

SmartSensor V

USER GUIDE

SmartSensor V

USER GUIDE

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Introduction

In this chapter

- SmartSensor V Package
- Selecting a Mounting Location

The Wavetronix SmartSensor V utilizes patented Digital Wave Radar™ technology to detect lane occupancy, traffic volume and average speed in up to eight lanes of traffic simultaneously. Classified as frequency modulated continuous wave (FMCW) radar, SmartSensor V collects data using a 10.525 GHz (X-band) operating radio frequency.

The installation and configuration process is quick and easy. Once installed, SmartSensor configures automatically, requires little or no on-site maintenance and may be remotely re-configured. This user guide provides the step-by-step process for installing and configuring the SmartSensor, including mounting and alignment guidelines and instructions for both automatic and manual sensor configurations. Any questions about the information in this guide should be directed to Wavetronix or your distributor.

Note

Do not attempt to service or repair this unit. This unit does not contain any components and/or parts serviceable in the field. Any attempt to open this unit, except as expressly written and directed by Wavetronix, will void the customer warranty. Wavetronix is not liable for any bodily harm or damage caused if service is attempted or if the back cover of the SmartSensor unit is opened. Refer all service questions to Wavetronix or an authorized distributor.

SmartSensor V Package

A typical sensor package contains the following items:

- 10.525 GHz SmartSensor V radar traffic sensor
- SmartSensor mounting kit
- SmartSensor 8-conductor cable
- SmartSensor Manager software
- *SmartSensor V User Guide*

Note

Check the packing slip for actual contents. If any of these items are missing, note the serial number located on the back of the sensor and contact your distributor.

Additional products may be purchased through your distributor. The following optional items are not included unless specifically ordered (check packing list for actual inventory):

- Click 172/174™ contact closure adapter
- Click 200™ surge protector
- Click 201/202/204™ AC to DC converter
- Click 210™ circuit breaker and switch
- Click 230™ AC surge module

Selecting a Mounting Location

Consider the following guidelines when selecting a mounting location:

- **Lane Coverage** - Sensor mounting locations should be selected so that all monitored lanes are within 10 to 200 ft. (3 to 61 m) and run parallel with each other. If more than eight lanes need to be simultaneously monitored, consider using multiple sensors or the SmartSensor HD, which can monitor up to 10 lanes simultaneously.
- **Parallel Lanes** - When the sensor is used to collect both mainline and ramp data, the pole position should be selected so that the on and off ramp lanes run parallel with the mainline. If lanes are not parallel, installation of multiple SmartSensor units should be considered to achieve the sensor's $\pm 2^\circ$ side-to-side angle requirement.
- **Sensors on the Same Pole** - When multiple sensors are mounted on the same pole, they will not be subject to interference if they are configured to operating using different RF channels and are separated vertically by a few feet. The higher sensor would typically be used for the lanes further from the pole in order to minimize occlusion.
- **Sensors on Opposing Poles** - SmartSensor units facing each other on opposing poles should operate on different RF channels and be separated by a 40-ft. (12.2-m) lateral offset, if possible.

- **Line of Sight** - The SmartSensor is designed to work accurately in the presence of barriers, but in general if there is an alternate mounting location that would avoid any type of structural occlusion, this is preferred. Avoid occlusion by trees, signs, and other roadside structures.
- **Neighboring Structures and Parallel Walls** - It is also preferred that sensor locations have a 30-ft. (9.1-m) lateral separation from overhead sign bridges, overpasses, tunnels, parallel walls and parallel-parked vehicles in order to avoid multiple reflection paths from a single vehicle.
- **Mounting Height** - The mounting height should be based upon the offset from the lanes of interest. For each offset, the minimum, maximum and recommended range of heights is shown in Table 1.1, found in chapter 1. In general, the range of recommended heights is between 9 and 50 ft. (2.7 to 15.2 m).
- **Mounting Offset** - The minimum recommended offset from the edge of the first lane of interest is 10 ft. (3 m).
- **Arterial Locations** - Sensor sites on arterials or other roadway segments with regulated stop lines should be selected at mid-block positions to increase accuracy by increasing line of sight to stop-and-go vehicles.

