ASCII)
15	Channel signal strength ratio	Hundreds (100)	'0' – '9' (ASCII)
16	*(same)*	Tens (10)	'0' – '9' (ASCII)
17	*(same)*	Ones (1)	'0' – '9' (ASCII)
18	Status	0x40 *(see detail below)*	
19	Carriage return	0x0D	

<u>Status byte</u>

Bit 7-6:	always = 01 (to force displayable ASCII characters)
Bit 5:	always = 0
Bit 4:	always = 0
Bits 3-0:	always = 0

S Format messages are 19 bytes in length. The baud rate setting must be 4800 or greater to ensure that a complete message is sent before the radar processes a new message to send.

Strongest target strength values are relative and in the range 1-32.

Channel signal strength ratio is a measure of the directionality of the target. A higher number is more directional.

When the Unit Resolution (Setting 1/21) is set for ones, the speeds reported use the Hundreds, Tens and Ones fields. The Tenths fields are populated with a space character. An S Format message can carry a maximum speed in ones of 999.

When the Unit Resolution (Setting 1/21) is set for tenths, the speeds reported use the Hundreds, Tens, Ones and Tenths fields. An S Format message can carry a maximum speed in tenths of 999.9.

When the Unit Resolution (Setting 1/21) is set for hundredths, the speed reported is multiplied by ten: 88.36 MPH is reported as 8836 in the Hundreds, Tens, Ones and Tenths fields. The decimal point is assumed. An S Format message can carry a maximum speed in hundredths of 99.99.

7.15 BT Format – ASCII Timestamp from the unit's internal real-time clock

Byte #	Description	Value
1	Message Type	0x81
2	Status 1	*(see detail below)*
3	unused	0x40
4	ASCII space	0x20
5	Fractional second tens digit (ASCII)	
6	Fractional second ones digit (ASCII)	
7	ASCII space	0x20
8	Second tens digit (ASCII)	
9	Second ones digit (ASCII)	
10	ASCII space	0x20
11	Minute tens digit (ASCII)	
12	Minute ones digit (ASCII)	
13	ASCII space	0x20
14	Hour tens digit (ASCII)	
15	Hour ones digit (ASCII)	
16	Carriage Return	0x0D

Status 1 byte
Bit 7-6: always = 01 (to force displayable ASCII characters)
Bit 5: always = 0
Bit 4: always = 0
Bit 3: always = 0
Bit 2: always = 0
Bit 1: always = 1
Bit 0: transmitter status (0=off, 1=on)

The BT Format has the same basic format as the B Format except speeds are replaced with times. If a sensor is configured for this format and connected to a PC running the demo app, the unit's internal real-time clock's time is displayed in the app's four windows: hh mm ss fs.

BT Format messages are 16 bytes in length. The baud rate setting must be 4800 or greater to ensure that a complete message is sent before the radar processes a new message to send.

7.16 DT Format – ASCII Date/Time stamp from the unit's internal real-time clock

Byte #	Description	Value
1	Year thousands digit (ASCII)	
2	Year hundreds digit (ASCII)	
3	Year tens digit (ASCII)	
4	Year ones digit (ASCII)	
5	ASCII slash ("/")	0x2F
6	Month tens digit (ASCII)	
7	Month ones digit (ASCII)	
8	ASCII slash ("/")	0x2F
9	Date tens digit (ASCII)	
10	Date ones digit (ASCII)	
11	ASCII space	0x20
12	Hour tens digit (ASCII)	
13	Hour ones digit (ASCII)	
14	ASCII colon (":")	0x3A
15	Minute tens digit (ASCII)	
16	Minute ones digit (ASCII)	
17	ASCII colon (":")	0x3A
18	Second tens digit (ASCII)	
19	Second ones digit (ASCII)	
20	ASCII decimal point (".")	0x2E
21	Fractional second tens digit (ASCII)	
22	Fractional second ones digit (ASCII)	
23	Carriage Return	0x0D

The DT Format message is an ASCII string showing the unit's internal real-time clock's date and time as follows: "2000/12/31 23:59:59.99<cr>".

DT Format messages are 23 bytes in length. The baud rate setting must be 9600 or greater to ensure that a complete message is sent before the radar processes a new message to send.

7.17 DBG1 Format – ASCII information for all tracked statistics targets

This format is only used in the stats unit.

Byte #	Description	Value
1	ASCII “T”	0x54
2	Target number tens digit	
3	Target number ones digit	
4	ASCII space	0x20
5	Target ID thousands digit	
6	Target ID hundreds digit	
7	Target ID tens digit	
8	Target ID ones digit	
9	ASCII space	0x20
10	Target direction – ASCII “C” for closing, “A” for away, “?” for unknown	
11	Last target speed hundreds digit	
12	Last target speed tens digit	
13	Last target speed ones digit	
14	ASCII space	0x20
15	Peak speed direction – “C”, “A” or “?”	
16	Peak speed hundreds digit	
17	Peak speed tens digit	
18	Peak speed ones digit	
19	ASCII space	0x20
20	Average speed direction – “C”, “A” or “?”	
21	Average speed hundreds digit	
22	Average speed tens digit	
23	Average speed ones digit	
24	ASCII space	0x20
25	Target Strength tens digit	
26	Target Strength ones digit	
27	ASCII space	0x20
28	Target duration thousands digit	
29	Target duration hundreds digit	
30	Target duration tens digit	
31	Target duration ones digit	
32	ASCII space	0x20
33	Carriage Return	0x0D

When the DBG1 Format is selected, the unit streams a 33-byte ASCII message as defined above (e.g. “T00 0018 A040 A041 A040 18 0006 <cr>“) for each of the targets being tracked.

If the unit is configured for tenths resolution, a decimal point and tenths digit are added to each speed value (e.g. “T00 0018 A040.1 A041.3 A040.4 18 0006 <cr>”) and the message length is 39 bytes.

If the unit is configured for hundredths resolution, a decimal point and tenths and hundredths digits are added to each speed value (e.g. “T00 0018 A040.18 A041.37 A040.42 18 0006 <cr>”) and the message length is 42 bytes.

Since the unit can track up to 15 targets, the baud rate setting must be set at 115200 to ensure that a complete message for each target is sent before the radar processes new target information.

DBG1 messages can be used with LOG messages described in the next section to monitor stats targets. The following series of messages shows the sensor tracking three targets with IDs of 494, 512 and 515. In the third group, Target ID 512 has disappeared from the sensor's view, and it is LOGged as a timestamped statistic with the info in that LOG message. A few sections later, Target ID 515 disappears and is also LOGged as a stat. Following that, the sensor continues to track Target ID 494.

```
T00  494 C 30 C 35 C 31 68  212
T01  512 C 32 C 33 C 33 51   51
T02  515 C 40 C 42 C 41 51   43

T00  494 C 30 C 35 C 31 67  213
T01  512 C 32 C 33 C 33 51   52
T02  515 C 40 C 42 C 41 51   44

T00  494 C 30 C 35 C 31 63  214
T01  515 C 40 C 42 C 41 51   45

LOG  512 2020/ 9/ 3 10:30:59 CLOS L 32 P 33 A 33 59 3   52

T00  494 C 30 C 35 C 31 60  215
T01  515 C 40 C 42 C 41 51   46

T00  494 C 30 C 35 C 31 51  216
T01  515 C 40 C 42 C 41 51   47

T00  494 C 30 C 35 C 31 59  217
T01  515 C 40 C 42 C 41 51   48

T00  494 C 30 C 35 C 31 54  218
T01  515 C 40 C 42 C 41 51   49

T00  494 C 30 C 35 C 31 56  219

LOG  515 2020/ 9/ 3 10:30:59 CLOS L 40 P 42 A 41 58 3   49

T00  494 C 30 C 35 C 31 56  220

T00  494 C 30 C 35 C 31 53  221

T00  494 C 30 C 35 C 31 59  227
```

7.18 LOG Message – ASCII information for statistics targets as they are lost

This format is only used in the stats unit.

Byte #	Description	Value
1	ASCII "L"	0x4C
2	ASCII "O"	0x4F
3	ASCII "G"	0x47
4	ASCII space	0x20
5	Target ID thousands digit	
6	Target ID hundreds digit	
7	Target ID tens digit	
8	Target ID ones digit	
9	ASCII space	0x20
10	Year thousands digit (ASCII)	
11	Year hundreds digit (ASCII)	
12	Year tens digit (ASCII)	
13	Year ones digit (ASCII)	
14	ASCII slash ("/")	0x2F
15	Month tens digit (ASCII)	
16	Month ones digit (ASCII)	
17	ASCII slash ("/")	0x2F
18	Date tens digit (ASCII)	
19	Date ones digit (ASCII)	
20	ASCII space	0x20
21	Hour tens digit (ASCII)	
22	Hour ones digit (ASCII)	
23	ASCII colon (":")	0x3A
24	Minute tens digit (ASCII)	
25	Minute ones digit (ASCII)	
26	ASCII colon (":")	0x3A
27	Second tens digit (ASCII)	
28	Second ones digit (ASCII)	
29	ASCII space	0x20
30	Direction first character (ASCII)	"A" or "C"
31	Direction second character (ASCII)	"W" or "L"
32	Direction third character (ASCII)	"A" or "O"
33	Direction fourth character (ASCII)	"Y" or "S"
34	ASCII space	0x20
35	ASCII "L"	0x4C
36	Last target speed hundreds digit	
37	Last target speed tens digit	
38	Last target speed ones digit	
39	ASCII space	0x20
40	ASCII "P"	0x50
41	Peak target speed hundreds digit	
42	Peak target speed tens digit	
43	Peak target speed ones digit	
44	ASCII space	0x20
45	ASCII "A"	0x41

46	Average target speed hundreds digit	
47	Average target speed tens digit	
48	Average target speed ones digit	
49	ASCII space	0x20
50	Target Strength tens digit	
51	Target Strength ones digit	
52	ASCII space	0x20
53	Target classification	
54	ASCII space	0x20
55	Target duration thousands digit	
56	Target duration hundreds digit	
57	Target duration tens digit	
58	Target duration ones digit	
59	ASCII space	0x20
60	Carriage Return	0x0D

When LOG messages are enabled with the Enable Stats LOG Messages setting on a port, the unit generates a 60-byte ASCII message as defined above
(e.g. "LOG 0015 2000/12/31 23:59:59 CLOS L040 P041 A040 19 2 0077 <cr>") for each of the targets lost in the last radar measuring period. It appends these LOG message(s) to the end of the selected standard streaming format messages.

If the unit is configured for tenths resolution, a decimal point and tenths digit is added to each speed value
(e.g. "LOG 0015 2000/12/31 23:59:59 CLOS L040.1 P041.3 A040.4 19 2 0077 <cr>") and each LOG message is 66 bytes long.

If the unit is configured for hundredths resolution, a decimal point and tenths and hundredths digits are added to each speed value
(e.g. "LOG 0015 2000/12/31 23:59:59 CLOS L040.18 P041.37 A040.42 19 2 0077 <cr>") and each LOG message is 69 bytes long.

Due to the length of these messages and the variable number of them, the baud rate setting should be set at 115200 to ensure that all generated messages are sent before the radar processes new target information.

To ensure that all LOG messages are transmitted, the Message Period value should be set to 0. If it is set higher to skip some streaming messages, any LOG messages meant to be appended to them will be lost.

8 Handshake Speed Data Protocols

When a handshake (polling) protocol is selected, the Stationary Speed Sensor II sends only one speed message for each speed data request (poll) it receives from the controller.

8.1 EE Polling

The simple EE Format Request is a two byte message as shown below. The response from the Stationary Speed Sensor II is a four byte message carrying fields for live visual speed (in hexadecimal) and direction. Since there is no addressing in the request message, it is assumed that it is directed to a unit with a Stationary Speed Sensor II ID of 2; and only a unit with ID=2 responds to it.

The EE Format only reports one speed - the strongest visual speed is reported.

When configured for Ones resolution, the 12 speed bits can carry a maximum speed of 4095. When in Tenths, the maximum is 409.5. And in Hundredths, it's 40.95.

8.1.1 EE Format Request (from Controller to Stationary Speed Sensor II)

Byte #	Description	Value
1	Start ID	0xEE
2	Check byte	0x12 (0xEE + 0x12 = 0 (mod 256))

8.1.2 EE Format Response (from Stationary Speed Sensor II to Ctlr)

Byte #	Description	Value
1	Start ID	0xEE
2-3	Speed (Byte 2 holds Bits 15-8) (Byte 3 holds Bits 7-0)	Bit 15 – valid bit (1=valid speed) Bit 14-13 – direction (11=away, 00=unknown, 01=closing Bit 12 – unused Bit 11-0 – speed in selected units and unit resolution
4	Check byte	Bytes 1-4 sum to 0 (mod 256)

8.2 EA Polling

EA Polling Request messages are like those for EE, but they contain Destination and Source IDs as shown below. The source ID is always 1 for the controller. The destination ID can be any value in the range from 2 through 254, and only a Stationary Speed Sensor II with that address will respond. Its response to the EA poll is to send a single speed message in the streaming format selected by the Output Format setting for that port. Only those ports configured as half-duplex respond to EA polling. Full-duplex ports stream speed messages continuously.

The demo PC application does not support EA polling.

8.2.1 EA Polling Request (from Controller to Stationary Speed Sensor II)

#	Description	Value
1	Start ID	0xEA
2	Destination ID	0x02 – 0xFE (2-254)
3	Source ID	0x01
4	Check byte	Bytes 1-4 sum to 0 (mod 256)

Examples of EA Polling Requests for different Destination IDs:
Note: Last byte of sum always = 00. Disregard any higher bytes for modulo 256 math.

Destination ID = 2	Destination ID = 37 (0x25)
0xEA	0xEA
0x02	0x25
0x01	0x01
0x13	0xF0
~~0x1~~00	~~0x2~~00

Method to calculate check byte for a given Destination ID e.g. ID 52 (0x34):
Subtract known bytes from 0x00.

0x00
\- 0xEA
\- 0x34
\- 0x01
~~0xFF~~E1

Disregard all but the lowest byte of the result. The check byte = 0xE1, so as above:

Destination ID = 52 (0x34)
0xEA
0x34
0x01
0xE1
~~0x2~~00

8.3 Polled Mode for D0-D4 Formats

The D0-D4 Formats described in Section 7 may also be used in polled mode. If polled mode is selected on the desired port, sending a 3 byte poll string of “*P<cr>”, (0x2A 0x50 0x0D) causes a return of the current target speed in the selected D0-D4 format. Used in conjunction with the Format D Polled Mode setting, only use the *P poll on full-duplex, streaming ports to reduce the quantity of streamed messages. On half-duplex ports, use EA polling as described in Section 8.2.

The demo PC application does not support polling in the D0-D4 formats.

9 Configuration Setting Descriptions

All the control and configuration settings available for the Stationary Speed Sensor IIs are described in this section. Here, they are arranged in the following groups of related function.

1. Basic Configuration
2. COM Ports
3. Target Recognition
4. Target Filtering
5. Speed Presentation
6. Locking Targets
7. Real-time Clock
8. Aux Pin Usage
9. Traffic Statistics (stats unit only)
10. System

The tables at the beginning of each of the sections below list the settings included in each group. The Setting column shows the setting names. The ID column shows the Packet Type and ID number to be used for each setting when building a Configuration Protocol message or command (Refer to Section 11 for the protocol format).

The Default column contains the factory default values for each setting.
√ in this column means that the setting is not used to configure a setting. It is used to request an action or status from the Stationary Speed Sensor II. And the Available Values column shows the possible values for each setting.

The table in Section 10 lists all the available settings in order of ID number for ease of reference.

9.1 Basic Configuration

Setting	ID	Default	Available Values
Transmitter Control	1/42	1	0 = Hold 1 = Transmit 2 = Automatic (stats unit only)
Mode	1/1	0	0 = Stationary
Target Direction	1/2	0	0 = Both 1 = Closing 2 = Away
Units	1/20	0	0 = MPH 1 = km/h 2 = knots 3 = meters/sec 4 = feet/sec 5 = cm/sec
Unit Resolution	1/21	0	0 = Ones

			1 = Tenths (default for Low Speed Sensor II 200-0880-03) 2 = Hundredths
OSD Date Time (CCTV unit only)	1/40	0	0 = Disabled 1 = Enabled
OSD NTSC/PAL (CCTV unit only)	1/56	0	0 = NTSC 1 = PAL
OSD On Screen Alarm Display (CCTV unit only)	2/6	1	0 = Disabled 1 = Enabled
OSD Alarm Type (CCTV unit only)	1/57	0	0 = Over 1 = Under

The X/Y notation for IDs in the table above means to use X for the Packet Type field in a Configuration Protocol command and to use Y for the Setting ID value. Refer to Section 11 for a description of the Configuration Protocol format.

The **Transmitter Control** setting (1/42) turns the radar transmitter on or off. The transmitter must be on for the radar to register speeds. The Automatic value is used in conjunction with statistics gathering. When a survey is loaded into the unit, it includes calendar settings to allow the unit to run statistics during certain time periods on certain days. When the Transmitter Control is set for Automatic, the statistics function controls the state of the transmitter by turning it off if no statistics are being gathered. This automatic control results in lower power draw and the ability run an interrupted survey for more days.

The **Mode** setting (1/1) is fixed in stationary mode (value = 0) and can be read but not changed.

The **Target Direction** setting (1/2) tells the radar to look for targets moving in certain direction(s) relative to the unit. The Target Direction values are Away to monitor receding targets only, Closing to monitor approaching targets only and Both to monitor targets moving in either direction.

The **Units** setting (1/20) selects the units of speed measurement. The available options are MPH, km/h, knots, meters/sec, feet/sec and cm/sec.
The **Unit Resolution** setting (1/21) can be set to report speeds in whole units, as 25; tenths of units, as 25.4; or hundredths of units, as 25.43.

The OSD (On Screen Display) settings are for the Speed CCTV Sensor model only. **OSD Date Time** enables the date and time to be overlaid on the video. **OSD NTSC/PAL** selects the video format. **OSD On Screen Alarm Display** enables an on-screen indication when the sensor detects a vehicle speed outside its alarm setting. And the **OSD Alarm Type** selects whether the alarm indication occurs when a target is over or under the alarm speed threshold.

9.2 COM Ports

Setting	COM A ID	COM B ID	COM C ID	COM D ID	Default	Available Values
COM A Link Configuration	2/16	-----	-----	-----	1	0 = 485 2W Half Duplex 1 = 485 4W Full Duplex
COM C Link Configuration	-----	-----	2/48	-----	0	0 = Disabled 1 = 485 2W Half Duplex
COM D Link Configuration	-----	-----	-----	2/64	0	0 = USB No Flow Control 1 = USB w/ Flow Control
Baud Rate	2/17	2/33	2/49	2/65	9	5 = 9600 baud 6 = 19200 baud 7 = 38400 baud 8 = 57600 baud 9 = 115200 baud 10 = 230400 baud 11 = 460800 baud 12 = 921600 baud
Output Format	2/18	2/34	2/50	2/66	2 for all but COM C 0 for COM C	0 = None (no serial output) 1 = A 2 = B 3 = D0 4 = D1 5 = D2 6 = D3 7 = D4 8 = EE 9 = Enhanced Output 10 = G 11 = GS 12 = S 13 = DBG1 (stats unit only) 14 = BT 15 = DT 16 = F0 17 = F1 18 = F2
Message Period	2/19	2/35	2/51	2/67	0	0 – 10000 ms (10 sec)
Leading Zero Character	2/20	2/36	2/52	2/68	1	0 = ASCII Space (0x20) 1 = ASCII Zero (0x30)
Format A Speed	2/21	2/37	2/53	2/69	0	0 = Strong Visual Target 1 = Fast Visual Target
Zeros After Target Loss	2/22	2/38	2/54	2/70	2	0 = No Zeros 1 = One Zero 2 = Stream Zeros
Format D Direction Character	2/23	2/39	2/55	2/71	0	0 = Disabled 1 = Enabled
Format D Update On Change Only	2/24	2/40	2/56	2/72	0	0 = Disabled 1 = Enabled

Format D Zero Report	2/25	2/41	2/57	2/73	0	0 = Disabled 1 = Enabled
Format D Polled Mode	2/26	2/42	2/58	2/74	0	0 = Disabled 1 = Enabled
Statistics LOG Messages (stats unit only)	2/27	2/43	2/59	2/75	0	0 = Disabled 1 = Enabled
Statistics Record Messages (stats unit only)	2/28	2/44	2/60	2/76	0	0 = Disabled 1 = Enabled

The X/Y notation for IDs in the table above means to use X for the Packet Type field in a Configuration Protocol command and to use Y for the Setting ID value. Refer to Section 11 for a description of the Configuration Protocol format.

Use the settings in this section to configure the serial ports and the messages they transmit.

The **Link Configuration** settings (2/16, 2/48 and 2/64) have different values and meanings for the different COM ports. Refer to the Connecting to the COM Ports section for more detail on the link configurations and their inter-dependencies.
COM A is an RS-485 port and can be configured as a 4-wire full-duplex port or as a 2-wire half-duplex port. If COM C is enabled, COM A cannot be configured as a 4-wire full-duplex port.
COM C is always a 2-wire half-duplex port. By default it is disabled, but it can be enabled if COM A is set up for 2-wire half-duplex operation.
COM D is a USB port and can be configured with or without flow control.
After a Link Configuration setting is changed, it will immediately report its new value to the controller, but the setting does not take effect to actually change the link type until the Process Baud/Link Update command is sent. This is so that the link type does not change while communicating over the link. The new setting will also take effect after a power cycle – in this case it is unnecessary to send the Process Baud/Link Update command. Refer to the System subsection in this section for more details on the Process Baud/Link Update command.

Each COM port has its own **Baud Rate** setting (2/17, 2/33, 2/49, 2/65) which can be set in the range from 9600 to 921600. 115200 is the default. Regardless of the baud rate, the serial port is always configured for 10 bit asynchronous data with 1 start bit, 8 data bits, 1 stop bit and no parity (8N1).
After a Baud Rate setting is changed, it will immediately report its new value to the controller, but the setting does not take effect to actually change the baud rate until the Process Baud/Link Update command is sent. This is so that the baud rate does not change while communicating over the link. The new setting will also take effect after a power cycle – in this case it is unnecessary to send the Process Baud/Link Update command. Refer to the System subsection in this section for more details on the Process Baud/Link Update command.

The Stationary Speed Sensor II can transmit speed and status messages out the serial port in different formats for different applications. The **Output Format** setting (2/18, 2/34, 2/50 and 2/66 for the four COM ports) selects the format for transmitted messages. Refer to Appendices A and B for more details on the message contents for different formats.

A half-duplex RS-485 port cannot be configured to stream out continuous speed data because it would never be able to receive a command from the controller over the same pair of wires. For this reason, half-duplex ports are limited to the EE and EA handshaking protocols described in Section 7 and only send out a speed message when requested (or polled) by the controller.
A full-duplex port (RS-232 or RS-485) continuously streams out messages in any format described in Section 7. It can also respond to EE and D0-D4 polling described in Section 8 – but not EA polling.

When configured for a streaming message format, the Stationary Speed Sensor II sends a message each time the radar generates new internal speed measurements – about 21 times per second or every 48 milliseconds. This is the default (and fastest) rate for streaming messages. If that rate is too fast for a user's application, it can be slowed down using the **Message Period** setting (2/19, 2/35, 2/51 and 2/67 for the four ports). With a range of 0 to 10,000 milliseconds, a delay of up to 10 seconds can be configured for the time between the beginning of one message and the next. This feature is only applicable for full-duplex ports which can stream data.
It is important to note that the sensor only has an opportunity to send a new message at its internal operating rate of once per 48 ms. That means any value for this setting between 0 and 48 results in a 48 ms period. Any value between 49 and 96 results in a 96 ms period. Generalizing, whatever actual value is selected for this setting results in messages sent out at a rate of the next higher multiple of 48 ms.

The **Leading Zero Character** setting (2/20, 2/36, 2/52 and 2/68 for the four ports) defines the character used for leading zeros on speeds in ASCII visual speed message formats (A, B, D0-D3 and S). It can be set = 0 for a space character (ASCII 0x20) or = 1 for a zero character (ASCII 0x30). Examples below show how different numbers would appear on a speed sign or print-out.
Space – ASCII spaces are used for leading zero characters
"500"
" 50"
" 5"
"   "
Zero – ASCII zeros are used for leading zero characters
"500"
"050"
"005"
"000"

The **Format A Speed** setting (2/21, 2/37, 2/53 and 2/69 for the four ports) determines what speed will be reported in the A Format messages: either the Strong visual target or the Fast visual target. It only applies when the Output Format setting is for the A Format.

Use the **Zeros After Target Loss** setting (2/22, 2/38, 2/54 and 2/70 for the four ports) to configure what, if any, streaming messages are sent when no target is present. After a target is lost and when no valid speeds are detected, the Stationary Speed Sensor II by default streams messages with speed values set to zero. As an option, a port can be configured to stop streaming messages completely after the last valid message until a new target is acquired. A third option sends one "zero speed" message after the last valid

message before halting the message stream. This single message might be used to clear a speed board after the last speed was displayed.
Beware of changing the Zeros After Target Loss setting from the default "streaming" value. When no target is present and the Stationary Speed Sensor II is not transmitting any serial data, the link can appear broken or dead.

The D0, D1, D2 and D3 formats have a field for an ASCII direction character. It indicates "+" for an approaching target, "-" for a receding target or "?" if the direction cannot be determined. Enable or disable this byte in the message using the **Format D Direction Character** setting (2/23, 2/39, 2/55 and 2/71 for the four ports).

When streaming in any of the D0-D4 formats, another way to reduce speed message traffic on the link is to send a message only when the new speed reading is different from the last. Enable or disable this feature with the **Format D Update On Change Only** setting (2/24, 2/40, 2/56 and 2/72 for the four ports). When it is enabled and there are no targets, the Stationary Speed Sensor II does not send out any speed messages, and the link may appear dead.
To turn on a "keep-alive" signal from the unit, enable the **Format D Zero Report** setting (2/25, 2/41, 2/57 and 2/73 for the four ports) to configure it to send a zero-speed message every 2 seconds when no target is present. These two settings are limited to a port configured for the D0, D1, D2, D3 or D4 Format.

One last feature that the D0-D4 Formats share is that they can operate in polled mode like the EE Format. When the **Format D Polled Mode** setting (2/26, 2/42, 2/58 and 2/74 for the four ports) is enabled, a speed message is only transmitted after the Stationary Speed Sensor II receives a poll message from the controller. The poll is "*P" followed by a carriage return (in hex: 0x2A, 0x50, 0x0D). No messages are automatically streamed out when this setting is enabled.
Enable this setting only on full-duplex ports. It is only intended as a way to reduce streamed messages. To poll for a D0-D4 format message on a half-duplex port, use EA polling as described in Section 8.2.

When the stats sensor unit is tracking targets and gathering statistics, enabling the **Statistics LOG Messages** setting (2/27, 2/43, 2/59 and 2/75 for the four ports) configures the sensor to append ASCII strings to the end of standard streaming messages. These strings identify targets that were lost from tracking in the last radar measurement period – this is the point at which a target is included in the statistics counts.
This feature is especially effective when used in conjunction with the DBG1 streaming format. The DBG1 format streams out strings of data after each 48 ms processing period for each target being tracked. Monitoring this data can tell a user how many targets are being tracked; what their latest, fastest and average speeds are; and how long they have been tracked. In the streamed data for the period following the loss of one or more targets, LOG messages will be appended to show the final data for each lost target as it is saved in the statistics gathering function.
In order to receive all LOG messages, ensure that the Message Period setting = 0 so that the sensor sends out messages for each 48ms period. If the message period is longer, speed messages are not sent out each period; LOG messages for skipped periods are not saved – they are lost. In addition, always use a full-duplex, streaming port to monitor LOG messages. As above, they are not saved up for whenever the controller may poll for a speed message.

Use the **Statistics Record Messages** setting (2/28, 2/44, 2/60 and 2/76 for the four ports) on the stats unit to enable raw statistics records to be streamed out a port when they are generated – normally on a 1, 2, 5, 10, 30 or 60 minute period. These messages are only generated if the survey is configured for External data. Refer to the Traffic Statistics section for more detail on tracking, gathering and storing statistics data.

9.3 Target Recognition

Setting	ID	Default	Available Values
Faster Target Tracking	1/13	1	0 = Disabled 1 = Enabled
Sensitivity	1/4	16	0 (min) – 16 (max)
Target Acquisition Density	1/55	70	1 – 100%
Target Acquisition Span	1/122	500	1 – 650 ms
Target Loss Density	1/62	0	0 – 100%
Target Loss Span	1/123	500	1 – 650 ms
Visual Target Strength Sensitivity	1/85	99	1 (min) – 99 (max)
Stats Target Strength Sensitivity (stats unit only)	1/120	50	1 (min) – 99 (max)

The X/Y notation for IDs in the table above means to use X for the Packet Type field in a Configuration Protocol command and to use Y for the Setting ID value. Refer to Section 11 for a description of the Configuration Protocol format.

Before covering the settings used to adjust the target recognition features of the Stationary Speed Sensor II, a more detailed definition of “target” is needed. The base sensor unit has only one type of target: **Visual Targets.** A sensor unit with stats identifies two different types of targets: **Visual Targets** and **Stats Targets**.
Visual Targets are the targets that might display on a “Your Speed Is” sign on the side of the road. The speed of a target far from the radar/sign and at the distant edge of the radar’s range may flicker on the display until it gets close enough to the radar for solid recognition. Basically, the radar reports what it actually detects in real time for Visual Targets. Strong targets, fast targets and locked targets reported in speed messages are of the Visual Target type.
When a sensor with stats is counting targets for statistics, it should count each target only once. After the radar sees a Stats Target for the first time, it needs to “hold on to it” until it completely disappears from the radar’s view – without the target dropping out and reappearing. For this and other reasons, Stats Targets are treated differently in the radar processing. Last speed, peak speed and average speed reported in statistics messages are of the Stats Target type. The sensor models with stats can track up to 15 different Stats Targets of different speeds and/or sizes.

The **Faster Target Tracking** setting (1/13) allows acquisition and tracking of a faster visual target when a slower target has already been acquired as the strong visual target. An example of a time when this capability is helpful is when a small car is passing a large truck. The truck is reported as the main target because of its larger size. The car is then reported as the fast target.

Sensitivity (1/4) is the main setting used by the radar affecting target recognition. With a higher sensitivity, the Stationary Speed Sensor II looks as far away as possible for targets and gives the unit its highest performance. It is also able to "see" smaller targets. Use lower sensitivity for targets closer to the unit and when you want to restrict it from seeing smaller objects or objects farther out in the background. The value of this setting affects recognition of both visual targets and stats targets.
The range of values for this setting is 0 through 16. Use 16 for maximum sensitivity and 1 for minimum sensitivity. A sensitivity setting of 0 allows no target acquisition at all.

Standard radar operation reports a target speed when analysis of its most recent data results in a target meeting the sensitivity requirements outlined above. Once a target is acquired, it is tracked until it no longer meets those requirements.
The Target Acquisition and Loss settings give more control over the criteria used to acquire and then lose a target. They affect recognition of both visual and stats targets.
The **Target Acquisition Density** and **Target Acquisition Span** settings (1/55 and 1/122) are used as a pair to affect when the radar acquires a target. The Density value specifies a percentage (1-100), and the Span value specifies a length of time (1-650 ms). As an example, using values of 70% and 500 ms configure a sensor to acquire a target only after it sees it 70% of the time over any half-second period.

The **Target Loss Density** and **Target Loss Span** settings (1/62 and 1/123) are used in a similar way to tell the radar when it should lose a target. For example, values of 0% and 500 ms tell it to hold on to a target until it doesn't see it at all (0% of the time) for a full half-second.

Whereas the Sensitivity setting described above compares the target strength to the ambient noise from other radar reflections (signal to noise ratio) to declare recognition of a target, the Target Strength Sensitivity settings can be used to recognize or suppress targets depending purely on the target's strength. A higher value allows smaller, lower strength targets to be acquired. A lower value requires the target to be larger/closer before it is acquired.
The **Visual Target Strength Sensitivity** setting (1/85) only affects recognition of visual targets, and the **Stats Target Strength Sensitivity** setting (1/120) only affects recognition of stats targets.

9.4 Target Filtering

Setting	ID	Default	Available Values
Low Speed Threshold	1/7	0	0 - 8941
High Speed Threshold	1/11	200	0 - 8941

The X/Y notation for IDs in the table above means to use X for the Packet Type field in a Configuration Protocol command and to use Y for the Setting ID value. Refer to Section 11 for a description of the Configuration Protocol format.

Several settings can be used to filter out undesired targets. The first step is to ignore targets that are not moving in the desired direction. This is accomplished with the **Target Direction** setting (1/2) as described in the first subsection of this section, Basic Configuration.

Slow target speeds can be filtered out using the **Low Speed Threshold** setting (1/7). The range of values for this setting is 0 through 8941. Any targets with a speed slower than this threshold are ignored. This feature can be helpful when monitoring traffic around slow moving objects like pedestrians or trees blowing in the wind.
In a like manner, fast target speeds can be filtered out using the **High Speed Threshold** setting (1/11) which also has a range of 0-8941. Targets with speeds higher than this threshold are also ignored. It is important to set the High Speed Threshold higher than the Low Speed Threshold or else all targets will be ignored.

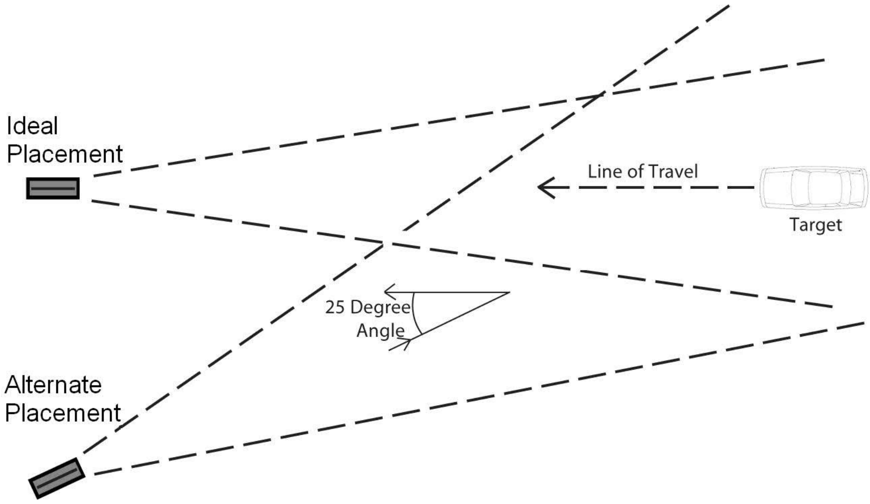
9.5 Speed Presentation

Setting	ID	Default	Available Values
Cosine Angle 1	1/18	0	0-70 degrees (1° increments)
Cosine Angle 2	1/19	0	0-70 degrees (1° increments)
Holdover Time	1/88	2	0 – 10 = 0 – 10 seconds 11 = Forever (default is 0 for Low Speed Sensor II 200-0880-03)

The X/Y notation for IDs in the table above means to use X for the Packet Type field in a Configuration Protocol command and to use Y for the Setting ID value. Refer to Section 11 for a description of the Configuration Protocol format.