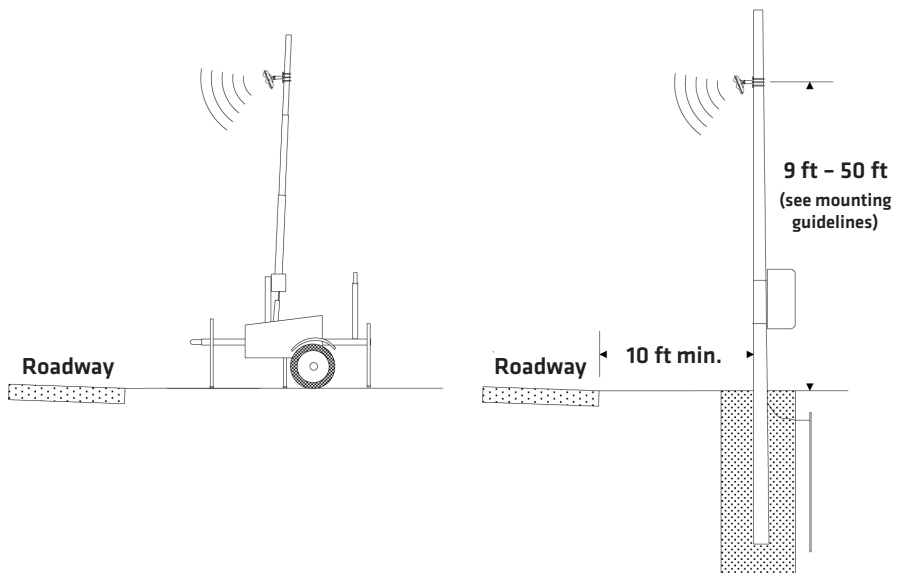


Figure I.1 - Portable (left) and Permanent (right) Sensor Stations

- **Freeway Locations** - The SmartSensor V is often used at permanent ATR stations. The number of stations along a single roadway and the distance between stations should be selected to achieve adequate levels of statistical confidence. Permanent ATR stations, which are selected to cover interstate, principal arterial and other national and state highways, are used to establish seasonal adjustment factors for count data from temporary collection sites (see Figure I.1).
- **Cable Lengths** - Ensure that you have sufficient homerun and sensor cabling. Cable

runs as long as 600 ft. (182.9 m) using 24 VDC operation and RS-485 communications. For longer connections, alternate wired and wireless options should be considered.

Part I

Installing the SmartSensor V

Chapter 1 - Installing the SmartSensor V

Chapter 2 - Connecting Power and Surge Protection

Installing the SmartSensor V

In this chapter

- Selecting the Offset and Mounting Height
- Attaching the Mount Bracket to the Pole
- Attaching the Sensor to the Mount Bracket
- Aligning the Sensor to the Roadway
- Applying Silicon Dielectric Compound
- Connecting the 8-conductor Cable

Installing the SmartSensor V is quick and easy. Once installed, the SmartSensor V requires little or no on-site maintenance. This chapter will describe the installation process, including how to attach the sensor to the pole and how to correctly align the sensor.

Selecting the Offset and Mounting Height

After selecting a mounting location within the recommended range of offsets (see introduction), use Table 1.1 to select a mounting height. See Figure 1.1 for an illustration of what is meant by offset and mounting height.