The internal measurements made by the radar are corrected and/or held after target loss depending on the settings in this section.

Stationary Speed Sensor IIs measure the most accurate speeds when targets are moving directly toward or away from them. Unfortunately, it is usually not advisable to mount one directly in the path of traffic. As with any radar, aiming at an angle results in lower speeds. At slight angles the error is very small; however at larger angles the error can become substantial.



These low speeds can be automatically corrected by the sensor using the **Cosine Angle** settings (1/18 and 1/19). Two settings are provided so two corrections can be made simultaneously. The two settings are independent and interchangeable. Either one can be used by itself or with the other as a pair. One cosine angle setting might be used for the horizontal "beside-the-road" angle shown in the diagram above. The other might be set for the vertical "over-the-road" angle if the Stationary Speed Sensor II is mounted on a pole. When the aim of the radar is aligned with the target's path, both angles should be set for 0 degrees, and no correction takes place. The range of these settings is 0-70 degrees.

The **Holdover Time** setting (1/88) is used to smooth the speed readings during intermittent dropouts. It only affects visual targets (not stats targets). When the unit is configured for a streaming message format, a message is transmitted out the COM port for each radar measurement period – every 48ms. The radar returns a speed of zero if it is unable to determine a valid speed for any given measurement time. When conditions are noisy or when the target is very small and almost out of range, these missed measurements (or dropouts) can make the series of speed reports appear erratic or jumpy.
Rather than interjecting dropouts in the series for invalid speeds, the last valid reading can be repeated (or held over) to provide continuity for noisy, intermittent targets. The Holdover Time setting can be set for 0-10 seconds in 1 second increments, or it can be set to Forever to hold the last speed the radar saw until a new one is acquired.

9.6 Locking Targets

Setting	ID	Default	Available Values
Strong Lock Enable	1/15	1	0 = Disabled 1 = Enabled
Fast Lock Enable	1/14	1	0 = Disabled 1 = Enabled
Strong Lock	1/43	0	0 = Release 1 = Lock
Fast Lock	1/44	0	0 = Release

			1 = Lock

The X/Y notation for IDs in the table above means to use X for the Packet Type field in a Configuration Protocol command and to use Y for the Setting ID value. Refer to Section 11 for a description of the Configuration Protocol format.

While monitoring a target's visual speed, the sensor can "lock-in" the speed at any point in time while still tracking the changing speed of the target (track-through lock). Either the speed of the strong visual target or the fast visual target can be locked but not both at the same time. Stats targets cannot be locked. To monitor locked targets, use the B or Enhanced Output Format which have fields to report the locked speed.

The **Strong Lock Enable** setting (1/15) disables or enables the locking feature for strong visual targets. If locking of fast visual targets is desired, in addition to enabling Faster Target Tracking as described in the Target Recognition subsection of this section, the **Fast Lock Enable** setting (1/14) must also be enabled.

Lock and release speeds using the **Strong Lock** (1/43) and **Fast Lock** (1/44) commands. The current locked speed, strong or fast, must be released before any other speed can be locked.

9.7 Real-time Clock

Setting	ID	Default	Available Values
RTC Calibration Factor	1/106	0x80	0x80 - 0xC8
RTC Year	1/107	none	2000 - 2399
RTC Month	1/108	none	1 - 12
RTC Date	1/109	none	1 - 31
RTC Hour	1/110	none	00 - 23
RTC Minute	1/111	none	00 - 59
RTC Second	1/112	none	00 - 59
RTC Fractional Second	1/113	none	0 - 99
RTC Weekday	1/124	none	1 (Monday) – 7 (Sunday)

The X/Y notation for IDs in the table above means to use X for the Packet Type field in a Configuration Protocol command and to use Y for the Setting ID value. Refer to Section 11 for a description of the Configuration Protocol format.

The real-time clock in the sensor has an internal battery and keeps the current time and date whether the unit is powered up or not. The following settings can be changed or read to set or get the current time and date:
The **RTC Calibration Factor** setting (1/106) accepts values between 128 (0x80) and 200 (0xC8). A higher value will speed up the clock and a lower value will slow it down.
The **RTC Year** setting (1/107) holds a value between 2000 and 2399.
The **RTC Month** setting (1/108) holds a value between 1 and 12.
The **RTC Date** setting (1/109) holds the day of month value between 1 and 31.
The **RTC Hour** setting (1/110) holds a 24 hour clock value between 0 and 23.
The **RTC Minute** setting (1/111) holds a value between 0 and 59.
The **RTC Second** setting (1/112) holds a value between 0 and 59.

The **RTC Fractional Second** setting (1/113) holds a value between 0 and 99 representing 0 to 0.99 seconds.
The **RTC Weekday** setting (1/124) holds the day of week value between 1 and 7 where 1=Monday and 7=Sunday.

9.8 Aux Pin Usage

Setting	ID	Default	Available Values
Aux Pin Configuration	1/16	0	0 = Disabled 1 = Speed Alarm 2 = Stats Status (stats unit only)
Alarm Speed Threshold	1/12	322	0 - 8941
Alarm Type (appears under Basic Configuration for CCTV sensor)	1/57	0	0 = Over 1 = Under

The X/Y notation for IDs in the table above means to use X for the Packet Type field in a Configuration Protocol command and to use Y for the Setting ID value. Refer to Section 11 for a description of the Configuration Protocol format.

The Stationary Speed Sensor II can provide an external signal for notification of a condition or status. Refer to the Connecting the Stationary Speed Sensor II/Auxiliary Relay Connections section for details on the physical connection of the AUX contacts used.

Use the **Aux Pin Configuration** setting (1/16) to enable either a speed alarm or a stats status notification. When configured for Speed Alarm, the AUX relay activates when a visual strong target is traveling faster or slower than a preset alarm threshold.
When configured for Stats Status (on stats sensors only), the AUX signal can be connected to an LED to provide a readiness indicator from the unit. As long as the radar transmitter is off, the AUX contacts are open. When the transmitters is on, the contacts close for 0.5 seconds and open for 4.5 seconds for a slow blink signaling that the unit is monitoring traffic for stats. As each target is logged the unit performs a quicker sequence of 0.25 seconds closed and 0.25 seconds open.

When the Speed Alarm feature is enabled, use the **Alarm Speed Threshold** setting (1/12) to set up the target speed where the speed alarm activates. The range of values for this setting is 0-322. When a strong visual target is traveling faster (or slower) than this threshold, the state of the AUX contacts changes from an open circuit to a contact closure. When the target slows down (or speeds up) out of the alarm range, the contact closure opens again.

Use the **Alarm Type** setting (1/57) to determine whether the alarm condition is triggered by a target traveling over or under the alarm speed threshold.

9.9 Traffic Statistics (stats unit only)

Setting	ID	Default	Available Values
Statistics Monitor	1/9	0	0 = Disabled 1 = Enabled
Minimum Tracking Distance	2/4	50	0 – 500 feet
Classification Training	2/96	0	0 = Disabled 1 = Enabled
Training Status	2/97	0	0 = Incomplete 1 = Complete
Get Training Data	2/98	√	1 = Request current status of training data (read only)
Away Class 1 Threshold	2/99	84	0 – 99
Away Class 2 Threshold	2/100	68	0 – 99
Away Class 3 Threshold	2/101	53	0 – 99
Away Class 4 Threshold	2/102	37	0 – 99
Away Class 5 Threshold	2/103	0	0 – 99
Closing Class 1 Threshold	2/104	84	0 – 99
Closing Class 2 Threshold	2/105	68	0 – 99
Closing Class 3 Threshold	2/106	53	0 – 99
Closing Class 4 Threshold	2/107	37	0 – 99
Closing Class 5 Threshold	2/108	0	0 – 99
Stats Record Type	2/109	0	0 = Individual Records 1 = Grouped Records

The X/Y notation for IDs in the table above means to use X for the Packet Type field in a Configuration Protocol command and to use Y for the Setting ID value. Refer to Section 11 for a description of the Configuration Protocol format.

The Stationary Speed Sensor II model with stats can count vehicles and store statistics on their speeds and classifications over time. Most of the user interface for the statistics functions is provided in the StalkerSTATS PC application, but some functions can be handled with these settings.

The **Statistics Monitor** setting (1/9) turns on or off the basic statistics gathering functions. It must be enabled for statistics to be counted.

The **Minimum Tracking Distance** setting (2/4) can be used to filter out some short-lived targets during a survey. An ideal survey location would not have intersecting streets or driveways along the path of the surveyed vehicles, but sometimes this cannot be avoided. To keep from counting vehicles that only travel a portion of the survey path by turning onto or off of the roadway, set the Minimum Tracking Distance for a distance (in feet) that a target needs to travel to be counted in the survey. The range of settings is 0-500 feet with a default of 50 feet.

One of the qualities of stats targets is their classification: Class 1 (larger targets) through Class 5 (smaller targets). The sensor determines a target's class based on the amount of initial transmitted radar energy that bounces off the target and is returned to the sensor. This returned energy depends not only on the physical size of the target but also the target's shape, surface topography and physical bearing to the radar. In some cases, a large target may return less energy than a smaller target. So while target classes may not correlate exactly to different types of vehicles, Class 1 targets appear relatively larger to the radar than Class 2 and so on.

The sensor calculates the intensity, in the range 1-99, of the returned radar signal for each target it tracks. It then assigns a Class depending on where that intensity falls in the range of Class Thresholds. The ten thresholds are split into five for **Away Class n Threshold** settings (2/99 – 2/103) and five for **Closing Class n Threshold** settings (2/104 – 2/108). There are separate sets of thresholds for closing vs. away targets because the radar may be set up on one side of a roadway, and closing targets look different to it than away targets which travel at more of an angle to the radar. Other installation locations provide similar differences.

There are default settings for the thresholds, but they may be set to any level by the user, or the unit may train itself for the range of targets it sees in a particular installation. This is accomplished by setting up the radar on a survey site and turning on the **Classification Training** setting (2/96). The radar will then monitor the next 100 targets it sees, calculate the intensity range of those targets, and then automatically set the thresholds evenly spaced within that range. This training gives reasonable assurance that the statistics survey will provide results with targets spread throughout the class range. Note that if the unit is configured for only one direction of traffic, Away or Closing, it only tracks 100 targets moving in that direction. If it is set up for Both directions, it tracks 100 away targets to determine the Away Thresholds and 100 closing targets for the Closing Thresholds.

As soon as the Classification Training is enabled, the **Training Status** setting (2/97) is automatically set to Incomplete. After the training is complete, the Classification Training setting is automatically disabled, the Training Status is automatically set to Complete, and the Class Threshold settings are updated with the newly calculated thresholds.

While training is in progress, it is possible to monitor how many of the 100 targets have been registered and their intensities. After receiving the **Get Training Data** command (2/98), the unit responds by sending out an ASCII stream of data: an “A” followed by the intensities of the 100 Away targets and then a “C” followed by the 100 Closing intensities. The intensities are initially reported as 0 and are then replaced by the intensities of actual targets as they are tracked.

The training settings are remembered through power cycles, so it is possible to configure the unit to train and power it down before going out to the survey site. Then, on-site, simply aim the unit and power it up. It will then automatically start to train as it sees targets. After completion of training, it then automatically starts to gather statistics based on the trained classification thresholds. The targets monitored during the training period are not included in the statistics counts.

Periodically, statistics are stored in the non-volatile memory of the sensor so that they will remain saved if the sensor is powered down. The **Stats Record Type** setting (2/109) can be configured for Individual Records or for Grouped Records. The default setting is for Individual Target Records. Whenever this setting is changed, all stats target records are erased so that there will never be a mix of individual and grouped records.

When configured for Individual Records, a separate record is created for each target that the sensor counts as a statistic. These records have more detail about each target than the Grouped Records. The Individual Record format is as follows:

Individual Target Record		
Num Bytes	**Field**	**Detail**
2	Record Length	In bytes
1	Record Type	4 for Individual Target Records
2	Record Number	3 through last record number
1	Sensor Unit ID	2 – 254
3	Target Count Date	Year / month / date
4	Target Count Time	Hour / min / sec / fractional seconds (.00 - .99)
1	Target Duration	In seconds
1	Direction/Units**	See Direction/Units Bit Map table below
1	Vehicle Class	Class 1 - 5
2	Contact ID	
2	Average Target Speed	
2	Peak Target Speed	
2	Last Target Speed	
1	Maximum Target Strength	
1	Unused	
1	Unused	
1	Unused	
1	Unused	
1	Unused	
2	Record CRC	
32	Total number of bytes in record	
Note: all bytes are in hex format – not ASCII characters		
Note: all 2-byte fields are stored with low byte first		

Direction/Units Bit Map**	
Bits 1,0	01 = closing 10 = away
Bits 4,3,2	000 = MPH 001 = km/h 010 = knots 011 = m/s 100 = f/s 101 = cm/s
Bits 7,6,5	unused

When configured for Grouped Records, a set of records is created for all the targets the sensor has seen in the latest measurement period. There are separate records for closing vs. away targets and for each of the five possible vehicle classes – up to a total of ten records for each measurement period. No record is stored if there were no targets in a particular combination of direction and class. The Grouped Record format is as follows:

Grouped Target Record		
Num Bytes	**Field**	**Detail**
2	Record Length	In bytes
1	Record Type	3 for Grouped Records
2	Record Number	3 through last record number
4	Record Save Date	Year (0-99) / mon (1-12) / date (1-31) / day of week (1=Monday – 7)
2	Record Save Time	Hour (0-23) / min (0-59)
1	Direction/Units**	See Direction/Units Bit Map table above
1	Vehicle Class	Single class (1-5) or all classes (0)
1	Bucket Speed Span	Min: 1 MPH
1	Bucket Time Span	Min: 1 minute
2	Lowest Speed in Time Span	e.g. 21 MPH
2	First Bucket Count	Target count for lowest speed measured during period
	↕	2 bytes per count for each speed between lowest and highest
2	Last Bucket Count	Target count for highest speed measured during period
2	Record CRC	
19 + 2x	Total number of bytes in record	19 overhead bytes + 2 bytes per bucket count
Note: all bytes are in hex format – not ASCII characters		
Note: all 2-byte fields are stored with low byte first		

9.10 System

Setting	ID	Default	Available Values
Reset Unit	1/84	√	1 = Request a reset of the unit
Force Product Defaults	1/74	0	0 = No Action 1 = Force Settings
Process Baud/Link Update	2/3	0	0 = No Update 1 = Update
Get Product ID	1/37	√	1 = Request the Product ID (read only)
Get Product Type	1/79	√	1 = Request the Product Type (read only)
Get Software Version	1/81	√	1 = Request the Software Version (read only)
Get Hardware ID	1/82	√	1 = Request the Hardware ID (read only)

The X/Y notation for IDs in the table above means to use X for the Packet Type field in a Configuration Protocol command and to use Y for the Setting ID value. Refer to Section 11 for a description of the Configuration Protocol format.

The "Get" settings (or commands) in this section are used to query the Stationary Speed Sensor II for information about itself. The values cannot be changed by the user; they are constant and depend on the model of the unit and version of software loaded into it.

To reset a unit, send the **Reset Unit** command (1/84) with a value of 1. This causes the unit to reset itself after a ten second delay. No settings are changed, but the unit is restarted.

Use the **Force Product Defaults** command (1/74) to return a unit to a known state. All settings are reset to the default values as shown in this section.

The **Process Baud/Link Update** command (2/3) is used after the Link Configuration and Baud Rate commands as described in the COM Ports subsection in this section. Since both of those commands change basic link properties, if the sensor acted on them immediately after receiving them, its response would be in a different baud rate or the link type would change before the response goes out. The consequences could be worse if a controller tries to change multiple settings (as happens with the Dashboard demo PC app) with a baud rate or link type change in the middle of the sequence of commands: the first commands would go through successfully, but any commands after the baud rate or link type changed would not.

Once any baud rate or link configuration settings have been changed without actually affecting the communications link, sending the Process Baud/Link Update command with a value of 1 makes those changes take effect. On receiving the command, the unit will immediately reconfigure the port (or ports if more than one COM port is changed) and send its response in the new baud rate and/or over the new link type. After sending the command, the PC/controller should expect these changes and reconfigure its own configuration on its side of the link.

If the user has access to the sensor's power and can turn it on and off, use of the Process Baud/Link Update command is not necessary. After any baud rate or link type settings have been changed, simply turning the unit off and back on will make the new settings take effect.