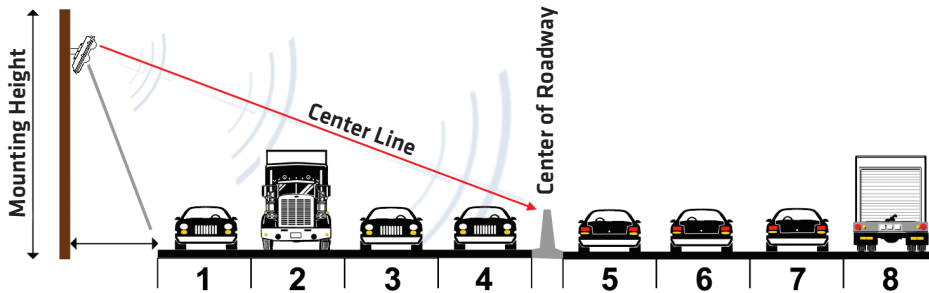


Figure 1.1 – Mounting and Aiming a SmartSensor V

	Offset from 1st Detection Lane (ft / m)	Recommended Mounting Height (ft / m)	Minimum Mounting Height (ft / m)	Maximum Mounting Height (ft / m)
	9 / 2.7	12 / 3.7	9 / 2.7	15 / 4.6
	10 / 3	12 / 3.7	9 / 2.7	15 / 4.6
	11 / 3.4	12 / 3.7	9 / 2.7	16 / 4.9
	12 / 3.7	13 / 4	10 / 3	16 / 4.9
	13 / 4	13 / 4	11 / 3.4	17 / 5.2
	14 / 4.3	14 / 4.3	11 / 3.4	17 / 5.2
	15 / 4.6	15 / 4.6	12 / 3.7	18 / 5.5
	16 / 4.9	15 / 4.6	12 / 3.7	18 / 5.5
	17 / 5.2	16 / 4.9	13 / 4	18 / 5.5
	18 / 5.5	17 / 5.2	14 / 4.3	19 / 5.8
	19 / 5.8	17 / 5.2	14 / 4.3	19 / 5.8
	20 / 6.1	18 / 5.5	15 / 4.6	20 / 6.1
	21 / 6.4	18 / 5.5	15 / 4.6	21 / 6.4
	22 / 6.7	18 / 5.5	16 / 4.9	22 / 6.7
	23 / 7	19 / 5.8	16 / 4.9	23 / 7
	24 / 7.3	19 / 5.8	16 / 4.9	24 / 7.3
	25 / 7.6	20 / 6.1	17 / 5.2	25 / 7.6
	26 / 7.9	20 / 6.1	17 / 5.2	26 / 7.9
	27 / 8.2	21 / 6.4	18 / 5.5	27 / 8.2
	28 / 8.5	21 / 6.4	18 / 5.5	28 / 8.5
	29 / 8.8	21 / 6.4	18 / 5.5	29 / 8.8
	30 / 9.1	22 / 6.7	19 / 5.8	30 / 9.1
	31 / 9.4	22 / 6.7	19 / 5.8	31 / 9.4

Recommended Offset

32 / 9.8	22 / 6.7	19 / 5.8	32 / 9.8
33 / 10.1	23 / 7	19 / 5.8	33 / 10.1
34 / 10.4	23 / 7	19 / 5.8	34 / 10.4
35 / 10.7	23 / 7	20 / 6.1	35 / 10.7
36 / 11	23 / 7	20 / 6.1	36 / 11
37 / 11.3	23 / 7	20 / 6.1	37 / 11.3
38 / 11.6	24 / 7.3	21 / 6.4	38 / 11.6
39 / 11.9	24 / 7.3	21 / 6.4	39 / 11.9
40 / 12.2	25 / 7.6	22 / 6.7	40 / 12.2
41 / 12.5	25 / 7.6	22 / 6.7	41 / 12.5
42 / 12.8	26 / 7.9	22 / 6.7	42 / 12.8
43 / 13.1	26 / 7.9	22 / 6.7	43 / 13.1
44 / 13.4	27 / 8.2	23 / 7	44 / 13.4
45 / 13.7	27 / 8.2	23 / 7	45 / 13.7
46 / 14	28 / 8.5	23 / 7	46 / 14
47 / 14.3	28 / 8.5	24 / 7.3	47 / 14.3
48 / 14.6	29 / 8.8	24 / 7.3	48 / 14.6
49 / 14.9	29 / 8.8	24 / 7.3	49 / 14.9
50-180 / 15.2-54.9	30 / 9.1	25 / 7.6	Must be < offset

Table 1.1 – Mounting Height Guidelines

Attaching the Mount Bracket to the Pole

Before attaching the mount bracket to the pole, first make sure that your cables are long enough to reach the sensor height and to stretch across the distance from the sensor to the cabinet.

Follow the steps below to correctly attach the mount to the pole (see Figure 1.2):

- 1** Look up the recommended mounting height from Table 1.1.
- 2** Insert the stainless steel straps through the slots in the mount bracket.
- 3** Position the mount on the pole so that the head of the mount is pointing towards the middle of the lanes of interest.
- 4** Tighten the strap screws.

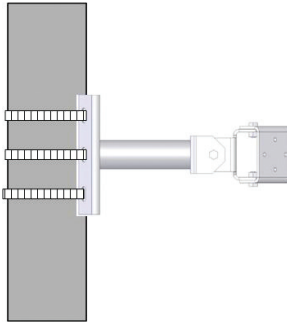


Figure 1.2 – Attaching the Mount Bracket to the Pole

Note

Depending on the site and type of traffic, the sensor may tend to over- or undercount. If the sensor is overcounting, reduce the height of the sensor by three ft. (0.9 m) and reconfigure the sensor. If the sensor is undercounting, increase the height of the sensor by three ft. (0.9 m) and reconfigure. Normally, reducing the height of the sensor improves performance.

Attaching the Sensor to the Mount Bracket

Use the following steps to securely fasten the sensor to the mount bracket (see Figure 1.3).

- 1** Align the bolts on the back of the SmartSensor V with the holes in the mounting bracket. The 10-pin connector on the SmartSensor V should be pointing towards the ground.
- 2** Place the lock washers onto the bolts after the bolts are in the mounting bracket holes.
- 3** Thread on the nuts and tighten.

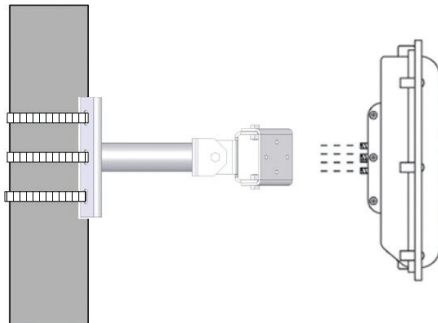


Figure 1.3 – Attaching the Sensor to the Mounting Bracket

Aligning the Sensor to the Roadway

Follow the steps below to correctly align the SmartSensor V (see Figure 1.4):



Figure 1.4 – Aiming the SmartSensor

- 1 Aim the front of the sensor at the center of the detection area. Refer to Figure 1.1 as an illustration of where to aim the sensor.
- 2 Adjust the side-to-side angle to within approximately $\pm 2^\circ$ of perpendicular to the flow of traffic.
- 3 Tighten mounting bracket bolts.

Applying Silicon Dielectric Compound

Use the following steps to correctly apply the silicon dielectric compound:

- 1 Tear the tab off the tube of silicon dielectric compound.
- 2 Squeeze about 25% of the silicon into the connector at the base of the SmartSensor V as shown in Figure 1.5. Be sure to wipe off any excess compound.



Figure 1.5 – Applying Silicon Dielectric Compound

Connecting the 8-conductor Cable

- 1 Attach the cable connector to the 10-pin connector at the base of the SmartSensor V as shown in Figure 1.6. The sensor connector is keyed to ensure proper connection; simply twist the connector clockwise until you hear it click into place.
- 2 Strap the cable to the pole or run it through a conduit to avoid undue movement from wind and reduce cable strain.