A Stationary Speed Sensor II responds to a **Get Product ID** command (1/37) with an ASCII string containing the product model name and the version of software loaded into it. An example is “Stationary Speed Sensor II Ver: 1.1.0”.

The response to a **Get Product Type** command (1/79) is a three byte hexadecimal value associated with the model of the Stationary Speed Sensor II. The values are:

0x52A200	Stationary II Speed Sensor
0xFEDB0B	Traffic Statistics Sensor
0xDF1AEE	Speed CCTV Sensor

The **Get Software Version** command (1/81) returns an ASCII string with the loaded software’s version. e.g. “1.0.0”

The **Get Hardware ID** command (1/82) returns a 32-byte ASCII string with the internal Hardware ID unique to each sensor.

10 Configuration Settings Table

All of the settings available for the Stationary Speed Sensor II are listed below in numerical order of the **Setting IDs** which are shown in decimal and hexadecimal format.

The **Setting Description** column shows the setting names. It also has references to the subsection in Section 9 where the setting is described in detail.

Packet Type	Setting ID		Setting Description
	Dec	Hex	
1	**1**	0x01	Mode 1 – Basic Configuration
1	**2**	0x02	Target Direction 1 – Basic Configuration
1	**4**	0x04	Sensitivity 3 – Target Recognition
1	**7**	0x07	Low Speed Threshold 4 – Target Filtering
1	**9**	0x09	Statistics Monitor (stats unit only) 9 – Traffic Statistics
1	**11**	0x0B	High Speed Threshold 4 – Target Filtering
1	**12**	0x0C	Alarm Speed Threshold 8 – Aux Pin Usage
1	**13**	0x0D	Faster Target Tracking 3 – Target Recognition
1	**14**	0x0E	Fast Lock Enable 6 – Locking Targets
1	**15**	0x0F	Strong Lock Enable 6 – Locking Targets
1	**16**	0x10	Aux Pin Configuration 8 – Aux Pin Usage
1	**18**	0x12	Cosine Angle 1 5 – Speed Presentation
1	**19**	0x13	Cosine Angle 2 5 – Speed Presentation
1	**20**	0x14	Units 1 – Basic Configuration
1	**21**	0x15	Unit Resolution 1 – Basic Configuration
1	**37**	0x25	Get Product ID 10 - System
1	**40**	0x28	OSD Date Time (CCTV unit only) 1 – Basic Configuration
1	**42**	0x2A	Transmitter Control 1 – Basic Configuration
1	**43**	0x2B	Strong Lock 6 – Locking Targets
1	**44**	0x2C	Fast Lock 6 – Locking Targets

1	**55**	0x37	Target Acquisition Density 3 – Target Recognition
1	**56**	0x38	OSD NTSC/PAL (CCTV unit only) 1 – Basic Configuration
1	**57**	0x39	Alarm Type 8 – Aux Pin Usage
1	**62**	0x3E	Target Loss Density 3 – Target Recognition
1	**74**	0x4A	Force Product Defaults 10 - System
1	**79**	0x4F	Get Product Type 10 - System
1	**81**	0x51	Get Software Version 10 - System
1	**82**	0x52	Get Hardware ID 10 - System
1	**84**	0x54	Reset Unit 10 - System
1	**85**	0x55	Visual Target Strength Sensitivity 3 – Target Recognition
1	**88**	0x58	Holdover Time 5 – Speed Presentation
1	**106**	0x6A	RTC Calibration Factor 7 – Real-time Clock
1	**107**	0x6B	RTC Year 7 – Real-time Clock
1	**108**	0x6C	RTC Month 7 – Real-time Clock
1	**109**	0x6D	RTC Date 7 – Real-time Clock
1	**110**	0x6E	RTC Hour 7 – Real-time Clock
1	**111**	0x6F	RTC Minute 7 – Real-time Clock
1	**112**	0x70	RTC Second 7 – Real-time Clock
1	**113**	0x71	RTC Fractional Second 7 – Real-time Clock
1	**120**	0x78	Stats Target Strength Sensitivity (stats unit only) 3 – Target Recognition
1	**122**	0x7A	Target Acquisition Span 3 – Target Recognition
1	**123**	0x7B	Target Loss Span 3 – Target Recognition
1	**124**	0x7C	RTC Weekday 7 – Real-time Clock
2	**3**	0x03	Process Baud/Link Update 10 – System
2	**4**	0x04	Minimum Tracking Distance (stats unit only) 10 – Traffic Statistics

2	**6**	0x06	OSD On Screen Alarm Display (CCTV unit only) 1 – Basic Configuration
2	**16**	0x10	COM A Link Configuration 2 – COM Ports
2	**17**	0x11	COM A Baud Rate 2 – COM Ports
2	**18**	0x12	COM A Output Format 2 – COM Ports
2	**19**	0x13	COM A Message Period 2 – COM Ports
2	**20**	0x14	COM A Leading Zero Character 2 – COM Ports
2	**21**	0x15	COM A Format A Speed 2 – COM Ports
2	**22**	0x16	COM A Zeros After Target Loss 2 – COM Ports
2	**23**	0x17	COM A Format D Direction Character 2 – COM Ports
2	**24**	0x18	COM A Format D Update On Change Only 2 – COM Ports
2	**25**	0x19	COM A Format D Zero Report 2 – COM Ports
2	**26**	0x1A	COM A Format D Polled Mode 2 – COM Ports
2	**27**	0x1B	COM A Statistics LOG Messages (stats unit only) 2 – COM Ports
2	**28**	0x1C	COM A Statistics Record Messages (stats unit only) 2 – COM Ports
2	**33**	0x21	COM B Baud Rate 2 – COM Ports
2	**34**	0x22	COM B Output Format 2 – COM Ports
2	**35**	0x23	COM B Message Period 2 – COM Ports
2	**36**	0x24	COM B Leading Zero Character 2 – COM Ports
2	**37**	0x25	COM B Format A Speed 2 – COM Ports
2	**38**	0x26	COM B Zeros After Target Loss 2 – COM Ports
2	**39**	0x27	COM B Format D Direction Character 2 – COM Ports

2	**40**	0x28	COM B Format D Update On Change Only 2 – COM Ports
2	**41**	0x29	COM B Format D Zero Report 2 – COM Ports
2	**42**	0x2A	COM B Format D Polled Mode 2 – COM Ports
2	**43**	0x2B	COM B Statistics LOG Messages (stats unit only) 2 – COM Ports
2	**44**	0x2C	COM B Statistics Record Messages (stats unit only) 2 – COM Ports
2	**48**	0x30	COM C Link Configuration 2 – COM Ports
2	**49**	0x31	COM C Baud Rate 2 – COM Ports
2	**50**	0x32	COM C Output Format 2 – COM Ports
2	**51**	0x33	COM C Message Period 2 – COM Ports
2	**52**	0x34	COM C Leading Zero Character 2 – COM Ports
2	**53**	0x35	COM C Format A Speed 2 – COM Ports
2	**54**	0x36	COM C Zeros After Target Loss 2 – COM Ports
2	**55**	0x37	COM C Format D Direction Character 2 – COM Ports
2	**56**	0x38	COM C Format D Update On Change Only 2 – COM Ports
2	**57**	0x39	COM C Format D Zero Report 2 – COM Ports
2	**58**	0x3A	COM C Format D Polled Mode 2 – COM Ports
2	**59**	0x3B	COM C Statistics LOG Messages (stats unit only) 2 – COM Ports
2	**60**	0x3C	COM C Statistics Record Messages (stats unit only) 2 – COM Ports
2	**64**	0x40	COM D Link Configuration 2 – COM Ports
2	**65**	0x41	COM D Baud Rate 2 – COM Ports
2	**66**	0x42	COM D Output Format 2 – COM Ports

2	**67**	0x43	COM D Message Period 2 – COM Ports
2	**68**	0x44	COM D Leading Zero Character 2 – COM Ports
2	**69**	0x45	COM D Format A Speed 2 – COM Ports
2	**70**	0x46	COM D Zeros After Target Loss 2 – COM Ports
2	**71**	0x47	COM D Format D Direction Character 2 – COM Ports
2	**72**	0x48	COM D Format D Update On Change Only 2 – COM Ports
2	**73**	0x49	COM D Format D Zero Report 2 – COM Ports
2	**74**	0x4A	COM D Format D Polled Mode 2 – COM Ports
2	**75**	0x4B	COM D Statistics LOG Messages (stats unit only) 2 – COM Ports
2	**76**	0x4C	COM D Statistics Record Messages (stats unit only) 2 – COM Ports
2	**96**	0x60	Classification Training (stats unit only) 9 – Traffic Statistics
2	**97**	0x61	Training Status (stats unit only) 9 – Traffic Statistics
2	**98**	0x62	Get Training Data (stats unit only) 9 – Traffic Statistics
2	**99**	0x63	Away Class 1 Threshold (stats unit only) 9 – Traffic Statistics
2	**100**	0x64	Away Class 2 Threshold (stats unit only) 9 – Traffic Statistics
2	**101**	0x65	Away Class 3 Threshold (stats unit only) 9 – Traffic Statistics
2	**102**	0x66	Away Class 4 Threshold (stats unit only) 9 – Traffic Statistics
2	**103**	0x67	Away Class 5 Threshold (stats unit only) 9 – Traffic Statistics

2	**104**	0x68	Closing Class 1 Threshold (stats unit only) 9 – Traffic Statistics
2	**105**	0x69	Closing Class 2 Threshold (stats unit only) 9 – Traffic Statistics
2	**106**	0x6A	Closing Class 3 Threshold (stats unit only) 9 – Traffic Statistics
2	**107**	0x6B	Closing Class 4 Threshold (stats unit only) 9 – Traffic Statistics
2	**108**	0x6C	Closing Class 5 Threshold (stats unit only) 9 – Traffic Statistics
2	**109**	0x6D	Stats Record Type (stats unit only) 9 – Traffic Statistics

11 Configuration Protocol

Refer to the chapter on Custom Applications to Control Stationary Speed Sensor IIs for details on using this protocol to control Stationary Speed Sensor IIs.

Configuration packet format

#	Description	Value
1	Start ID	0xEF
2	Destination ID	2 – 254 (0x02 – 0xFE) For broadcast: 255 (0xFF)
3	Source ID	0x01
4	Packet Type	0x01 or 0x02
5	Payload Length (LSB)	The Payload Length is a 2-byte word which is the number of bytes starting with byte #7 through and including the last byte before the checksum bytes.
6	Payload Length (MSB)	*(see above)*
7	Command ID/ Setting ID	**Get method**: Command ID value = Setting ID in hex (and byte #9 = 0x00): causes the Speed Sensor to return the current setting **Change method**: Command ID value = Setting ID in hex (and byte #9 = 0x01): causes the Speed Sensor to select the next possible setting **Set method**: Command ID value = Setting ID in hex + 0x80: causes the Speed Sensor to use the value in byte #9 as the new configuration setting
8	Antenna Number	Reserved (use 0x00 or 0x01)
9	Configuration Value	**Get method**: Value = 0x00 **Change method**: Value = 0x01 **Set method**: Value = new desired value in hex (for multi-byte values, the LSB is first and is followed by the more significant bytes in low to high order)
10	Checksum (LSB)	The checksum should equal the 16-bit sum of pairs of bytes in LSB, MSB order starting with byte #1 as the first LSB through and including the last byte before the Checksum (in this case, byte #9). In the case of an odd number of bytes, 0x00 is used as the last MSB value. (See example below.)
11	Checksum (MSB)	*(see above)*

The following is an example showing a command to set UNITS to km/h.

#	Description	Value
1	Start ID	**0xEF**
2	Destination ID	**0x02**
3	Source ID	**0x01**
4	Packet Type	**0x01**
5	Payload Length (LSB)	**0x03** (length = 0x0003 = 3 bytes)
6	Payload Length (MSB)	**0x00**
7	Command ID	**0x94** = 0x14 (Setting 20) + 0x80 (set method)

8	Antenna Number	**0x00**
9	Configuration Value	**0x01** (km/h)
10	Checksum (LSB)	**0x88**
11	Checksum (MSB)	**0x04**

Checksum = 0x0488 (truncated to the low order 2 bytes) = 0x02EF + 0x0101 + 0x0003 + 0x0094 + 0x01

12 Sensor variations

12.1 200-0880-03 Low Speed Sensor II – Side Connector

12.1.1 Summary

These sensors include the following changes to the base sensor (200-0880-00):

- The speed range is changed from 1~200 MPH to 0.1~70 MPH. See Specifications section for conversions to other units of measure.
- The buffer/message period changes from 48 ms to 147.5 ms.
- The default Resolution setting is changed from ones to tenths.
- The default Holdover Time setting is changed from 2 seconds to 0 seconds.

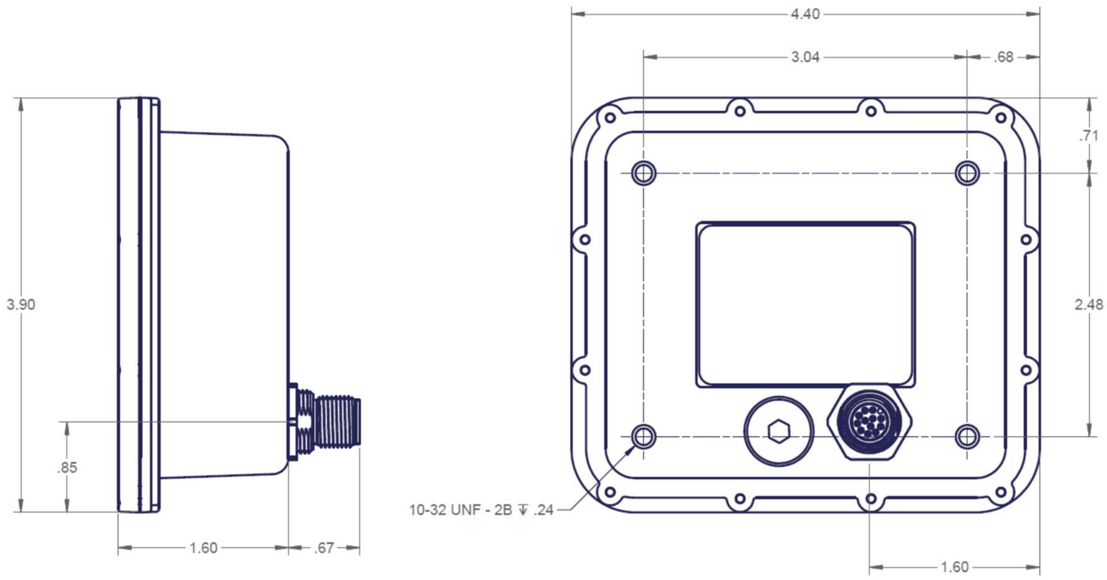
12.2 200-0880-52,53 Rear Connector – RS-232, RS-485, and USB Serial Port

12.2.1 Summary

These sensors include the following changes to the base sensor (200-0880-00,01):

- The electrical connector is moved from the side to the rear of the sensor.
- A USB communications port is added. The sensor is a USB secondary node compliant with USB 2.0 requirements. An external (host/primary node) 5 volts must be supplied to the sensor to operate the USB communications port. This is an additional communication port; no previously available communication ports were removed.
- The AC voltage input was removed to allow for the addition of the USB communications port.
- The external AUX relay function was changed from a 2 line switch closure function to a single grounded line operation. This is a normally open switch on pin 7 which is connected to sensor ground when the switch is closed.

12.2.2 Mechanical Description



12.2.3 Electrical Connection

The electrical connections on the rear port are as shown here.

Note: The USB operation requires the host's 5 volts be place on the pin 6. All other sensor functions will operate normally without this connection.

Pin Number	Wire Color	Primary Function	Secondary Function
1	Brown	Com D, D+(USB)	
2	Red	Com D, D-(USB)	
3	Orange	Com B, RS-232 RX (From Computer)	
4	Yellow	Com A, RS-485 RX-, Full Duplex	Com C, RS-485 T/R-, Half Duplex
5	Dark Green	DC POWER	
6	Blue	5 volts (USB only)	
7	Violet	RELAY	
8	Gray	Com A, RS-485 TX+, Full Duplex	Com A, RS-485 T/R+, Half Duplex
9	Black	Com A, RS-485 TX-, Full Duplex	Com A, RS-485 T/R-, Half Duplex
10	White	Com A, RS-485 RX+, Full Duplex	Com C, RS-485 T/R+, Half Duplex
11	Pink	Com B, RS-232 TX (To Computer)	
12	Light Green	GROUND	

12.2.4 Operation

To use the USB option the USB driver needs to be loaded on the computer the sensor will be attached to. The driver can be found on the Developers Kit CD or downloaded from the stalkerrader.com web site. After the driver is installed, anytime the sensor is connected it will show up on the computer as a standard com port device which can be accessed by any standard PC comport application.

To use the ACI's Dashboard PC application to configure the sensor through the USB com port be sure to use version 2.8.3 or newer. The version needs to support Com port D in its configuration set up.

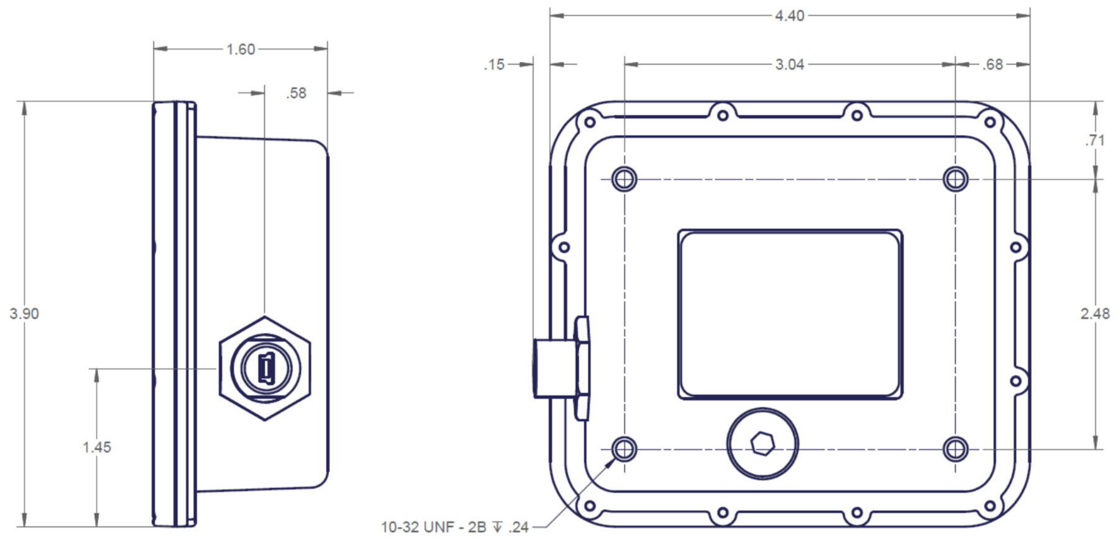
12.3 200-0880-54,55 Side Connector – USB Serial Port Only

12.3.1 Summary

These sensors include the following changes to the base sensor (200-0880-00,01):

- A USB Commination's Port was added with a USB 2.0 Type mini-B jack connector.
- The M-12 connector was removed, eliminating the RS-485, RS-232, and external trigger capabilities.
- The sensor runs off the USB supplied power and external power source is not needed.

12.3.2 Mechanical description



12.3.3 Electrical connections

The sensor uses a standard USB 2.0 Mini type B jack.

12.3.4 Operation

To use the USB option the USB driver needs to be loaded on the computer the sensor will be attached to. The driver can be found on the Developers Kit CD or downloaded from the stalkerrader.com web site. After the driver is installed, anytime the sensor is connected it will show up on the computer as a standard com port device which can be accessed by any standard PC comport application.

To use the ACI's Dashboard PC application to configure the sensor through the USB com port be sure to use version 2.8.3 or newer. The version needs to support Com port D in its configuration set up.

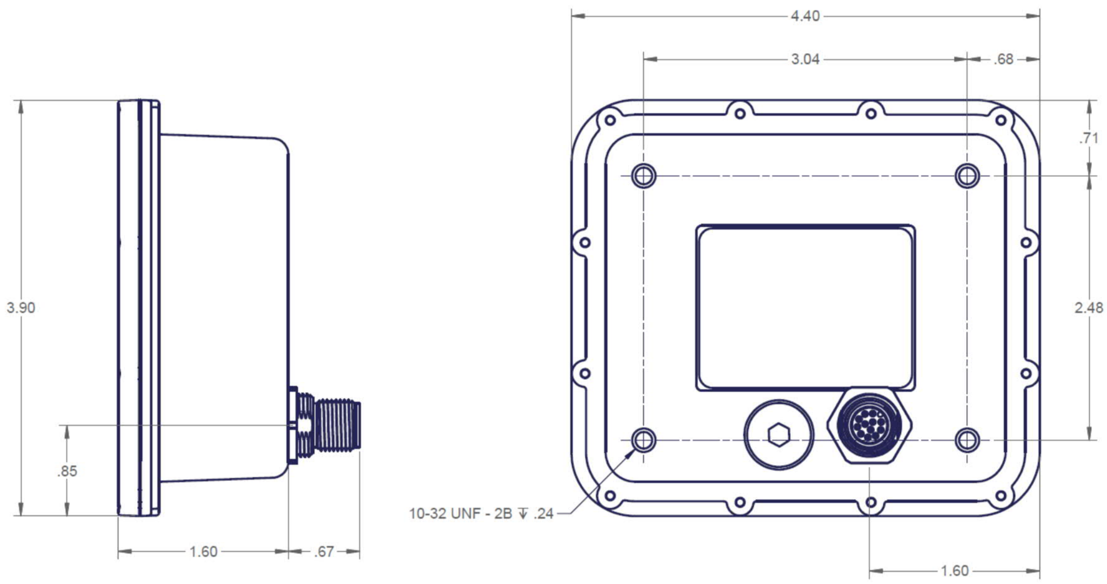
12.4 200-0880-56 Rear Connector – RS-232, RS-485, and USB Flash Memory Port

12.4.1 Summary

These sensors include the following changes to the base sensor (200-0880-01):

- The electrical connector is moved from the side to the rear of the sensor.
- A USB flash memory port is added.
- The AC voltage input was removed to allow for the addition of the USB memory port.
- The external AUX relay function was changed from a 2 line switch closure function to a single grounded line operation. This is a normally open switch on pin 7 which is connected to sensor ground when the switch is closed.

12.4.2 Mechanical Description



12.4.3 Electrical Connection

The electrical connections on the rear port are as shown here.

Pin Number	Wire Color	Primary Function	Secondary Function
1	Brown	USB memory, D+(USB)	
2	Red	USB memory, D-(USB)	
3	Orange	Com B, RS-232 RX (From Computer)	
4	Yellow	Com A, RS-485 RX-, Full Duplex	Com C, RS-485 T/R-, Half Duplex
5	Dark Green	DC POWER	
6	Blue	5 volts (USB memory drive only)	
7	Violet	RELAY	
8	Gray	Com A, RS-485 TX+, Full Duplex	Com A, RS-485 T/R+, Half Duplex
9	Black	Com A, RS-485 TX-, Full Duplex	Com A, RS-485 T/R-, Half Duplex
10	White	Com A, RS-485 RX+, Full Duplex	Com C, RS-485 T/R+, Half Duplex
11	Pink	Com B, RS-232 TX (To Computer)	
12	Light Green	GROUND	

12.4.4 Operation

The USB memory option is for use when collecting traffic data only. Then it is only used when the sensor is configured for External Memory by the survey set up in the PC application. When the USB memory drive is installed the sensor will copy any traffic data it has stored in its internal memory to the USB memory device and while it is installed the sensor will save all new traffic data to the USB memory drive.

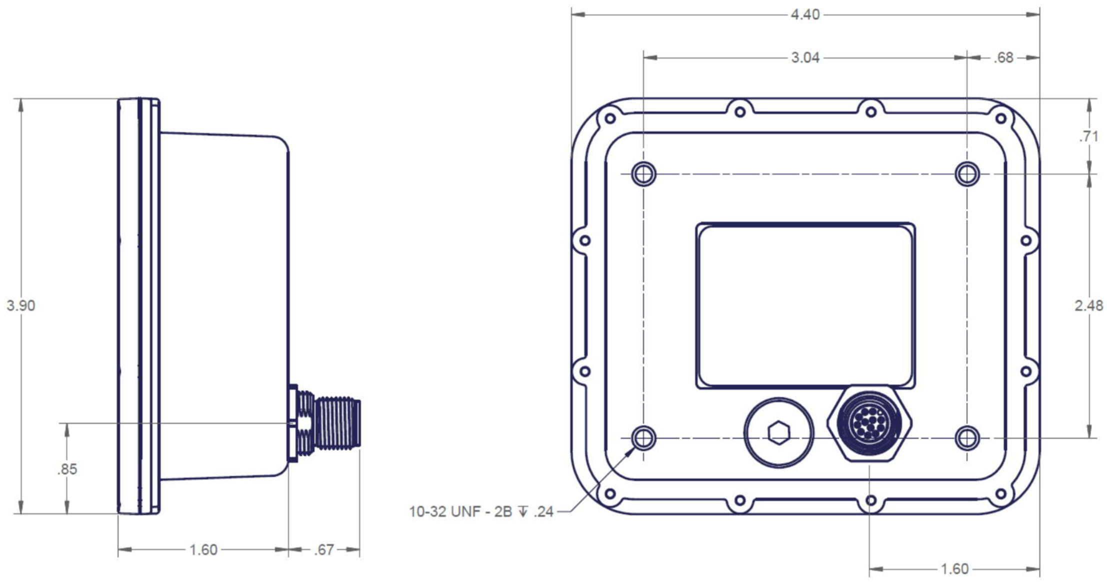
12.5 200-0880-57 Rear Connector – Two RS-232, USB Serial Port, and USB Flash Memory Port

12.5.1 Summary

These sensors include the following changes to the base sensor (200-0880-01):

- The electrical connector is moved from the side to the rear of the sensor.
- A USB flash memory port is added.
- COM A is changed from an RS-485 serial port to an RS-232 serial port.
- COM D is added as a USB serial port.
- The AC voltage input was removed to allow for the new COM A RS-232 serial port.
- The COM A and COM C RS-485 ports are removed to allow for the new COM D USB serial port and the USB flash memory port.
- The external AUX relay function was removed to allow for the 5V inputs for the USB ports.

12.5.2 Mechanical Description



12.5.3 Electrical Connection

The electrical connections on the rear port are as shown here.

Pin Number	Wire Color	Primary Function	Secondary Function
1	Brown	Com A, RS-232 TX (To Computer)	
2	Red	Com A, RS-232 RX (From Computer)	
3	Orange	Com B, RS-232 RX (From Computer)	
4	Yellow	Com D, D+(USB)	
5	Dark Green	DC POWER	
6	Blue	5 volts (USB memory drive only)	
7	Violet	5 volts (Com D USB only)	
8	Gray	USB memory, D+	
9	Black	USB memory, D-	
10	White	Com D, D-(USB)	
11	Pink	Com B, RS-232 TX (To Computer)	
12	Light Green	GROUND	

12.5.4 Operation

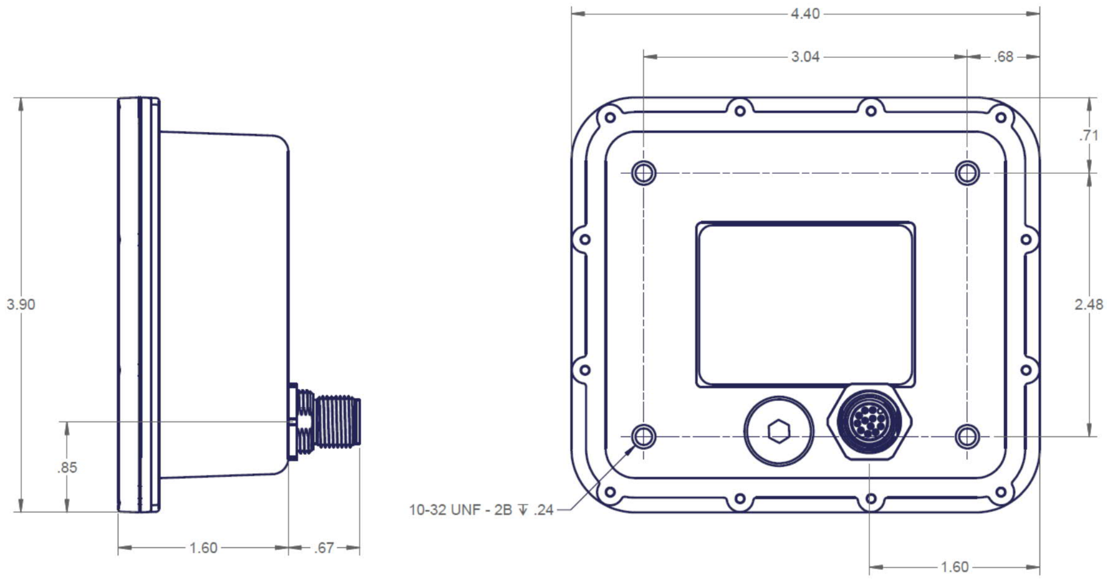
The USB memory option is for use when collecting traffic data only. Then it is only used when the sensor is configured for External Memory by the survey set up in the PC application. When the USB memory drive is installed the sensor will copy any traffic data it has stored in its internal memory to the USB memory device and while it is installed the sensor will save all new traffic data to the USB memory drive.

12.6 200-0880-60 Low Speed Sensor II – Rear Connector

12.6.1 Summary

This sensor is identical to the 200-0880-03 with the exception that this product has its connector on the rear instead of the side.

12.6.2 Mechanical Description



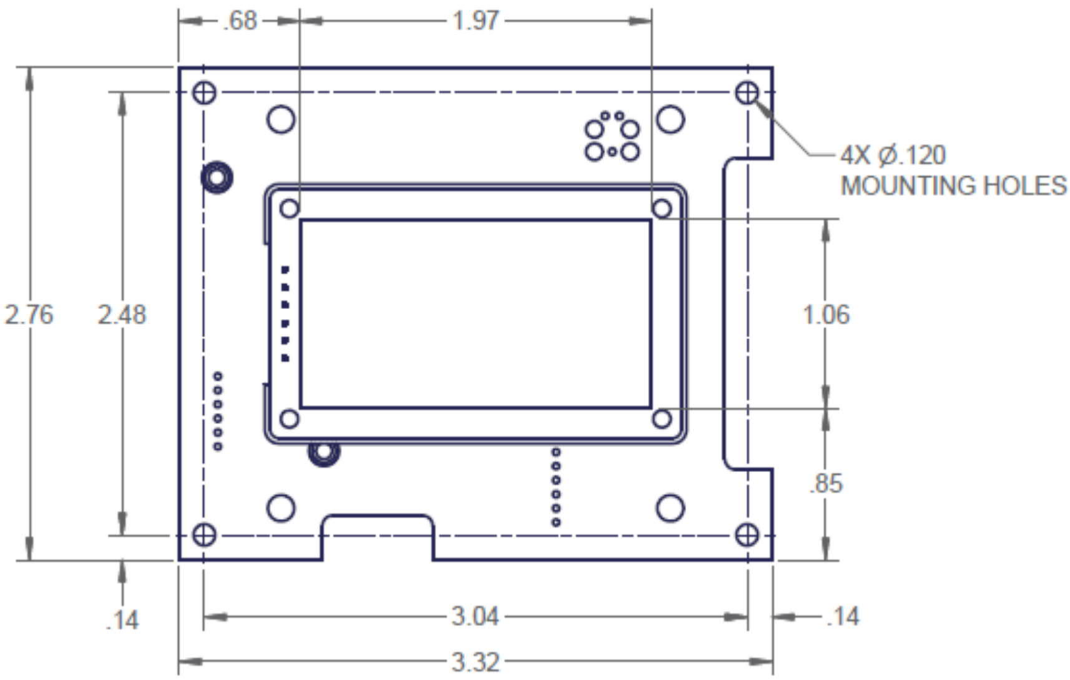
12.7 200-1004-00 OEM Stationary Sensor II – No Case

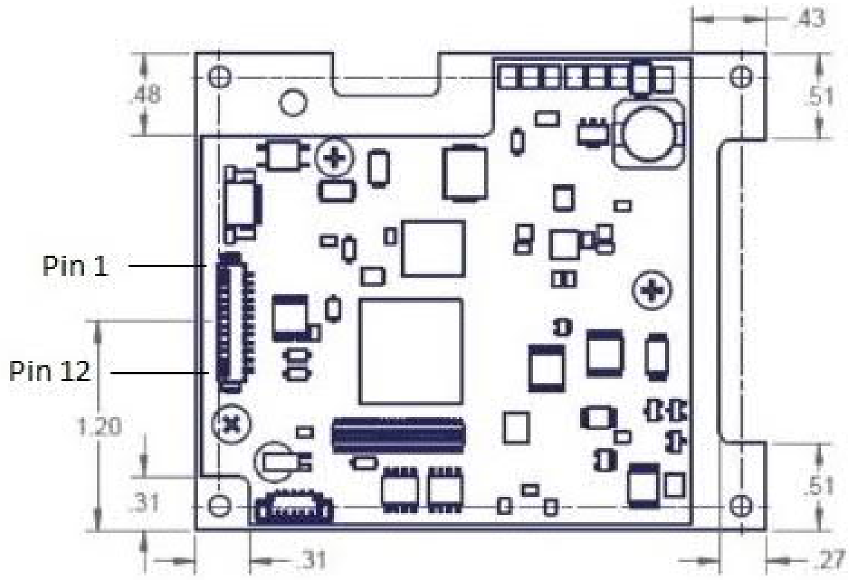
12.7.1 Summary

These sensors include the following changes to the base sensor (200-0880-00):

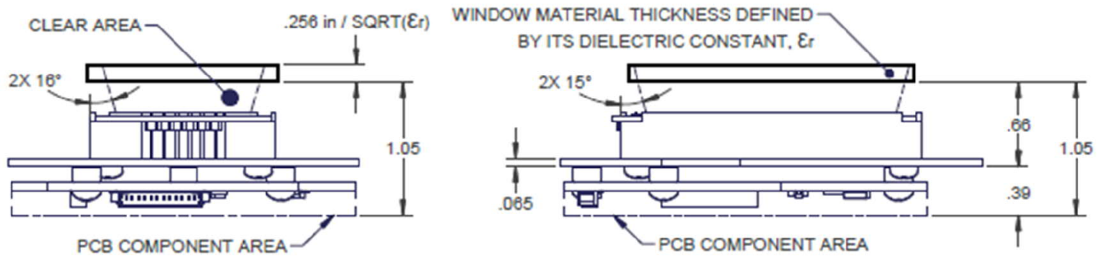
1. The housing was removed including the M-12 connector. The connector is replaced with a molex board to cable connector.
2. The real time clock function has been removed.
3. Data collection flash memory has been removed.
4. The AC voltage input has been removed.