Figure 1.6 - Attached Cable

Connecting Power and Surge Protection

2

In this chapter

- Connecting Lightning Surge Protection
- Grounding
- Connecting AC Power Conversion
- Connecting DC Power
- Wiring Communication

Once the sensor is installed, it will need to be wired for power and surge protection. This chapter will explain how to connect lightning surge protection, AC power conversion, DC power and basic communication.

Wavetronix Click products allow you to quickly and easily connect power and surge protection to your sensor application. Please refer to the Click quick-reference guides for more comprehensive product instructions. Chapter 9 contains information on how Click products make the sensor compatible with all standard control cabinets.

A pinout diagram showing the sensor cable's pinout and appropriate connection points can be found in Appendix A of this document.

Connecting Lightning Surge Protection

The first item of concern is surge protection. The SmartSensor V has onboard surge protection, meaning that unlike the SmartSensor HD, the V does not require a pole-mount box; the only external surge protection device, along with power and communication devices, will be stored in the main traffic cabinet.

Note

The onboard surge protection on the SmartSensor V makes surge protection in a pole-mount box unnecessary in standard installations; however, if the installation is in an area where surges are common, a surge protector in a pole-mount box can add an extra layer of protection. If you are interested in using a pole-mount box, contact Wavetronix Technical Services for instructions.

The exception to this would be if the installation involved power and wireless communication devices on the same pole as the sensor; in this case, a pole-mount box would need to be used (if this is the case and you need more information, contact Wavetronix Technical Services). In most cases, however, an installation looks like the figure below (though in some cases, rack cards are used).

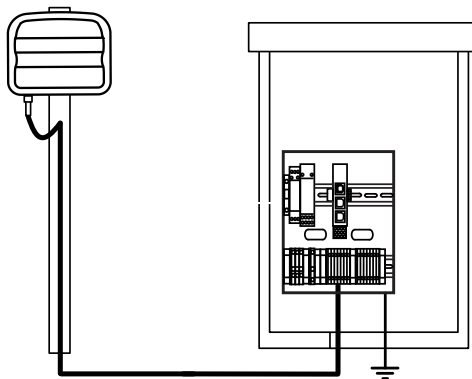


Figure 2.1 - Typical Cable Run (not to scale)

Follow the steps below to include surge protection using a Click 200 device (see Figure 2.1):

- 1 After installing the sensor, connect an 8-conductor cable to it.
- 2 Run the cable down the pole and underground to the main traffic cabinet.
- 3 Install a Click 200 on a DIN rail in the main traffic cabinet.
- 4 Connect the 8-conductor cable to the UNPROTECTED side of the Click 200 in the cabinet.

Note

The purpose of the Click 200 in the main cabinet is not to protect the sensor, but the electrical equipment inside of the main cabinet.

The Click 200 contains three terminal connectors on both the top and the bottom of the module (see Figure 2.2). The terminal connectors are removable and are red-keyed, allowing the connector to plug into only one specific jack. This both simplifies the wiring process and reduces the possibility of wiring errors.

The back four terminals consist of one +DC power, -DC and two surge ground connections; the middle four terminals are for RS-485 communication and consist of a +485 connection, a -485 connection, an RS-232 ground connection and a surge ground connection; the front four terminals are for RS-232 communication and consist of TD, RD, CTS and RTS.