12.7.2 Mechanical Description





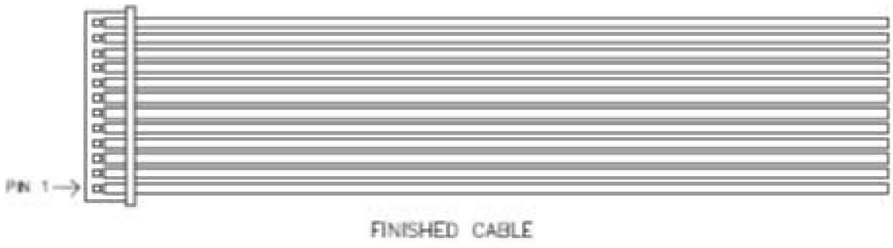
.43
.48
.51
Pin 1
Pin 12
1.20
.31
.51
.31
.27



CLEAR AREA
.256 in / SQRT(Ɛr)
2X 16°
1.05
PCB COMPONENT AREA
WINDOW MATERIAL THICKNESS DEFINED
BY ITS DIELECTRIC CONSTANT, Ɛr
2X 15°
.66
1.05
.065
.39
PCB COMPONENT AREA

12.7.3 Electrical Connections

Included with your sensor is a cable (Stalker Radar P/N 155-2461-00) that plugs into the sensor. It can be wired into the OEM system as required for your particular needs. The wiring diagram for the cable is shown below.



Pin Number	Wire Color	Primary Function	Secondary Function
1	Brown	Com A, RS-485 RX-, Full Duplex	Com C, RS-485 T/R-, Half Duplex
2	Red	DC POWER	
3	Orange	RELAY	
4	Yellow	RELAY	
5	Violet	Com A, RS-485 TX+, Full Duplex	Com A, RS-485 T/R+, Half Duplex
6	Blue	Com A, RS-485 TX-, Full Duplex	Com A, RS-485 T/R-, Half Duplex
7	Green	GROUND	
8	Gray	Com A, RS-485 RX+, Full Duplex	Com C, RS-485 T/R+, Half Duplex
9	White	Com B, RS-232 TX (To Computer)	
10	Black	unused	
11	White/Brown Stripe	unused	
12	White/Red Stripe	Com B, RS-232 RX (From Computer)	

An optional cable (Stalker Radar P/N 155-2445-00) is also available that can connect the sensor to an M-12 connector as pictured in Section 3.2. Its pinout for this sensor is as follows.

Pin Number	Primary Function	Secondary Function
1	unused	
2	unused	
3	Com B, RS-232 RX (From Computer)	
4	Com A, RS-485 RX-, Full Duplex	Com C, RS-485 T/R-, Half Duplex
5	DC POWER	
6	RELAY	
7	RELAY	
8	Com A, RS-485 TX+, Full Duplex	Com A, RS-485 T/R+, Half Duplex
9	Com A, RS-485 TX-, Full Duplex	Com A, RS-485 T/R-, Half Duplex
10	Com A, RS-485 RX+, Full Duplex	Com C, RS-485 T/R+, Half

		Duplex
11	Com B, RS-232 TX (To Computer)	
12	GROUND	

For designers who would like to develop their own cable to interface directly to the sensor, the connector on the sensor is a Molex Picoblade P/N 53261-1471. The mating connector to use on a cable is Molex housing P/N 51021-1200. Use Molex contacts 50079-8100.

12.7.4 Operation

If the sensor is to be mounted in an enclosure or behind a protective lens, make sure that there is space in front of the lens as specified in the Mechanical Description section above. The material in front of the lens should be a natural, undyed plastic such as polypropylene or high density polyethylene. Try to stay away from dyed material – especially black as many black dyes use carbon which will block the radar transmission. If the sensor is operating poorly, remove it from the enclosure or the lens to compare operation with nothing in front of it.

Also note: In this configuration the sensor is not FCC certified and will need to be certified by the end customer when integrated into their product.

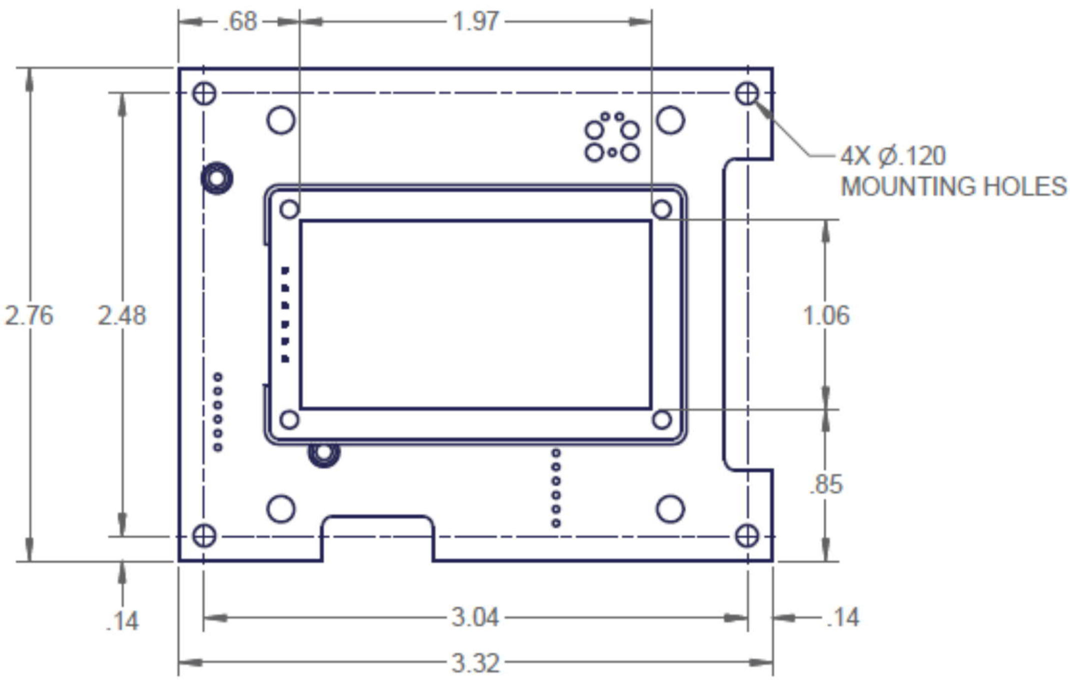
12.8 200-1004-02 OEM Traffic Statistics Sensor – No Case

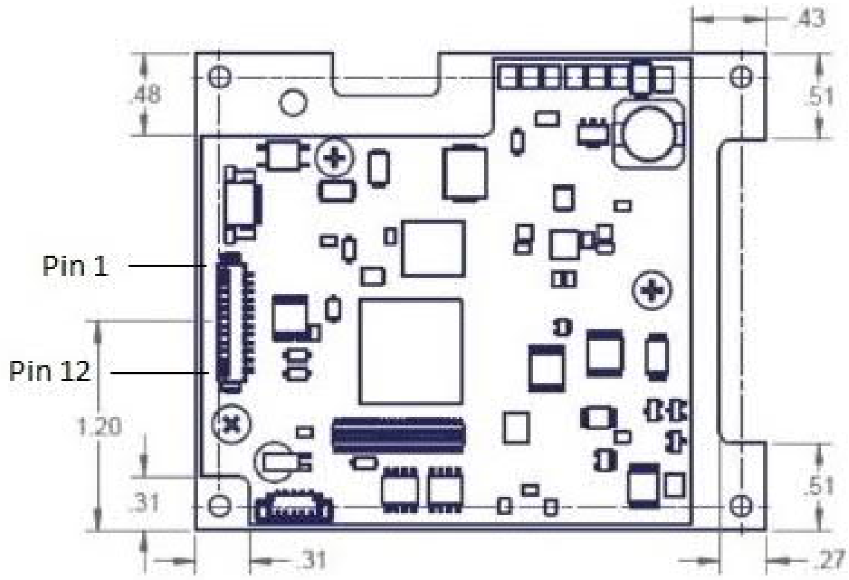
12.8.1 Summary

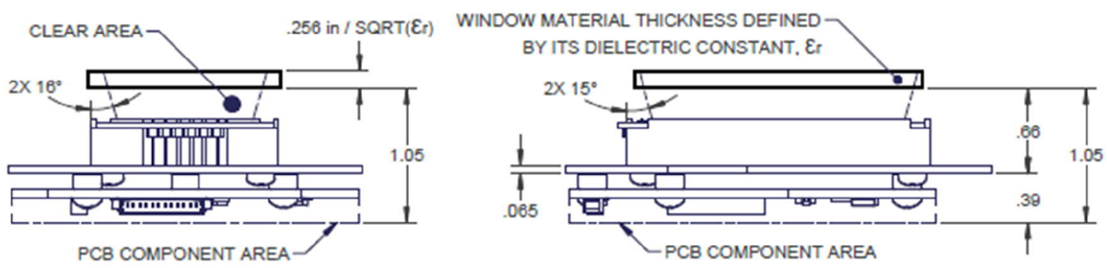
These sensors include the following changes to the 200-0880-53 Traffic Statistics Sensor with RS-485, RS-232, and USB Serial Ports

1. The housing was removed including the M-12 connector. The connector is replaced with a molex board to cable connector.

12.8.2 Mechanical Description

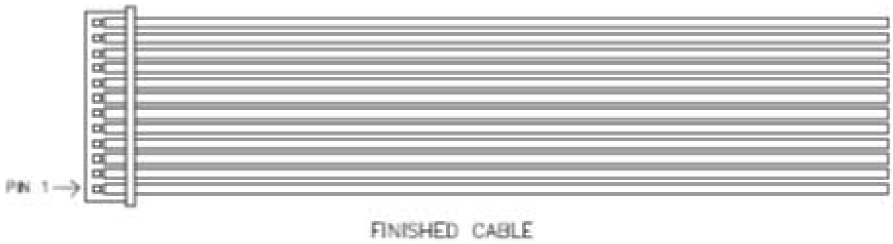



.43
.48
.51
Pin 1
Pin 12
1.20
.31
.51
.31
.27


CLEAR AREA
.256 in / SQRT(Ɛr)
WINDOW MATERIAL THICKNESS DEFINED
BY ITS DIELECTRIC CONSTANT, Ɛr
2X 16°
2X 15°
1.05
.66
1.05
.065
.39
PCB COMPONENT AREA
PCB COMPONENT AREA

12.8.3 Electrical Connections

Included with your sensor is a cable (Stalker Radar P/N 155-2461-00) that plugs into the sensor. It can be wired into the OEM system as required for your particular needs. The wiring diagram for the cable is shown below.



Pin Number	Wire Color	Primary Function	Secondary Function
1	Brown	Com A, RS-485 RX-, Full Duplex	Com C, RS-485 T/R-, Half Duplex
2	Red	DC POWER	
3	Orange	5 volts (USB only)	
4	Yellow	RELAY	
5	Violet	Com A, RS-485 TX+, Full Duplex	Com A, RS-485 T/R+, Half Duplex
6	Blue	Com A, RS-485 TX-, Full Duplex	Com A, RS-485 T/R-, Half Duplex
7	Green	GROUND	
8	Gray	Com A, RS-485 RX+, Full Duplex	Com C, RS-485 T/R+, Half Duplex
9	White	Com B, RS-232 TX (To Computer)	
10	Black	Com D, D+ (USB)	
11	White/Brown Stripe	Com D, D- (USB)	
12	White/Red Stripe	Com B, RS-232 RX (From Computer)	

An optional cable (Stalker Radar P/N 155-2445-00) is also available that can connect the sensor to an M-12 connector as pictured in Section 3.2. Its pinout for this sensor is as follows.

Pin Number	Primary Function	Secondary Function
1	Com D, D+ (USB)	
2	Com D, D- (USB)	
3	Com B, RS-232 RX (From Computer)	
4	Com A, RS-485 RX-, Full Duplex	Com C, RS-485 T/R-, Half Duplex
5	DC POWER	
6	5 volts (USB only)	
7	RELAY	
8	Com A, RS-485 TX+, Full Duplex	Com A, RS-485 T/R+, Half Duplex
9	Com A, RS-485 TX-, Full Duplex	Com A, RS-485 T/R-, Half Duplex
10	Com A, RS-485 RX+, Full Duplex	Com C, RS-485 T/R+, Half

		Duplex
11	Com B, RS-232 TX (To Computer)	
12	GROUND	

For designers who would like to develop their own cable to interface directly to the sensor, the connector on the sensor is a Molex Picoblade P/N 53261-1471. The mating connector to use on a cable is Molex housing P/N 51021-1200. Use Molex contacts 50079-8100.

12.8.4 Operation

To use the USB option the USB driver needs to be loaded on the computer the sensor will be attached to. The driver can be found on the Developers Kit CD or downloaded from the stalkerrader.com web site. After the driver is installed, anytime the sensor is connected it will show up on the computer as a standard com port device which can be accessed by any standard PC comport application.

If the sensor is to be mounted in an enclosure or behind a protective lens, make sure that there is space in front of the lens as specified in the Mechanical Description section above. The material in front of the lens should be a natural, undyed plastic such as polypropylene or high density polyethylene. Try to stay away from dyed material – especially black as many black dyes use carbon which will block the radar transmission. If the sensor is operating poorly, remove it from the enclosure or the lens to compare operation with nothing in front of it.

Also note: In this configuration the sensor is not FCC certified and will need to be certified by the end customer when integrated into their product.

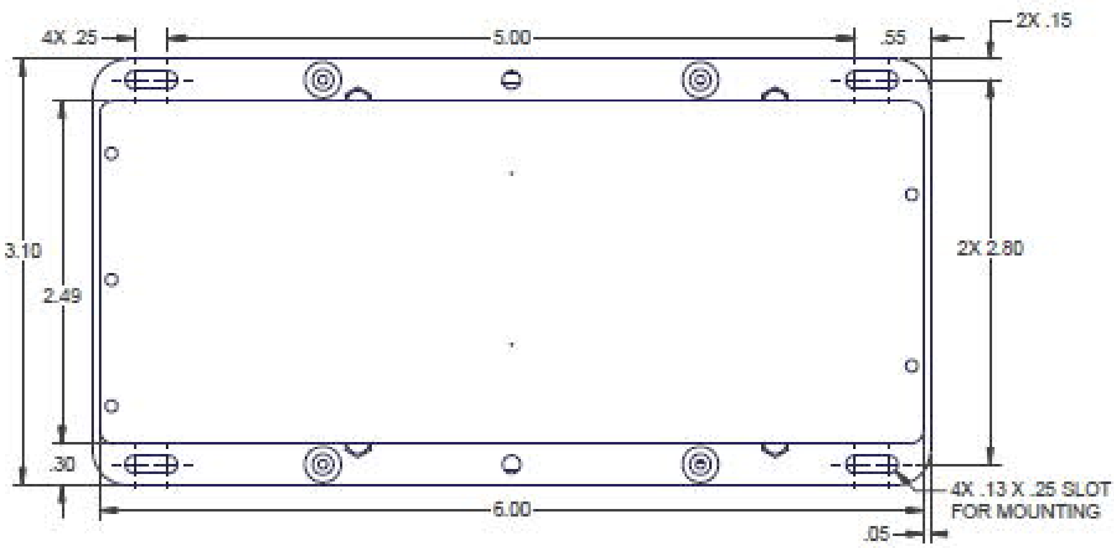
12.9 200-1033-00,01 OEM 6 x 26° Sensor – No Case

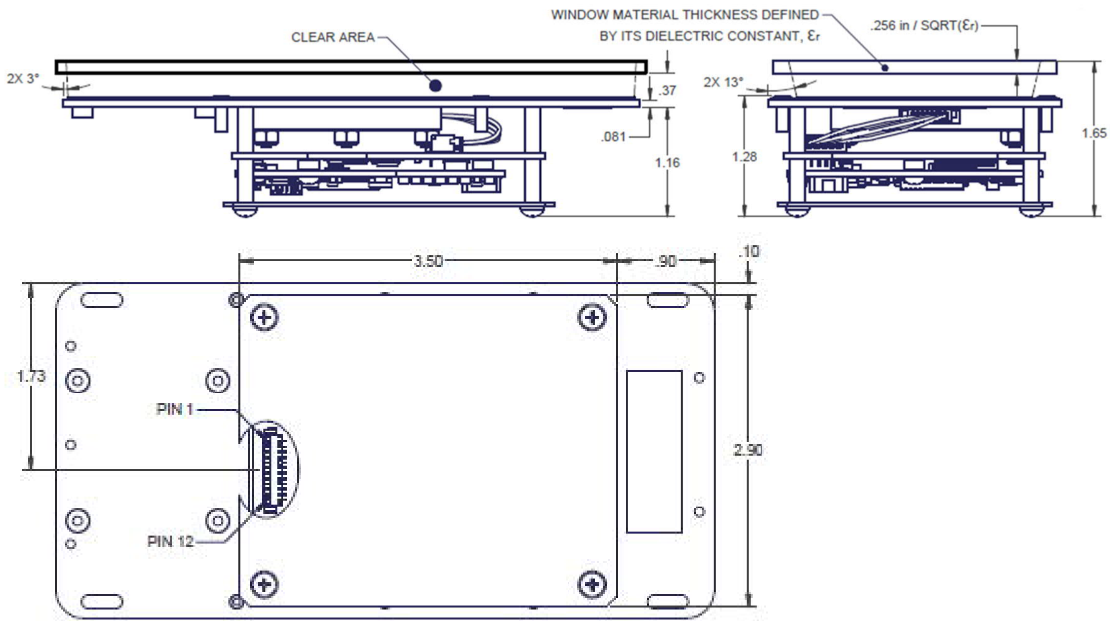
12.9.1 Summary

These sensors include the following changes to the base sensor (200-0880-00,01):

1. The housing was removed including the M-12 connector. The connector is replaced with a molex board to cable connector.
2. The standard 30x32 degree antenna is replaced by a 6x26 degree narrow beam antenna.
3. The AC voltage input was removed to allow for the addition of the USB communications port.
4. The external AUX relay function was changed from a 2 line switch closure function to a single grounded line operation. This is a normally open switch on pin 4 which is connected to sensor ground when the switch is closed.