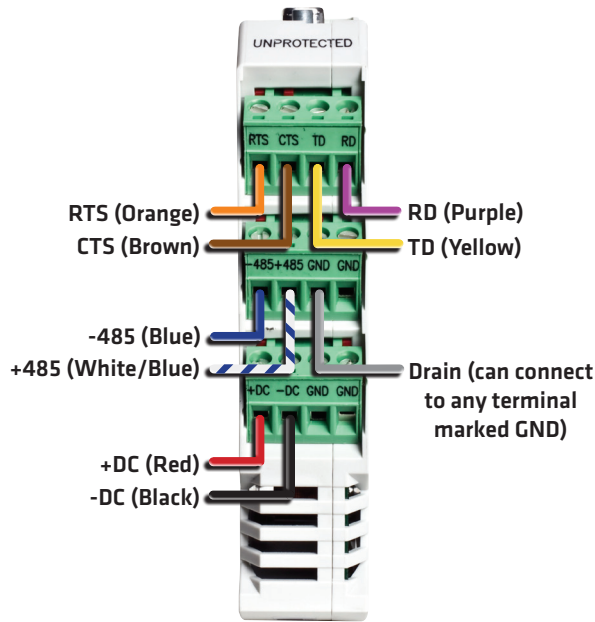


Figure 2.2 - Surge Protected Terminal Connections (Top)

Follow the diagram above to wire into the UNPROTECTED side of the Click 200.

Note

The predecessor to the SmartSensor V, the 105, used the 9-conductor cable. For information on this cable, see Appendix B.

Grounding

The Click 200 device in the main traffic cabinet should be grounded. The traffic cabinet should have a grounding lug; ground the Click 200 by connecting a 16 AWG or larger

grounding rod from a GND screw terminal on the UNPROTECTED side of the Click 200 to the cabinet's grounding lug.

The SmartSensor V itself also needs to be grounded via its grounding lug.

- 1 Connect a grounding wire to the grounding lug on the bottom of the sensor (see Figure 2.3).



Figure 2.3 - Grounding Lug on SmartSensor V

- 2 Connect the other end of the grounding wire to the earth ground for the pole that the sensor is mounted on. Do not attempt to run the grounding wire back to the main traffic cabinet.

Connecting AC Power Conversion

Since the sensor operates on 10–30 VDC, it is necessary to provide AC power conversion (unless reliable DC power is already available). Wavetronix recommends using the following three Click components. When all connected together and used to power a sensor, these modules are referred to collectively as the power plant.

- Click 201/202 AC to DC converter
- Click 230 AC surge module
- Click 210 circuit breaker and switch

A Click 201 provides 1 A of power and is capable of powering a single sensor, while a Click 202 provides 2 A and can power two sensors. (There is also a Click 204, which provides 4 A, but that will probably not be necessary for a SmartSensor V installation.)

The Click 230 helps limit current surges on the power lines; the Click 210 interrupts power during overload conditions and provides a convenient way to turn power on and off.

These Click modules will be mounted in the main traffic cabinet. A homerun cable is used to conduct DC power and communication signals to the sensor itself. For connections shorter than 600 ft. (182.9 m), use the 8-conductor cable as your homerun cable (be aware that for runs between 200 and 600 ft. [61 and 182.9 m], RS-232 will be unreliable; for more

information and for alternative wiring schemes, see Appendix C of this guide). This will simplify the wiring process and ensure reliable connections.

All of the modules discussed in the next few sections will go side by side on a DIN rail in the main traffic cabinet, as shown in Figure 2.4.

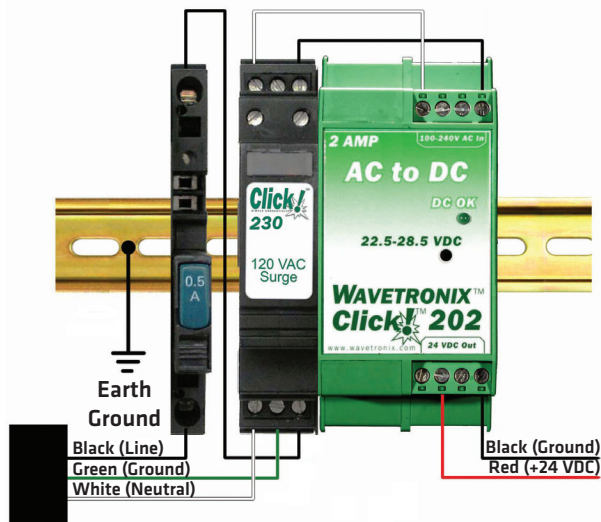


Figure 2.4 - Power Plant

Note

An authorized electrical technician should perform installation and operation of this unit. Persons other than authorized and approved electrical technicians should NOT attempt to connect this unit to a power supply and/or traffic control cabinet, as there is a serious risk of electrical shock through unsafe handling of the power source. Extreme caution should be used when connecting this unit to an active power supply.