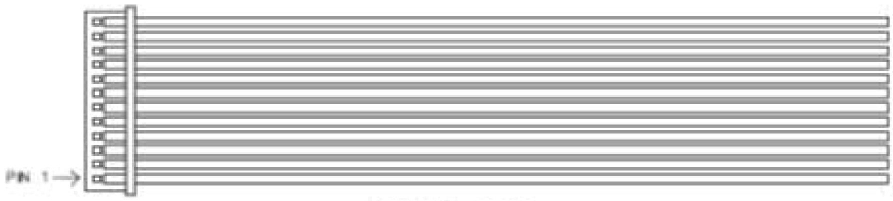
12.9.2 Mechanical Description





12.9.3 Electrical Connections

Included with your sensor is a cable (Stalker Radar P/N 155-2461-00) that plugs into the sensor. It can be wired into the OEM system as required for your particular needs. The wiring diagram for the cable is shown below.



Pin Number	Wire Color	Primary Function	Secondary Function
1	Brown	Com A, RS-485 RX-, Full Duplex	Com C, RS-485 T/R-, Half Duplex
2	Red	DC POWER	
3	Orange	USB V	
4	Yellow	RELAY	
5	Violet	Com A, RS-485 TX+, Full Duplex	Com A, RS-485 T/R+, Half Duplex
6	Blue	Com A, RS-485 TX-, Full Duplex	Com A, RS-485 T/R-, Half Duplex
7	Green	GROUND	
8	Gray	Com A, RS-485 RX+, Full Duplex	Com C, RS-485 T/R+, Half Duplex
9	White	Com B, RS-232 TX (To Computer)	
10	Black	USB D+	
11	White/Brown Stripe	USB D-	
12	White/Red Stripe	Com B, RS-232 RX (From Computer)	

An optional cable (Stalker Radar P/N 155-2445-00) is also available that can connect the sensor to an M-12 connector as pictured in Section 3.2. Its pinout for this sensor is as follows.

Pin Number	Primary Function	Secondary Function
1	USB D+	
2	USB D-	
3	Com B, RS-232 RX (From Computer)	
4	Com A, RS-485 RX-, Full Duplex	Com C, RS-485 T/R-, Half Duplex
5	DC POWER	
6	USB V	
7	RELAY	
8	Com A, RS-485 TX+, Full Duplex	Com A, RS-485 T/R+, Half Duplex
9	Com A, RS-485 TX-, Full Duplex	Com A, RS-485 T/R-, Half Duplex
10	Com A, RS-485 RX+, Full Duplex	Com C, RS-485 T/R+, Half Duplex
11	Com B, RS-232 TX (To Computer)	
12	GROUND	

For designers who would like to develop their own cable to interface directly to the sensor, the connector on the sensor is a Molex Picoblade P/N 53261-1471. The mating connector to use on a cable is Molex housing P/N 51021-1200. Use Molex contacts 50079-8100.

12.9.4 Operation

To use the USB option the USB driver needs to be loaded on the computer the sensor will be attached to. The driver can be found on the Developers Kit CD or downloaded from the stalkerrader.com web site. After the driver is installed, anytime the sensor is connected it will show up on the computer as a standard com port device which can be accessed by any standard PC comport application.

If the sensor is to be mounted in an enclosure or behind a protective lens, make sure that there is space in front of the lens as specified in the Mechanical Description section above. The material in front of the lens should be a natural, undyed plastic such as polypropylene or high density polyethylene. Try to stay away from dyed material – especially black as many black dyes use carbon which will block the radar transmission. If the sensor is operating poorly, remove it from the enclosure or the lens to compare operation with nothing in front of it.

Also note: In this configuration the sensor is not FCC certified and will need to be certified by the end customer when integrated into their product.

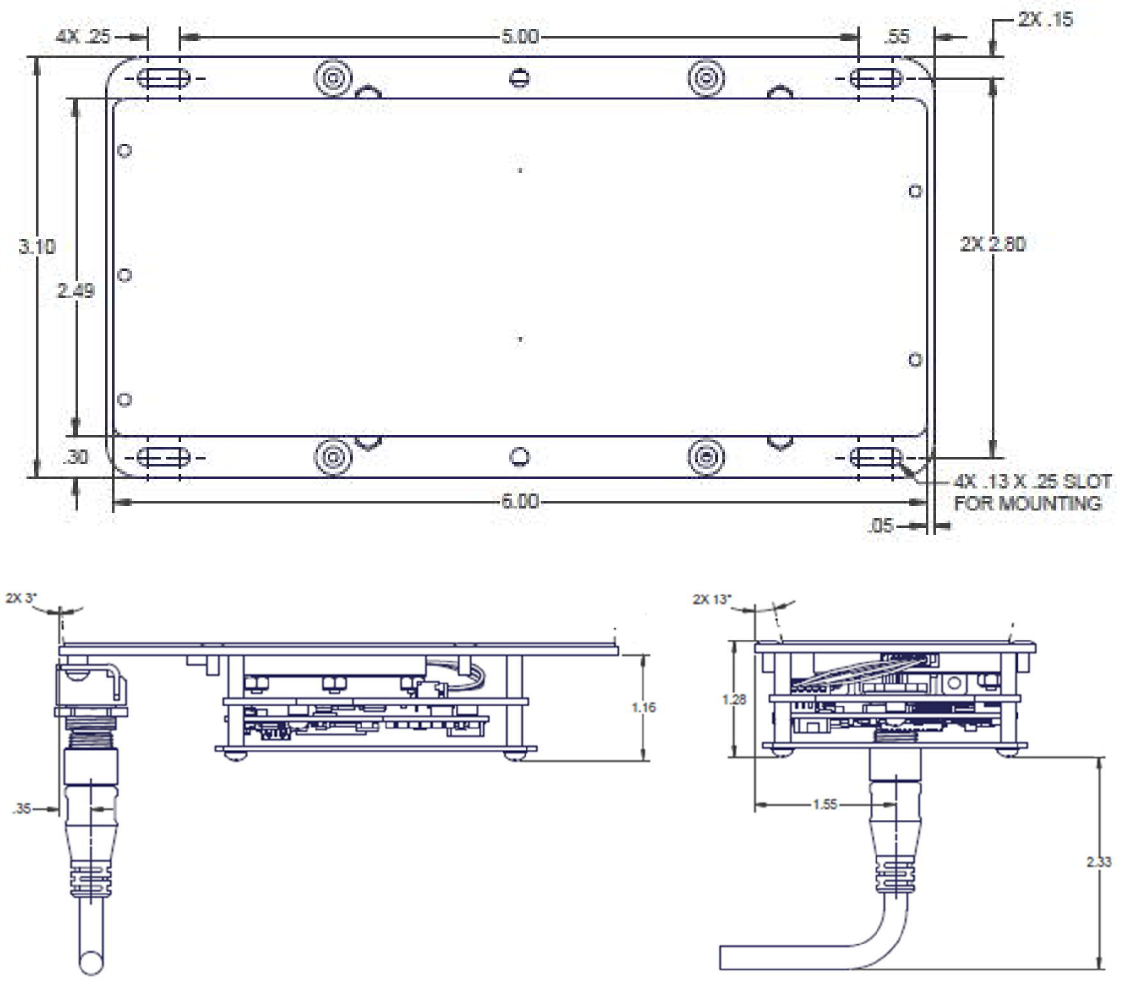
12.10 200-1033-10,11 OEM 6 x 26° Sensor with M-12 Connector – No Case

12.10.1 Summary

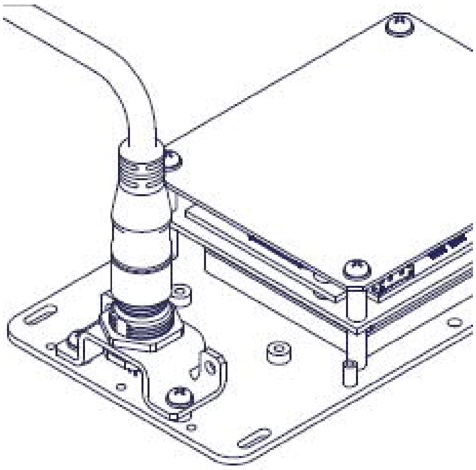
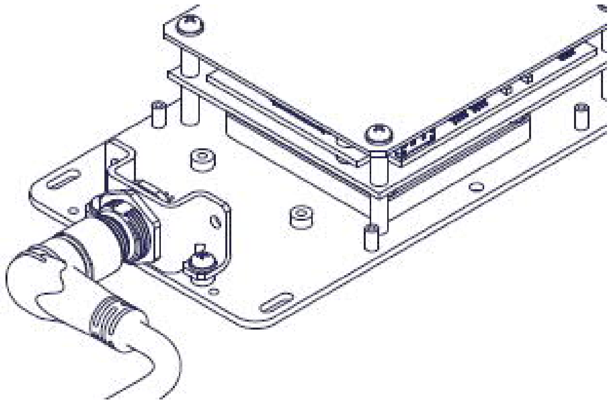
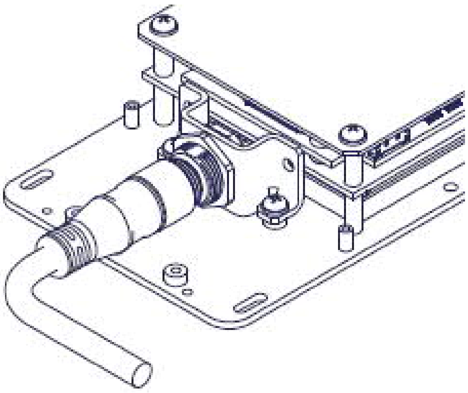
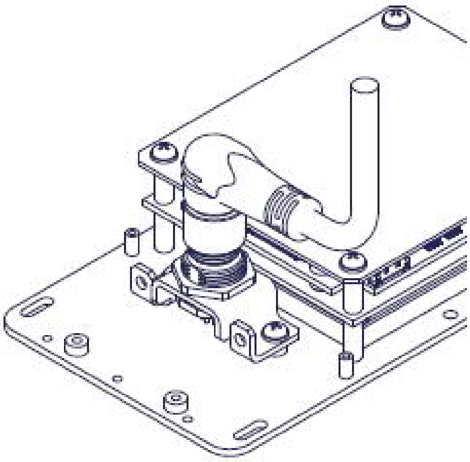
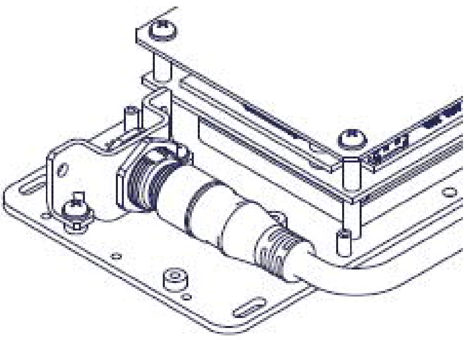
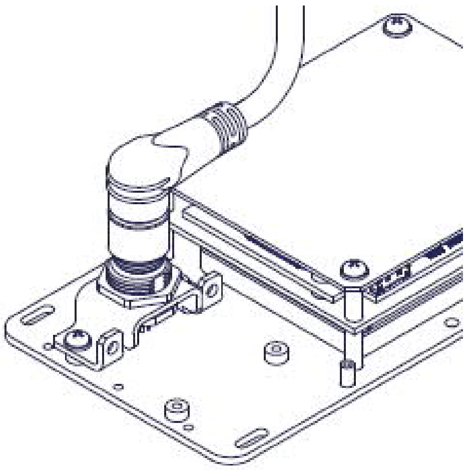
These sensors include the following changes to the 200-1033-00,01 sensors:

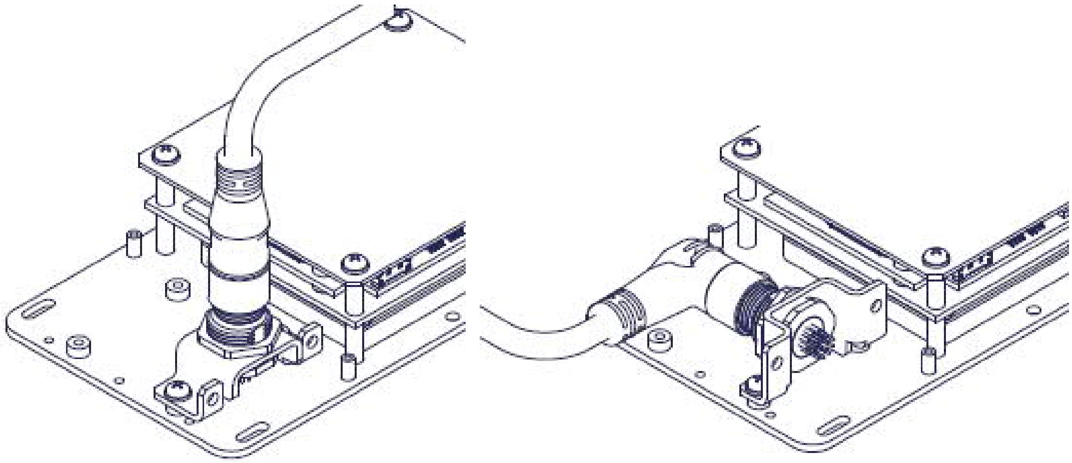
1. An M-12 connector with flex cable and bracket is added.

12.10.2 Mechanical Description



There are many ways to attach the M-12 cable and bracket to the sensor. A few possibilities are shown below with straight and right-angle cables.



12.10.3 Electrical Connections

Pin Number	Primary Function	Secondary Function
1	Com D, D+ (USB)	
2	Com D, D- (USB)	
3	Com B, RS-232 RX (From Computer)	
4	Com A, RS-485 RX-, Full Duplex	Com C, RS-485 T/R-, Half Duplex
5	DC POWER	
6	5 volts (USB only)	
7	RELAY	
8	Com A, RS-485 TX+, Full Duplex	Com A, RS-485 T/R+, Half Duplex
9	Com A, RS-485 TX-, Full Duplex	Com A, RS-485 T/R-, Half Duplex
10	Com A, RS-485 RX+, Full Duplex	Com C, RS-485 T/R+, Half Duplex
11	Com B, RS-232 TX (To Computer)	
12	GROUND	

12.10.4 Operation

The operation is identical to the 200-1033-00,01 sensor.

12.11 200-1174-53 Rear Connector – RS-232, RS-485, and USB Serial Port – Embedded Use

12.11.1 Summary

This sensor is identical to the 200-0880-53 with the exception that this product is intended for embedded use only where it will be installed inside a protective housing by the end user. This sensor does not provide any dust or water ingress protection.

13 FCC Requirements

This device is approved as an intentional radiator under FCC Part 15 with FCC identifier IBQACMI007.
No additional licensing is required to operate this device.
Operation is subject to the following two conditions:
(1) This device may not cause harmful interference, and
(2) This device must accept any interference received, including interference that may cause undesired operation.

Appendix A OEM 6° x 26° Stationary Speed Sensor II for Lane Discrimination

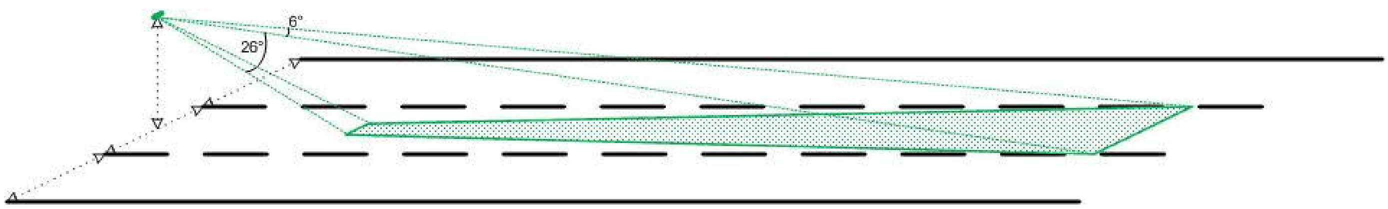
Applied Concepts makes several types of radar based speed sensors. Due to the narrow vertical beam width, the OEM 6° x 26° Stationary Speed Sensor II and the OEM 6° x 26° Traffic Statistics Sensor are specifically well suited for lane discrimination applications.

Sensor Installation

There are many aspects of mounting the Speed Sensor, all of which have an impact on the behavior, and the reliability of the results. This paper presents basic recommendations for installation and some of the background reasons behind them. From these descriptions, it is expected that users can determine how their particular environment impacts the installation and can make the necessary adjustments.

To begin the explanation of the installation we will describe the main factors involved. These factors are then expressed using more detailed charts towards the end of this section.

The recommended location of the sensor is above and in the center of the lane to be monitored. The Sensor should be pointed at a downward slope, towards the center of the lane. Since it has a 6° beam width in the horizontal direction and a 26° beam width in the vertical direction, it makes a trapezoidal pattern where it hits the roadway as shown below.



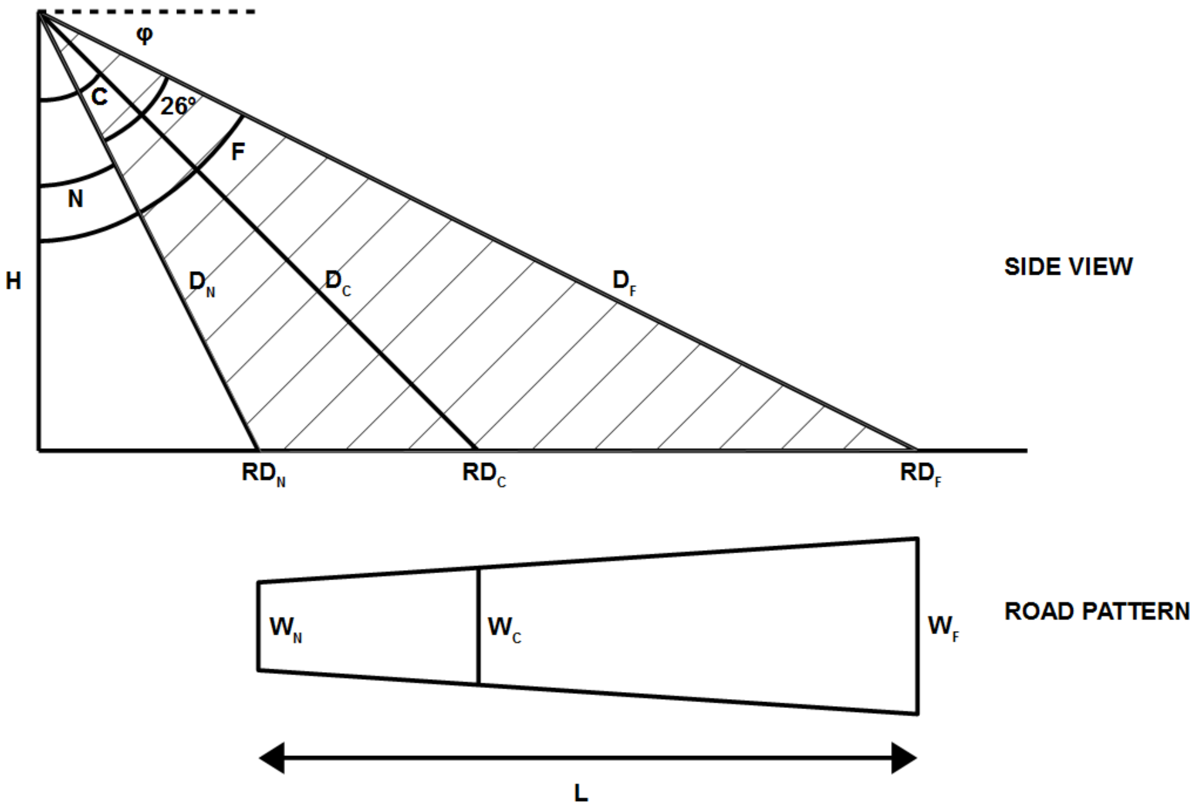
By specifying that the beam width is 6° by 26°, we mean that the majority of the power in the transmitted radar beam is within that pattern. Some of the radar's power actually extends in a wider pattern, but it is weaker outside the 6° x 26° boundaries.

Another thing to note about the rectangular beam is that the 6° dimension is aligned with the long dimension of the antenna and the 26° dimension is aligned with the short dimension of the antenna. Although it may seem counterintuitive, the larger the antenna is, the narrower the beam. For lane discrimination installations, the sensor should be mounted with its long side parallel to the ground.

The diagram below shows the geometry of the sensor installation. In the side view, the sensor is mounted at the top of a pole of height H and is tilted down at angle C (for center). The center of the beam hits the road at a distance RD_C (Road Distance $_{Center}$) from the base of the pole. The near and far edges of the beam hit the road at distances RD_N (Road Distance $_{Near}$) and RD_F (Road Distance $_{Far}$). The angles N (Near) and F (Far) are defined by the 26°

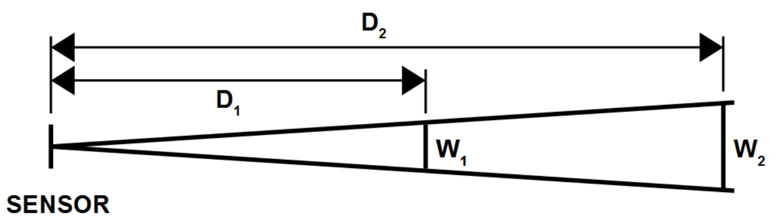
vertical beam width of the antenna: N = C-13° and F = C+13°. The road distance values can be calculated for a given pole height and mounting angle as follows:

$RD_N = H * \tan N$ $RD_C = H * \tan C$ $RD_F = H * \tan F$



The Road Pattern view above shows the size of the trapezoidal area where the beam hits the road surface. The length L of the pattern is the difference from the far edge to the near edge; $L = RD_F - RD_N$. The width of the pattern varies and depends on the distance the beam travels from the radar to intersect the road. As the signal travels away from the sensor, the width of the 6° beam increases roughly by the following equation.

Width = 0.1 * Distance



The beam distance for the near edge $D_N = \sqrt{(H^2 + RD_N^2)}$, so the beam width $W_N = 0.1 * \sqrt{(H^2 + RD_N^2)}$. In a like manner, the beam width W_C at RD_C is $0.1 * \sqrt{(H^2 + RD_C^2)}$, and the beam width W_F at the far end of the pattern is $0.1 * \sqrt{(H^2 + RD_F^2)}$

A typical lane width is 11 ft. (3.3m) and is the single most important factor in choosing the distance between the sensor and the target zone to be monitored. To perform lane discrimination a majority of the radar signal must be confined to the lane of interest, but some overlap into the adjacent lanes can be tolerated because of the low probability of a significant amount of reflective surface from a vehicle in the adjacent lane will be in view. Some of the effects of allowing the adjacent lanes to be exposed will be compensated for later when setting up the Target Strength Sensitivity of the sensor and will be explained later in this paper.

The explanation provided so far provides the theory and math for the calculations. The following tables define the beam pattern for a number of different pole heights and aiming angles to give a more practical view of the installation options and resulting beam patterns.

Pole Height H	Aiming Angle C	Road Distance Near RD_N	Road Distance Center RD_C	Road Distance Far RD_F	Beam Pattern Length L	Pattern Width Near W_N	Pattern Width Center W_C	Pattern Width Far W_F	Cosine Angle φ
15	45	9.37	15.00	24.01	14.63	1.77	2.12	2.83	45
15	50	11.30	17.88	29.44	18.14	1.88	2.33	3.30	40
15	55	13.51	21.42	37.13	23.62	2.02	2.62	4.00	35
15	60	16.09	25.98	49.06	32.98	2.20	3.00	5.13	30
15	65	19.20	32.17	70.57	51.37	2.44	3.55	7.21	25
15	70	23.10	41.21	122.17	99.07	2.75	4.39	12.31	20
15	75	28.21	55.98	429.54	401.33	3.20	5.80	42.98	15
15	60	16.09	25.98	49.06	32.98	2.20	3.00	5.13	30
15	61	16.66	27.06	52.31	35.65	2.24	3.09	5.44	29
15	62	17.26	28.21	55.98	38.73	2.29	3.20	5.80	28
15	63	17.88	29.44	60.16	42.29	2.33	3.30	6.20	27
15	64	18.52	30.75	64.97	46.45	2.38	3.42	6.67	26
15	65	19.20	32.17	70.57	51.37	2.44	3.55	7.21	25
15	66	19.91	33.69	77.17	57.26	2.49	3.69	7.86	24
15	67	20.65	35.34	85.07	64.42	2.55	3.84	8.64	23
15	68	21.42	37.13	94.71	73.28	2.62	4.00	9.59	22
15	69	22.24	39.08	106.73	84.49	2.68	4.19	10.78	21
15	70	23.10	41.21	122.17	99.07	2.75	4.39	12.31	20
15	71	24.01	43.56	142.72	118.71	2.83	4.61	14.35	19
15	72	24.96	46.17	171.45	146.49	2.91	4.85	17.21	18
15	73	25.98	49.06	214.51	188.53	3.00	5.13	21.50	17
15	74	27.06	52.31	286.22	259.16	3.09	5.44	28.66	16
15	75	28.21	55.98	429.54	401.33	3.20	5.80	42.98	15

Pole Height H	Aiming Angle C	Road Distance Near RD_N	Road Distance Center RD_C	Road Distance Far RD_F	Beam Pattern Length L	Pattern Width Near W_N	Pattern Width Center W_C	Pattern Width Far W_F	Cosine Angle φ
20	45	12.50	20.00	32.01	19.51	2.36	2.83	3.77	45
20	50	15.07	23.84	39.25	24.18	2.50	3.11	4.41	40
20	55	18.01	28.56	49.50	31.49	2.69	3.49	5.34	35
20	60	21.45	34.64	65.42	43.97	2.93	4.00	6.84	30
20	65	25.60	42.89	94.09	68.49	3.25	4.73	9.62	25
20	70	30.80	54.95	162.89	132.09	3.67	5.85	16.41	20
20	75	37.61	74.64	572.73	535.11	4.26	7.73	57.31	15
20	60	21.45	34.64	65.42	43.97	2.93	4.00	6.84	30
20	61	22.21	36.08	69.75	47.54	2.99	4.13	7.26	29
20	62	23.01	37.61	74.64	51.63	3.05	4.26	7.73	28
20	63	23.84	39.25	80.22	56.38	3.11	4.41	8.27	27
20	64	24.70	41.01	86.63	61.93	3.18	4.56	8.89	26
20	65	25.60	42.89	94.09	68.49	3.25	4.73	9.62	25
20	66	26.54	44.92	102.89	76.35	3.32	4.92	10.48	24
20	67	27.53	47.12	113.43	85.90	3.40	5.12	11.52	23
20	68	28.56	49.50	126.28	97.71	3.49	5.34	12.78	22
20	69	29.65	52.10	142.31	112.66	3.58	5.58	14.37	21
20	70	30.80	54.95	162.89	132.09	3.67	5.85	16.41	20
20	71	32.01	58.08	190.29	158.28	3.77	6.14	19.13	19
20	72	33.29	61.55	228.60	195.32	3.88	6.47	22.95	18
20	73	34.64	65.42	286.01	251.37	4.00	6.84	28.67	17
20	74	36.08	69.75	381.62	345.54	4.13	7.26	38.21	16
20	75	37.61	74.64	572.73	535.11	4.26	7.73	57.31	15

Pole Height H	Aiming Angle C	Road Distance Near RD_N	Road Distance Center RD_C	Road Distance Far RD_F	Beam Pattern Length L	Pattern Width Near W_N	Pattern Width Center W_C	Pattern Width Far W_F	Cosine Angle φ
25	45	15.62	25.00	40.01	24.39	2.95	3.54	4.72	45
25	50	18.84	29.79	49.07	30.23	3.13	3.89	5.51	40
25	55	22.51	35.70	61.88	39.37	3.36	4.36	6.67	35
25	60	26.81	43.30	81.77	54.96	3.67	5.00	8.55	30
25	65	32.00	53.61	117.62	85.62	4.06	5.92	12.02	25
25	70	38.50	68.69	203.61	165.11	4.59	7.31	20.51	20
25	75	47.02	93.30	715.91	668.89	5.33	9.66	71.63	15
25	60	26.81	43.30	81.77	54.96	3.67	5.00	8.55	30
25	61	27.77	45.10	87.19	59.42	3.74	5.16	9.07	29
25	62	28.76	47.02	93.30	64.54	3.81	5.33	9.66	28
25	63	29.79	49.07	100.27	70.48	3.89	5.51	10.33	27
25	64	30.87	51.26	108.29	77.41	3.97	5.70	11.11	26
25	65	32.00	53.61	117.62	85.62	4.06	5.92	12.02	25
25	66	33.18	56.15	128.61	95.44	4.15	6.15	13.10	24
25	67	34.41	58.90	141.78	107.37	4.25	6.40	14.40	23
25	68	35.70	61.88	157.84	122.14	4.36	6.67	15.98	22
25	69	37.06	65.13	177.88	140.82	4.47	6.98	17.96	21
25	70	38.50	68.69	203.61	165.11	4.59	7.31	20.51	20
25	71	40.01	72.61	237.86	197.85	4.72	7.68	23.92	19
25	72	41.61	76.94	285.75	244.14	4.85	8.09	28.68	18
25	73	43.30	81.77	357.52	314.22	5.00	8.55	35.84	17
25	74	45.10	87.19	477.03	431.93	5.16	9.07	47.77	16
25	75	47.02	93.30	715.91	668.89	5.33	9.66	71.63	15

There is one more very important point to make in considering the antenna location. The antenna should be mounted so that there are no obstacles between the radar and the lane to be monitored. Even though the beam width is only 6 degrees, some of the radar signal will exit in much wider beam angles from the antenna. The closer an object is to the antenna the stronger the signal will be that will be reflected back to the antenna. A very close object, even outside the 6 degree beam width, can reflect enough energy back to the antenna to overload the antenna and reduce its sensitivity. When installing the antenna, make sure there are no obstacles near the front of the antenna.

Sensor Configuration

There are four configuration registers that are used to customize the Speed Sensor for lane discrimination. They are the Target Direction, Cosine Angle 1, Target Strength Sensitivity, and the Holdover Time registers.

Target Direction (configuration ID 1/02)
The available values for the Target Direction setting are “Away” to monitor receding targets only, “Closing” to monitor approaching targets only and “Both” to monitor targets moving in either direction. Select the direction of traffic relative to the sensor for the lane to be monitored. The “Both” selection should not be used since lanes typically only have one direction of travel and using the “Both” setting may add unwanted reporting.

Cosine Angle 1 (configuration ID 1/18)
Radars measure the most accurate speeds when targets are moving directly toward or away from them. As with any radar, aiming at an angle results in lower readings than the actual speeds. At slight angles the error is very small; however at larger angles the error can become substantial.

These low speeds can be corrected using the Cosine Angle settings. The range of values for the two Cosine Angle settings is 0 – 45 degrees, in one degree increments.

In the Lane discrimination applications the Cosine Angle (φ in the charts above) is the complementary angle to the aiming angle of the sensor (C in the charts above). For example, if the sensor is pointing out at a 70 degree angle relative to a vertical pole, then the complement, or the cosine angle for the sensor is 20 degrees (90 - 70 = 20).

Target Strength Sensitivity (configuration ID 1/85 or 1/120)
Targets can be suppressed or acquired depending on their signal strength. A higher value for the Target Strength Sensitivity allows smaller, weaker targets to be acquired. A lower value requires the target to be larger/stronger before it is acquired. The range of values is 1-99. For lane discrimination applications we suggest a starting value of 50 for Target Strength Sensitivity.

The OEM 6° x 26° Stationary Sensor II has just one target strength sensitivity setting, the Visual Target Strength Sensitivity (ID 1/85). The OEM 6° x 26° Traffic Statistics Sensor has two: the Visual Target Strength Sensitivity as above and also the Stats Target Strength Sensitivity (ID 1/120). If the Traffic Statistics Sensor is being used to collect statistics, use this second setting.

Holdover Time (Configuration ID 1/88)
The Holdover Time sets a time for the last speed measurement to continue to be displayed after the signal has been lost. This is primarily for applications where the speed is to be visually displayed and the holdover aids in eliminating display flicker. In lane discrimination applications the output generally does not go to a visual display and so is not needed. The Holdover Time is settable from 0 to 10 seconds. For lane discrimination applications set this register to 0.

Fine Tuning the Set Up

Every installation should be treated as a unique set up. There are several sources of variability that may require an installation to be fine-tuned. These sources of variability range from differences in the sensitivity and transmit power from one sensor to the next, to lane width and road gradients of the installation site.

The primary tool for adjusting the performance of the sensor once it is installed is its Target Strength Sensitivity setting. The larger the sensitivity value stored in the configuration register, the wider the effective beam width. This will cause the target zone to increase, moving the near end closer to the sensor and the far end further away from the sensor; the drawback is the sensor will pick up more traffic in adjacent lanes. If your lanes are wide, then you can increase your sensitivity a little and have a longer target zone. Conversely, if the sensor is picking up too much traffic in adjacent lanes then you need to lower the sensitivity setting; this will also cause the length of the effective target zone to decrease.