Wiring a Circuit Breaker and Switch

The Click 210 is a compact circuit breaker DIN rail device designed to interrupt an electric current under overload conditions. The breaker is trip-free and can be easily reset after a current interruption by pushing the reset button.

To add a Click 210 circuit breaker and switch (see Figure 2.4):

- 1 Mount the Click 210 onto the DIN rail.
- 2 Connect power in to either side of the module.

- 3 Connect power out to the other side.

Wiring AC Surge Protection

To include AC surge protection in your installation (see Figure 2.4):

- 1 Mount the Click 230 onto the DIN rail.
- 2 Connect the line conductor (hot) from the Click 210 to terminal 5 on the IN side of the Click 230.
- 3 Connect the neutral wire to the terminal marked 1 on the Click 230.
- 4 Connect the ground wire to the terminal marked 3 on the Click 230.
- 5 Connect the outgoing and protected line wire to the terminal marked 2 on the Click 230.
- 6 Connect the outgoing and protected neutral wire to the terminal marked 6 on the Click 230.

The terminal blocks 3 and 4 are directly bonded via the metal mounting foot of the base element to the DIN rail. There is no need for any additional grounding between terminals 3 and 4 and the DIN rail.

Wiring AC Power Into the Click 201/202

Follow the steps below to properly wire an AC to DC power conversion module (see Figure 2.4 for how it fits into the rest of the power plant):

Note

Make sure power to AC mains is disconnected while wiring the AC input.

- 1 Mount the Click 201/202 onto the DIN rail.
- 2 Connect the line (hot) wire from the Click 230 into the L screw terminal on the top of the Click 201/202, as shown in Figure 2.5. The line wire is usually black.
- 3 Connect the neutral wire from the Click 230 to the N screw terminal to the top of the Click 201/202. The neutral wire is usually white.



Figure 2.5 – Wiring AC Power into the Click 201/202

Note

The NC screw terminal is not connected internally. Connecting a wire to a no connect (NC) terminal simply gives it a convenient termination point.

Wiring DC Power Out of the Click 201/202

- 1 Connect a +DC conductor (usually a red wire) to the + screw terminal on the bottom of the Click 201/202 (see Figure 2.6).
- 2 Connect a -DC conductor (usually a black wire) to either of the - screw terminals on the bottom of the Click 201/202.



Figure 2.6 – Wiring DC Power Out of the Click 201/202

Note

Do not use the screw terminal marked DCOK; it provides only 20 mA and should be used only for monitoring the power supply.

The screw terminal connectors on the top and bottom of the module are removable to simplify wiring and are red-keyed, allowing the connector to plug into only one correct jack.

Connecting DC Power

The next step in powering your sensor is connecting the newly converted DC power from the Click 201/202 into the Click 200; this will then be sent from the Click 200 via the homerun cable to the sensor.

There are two ways in which power can be connected to the Click 200: through the T-bus or through the screw terminals on the PROTECTED side of the Click 200.

Connecting Power through the T-bus

The Click 200 is mounted on the T-bus, which consists of a number of small modules that pass power and communications to any device mounted on them. For this reason, one way to get power to a Click 200 is to provide power to the T-bus via the 5-position screw terminal. (The power plant is usually mounted on the same DIN rail as the T-bus and Click 200, or at least very near to them).

To wire DC power directly into a 5-position screw terminal (see Figure 2.7):

- 1 Connect +DC (the red wire from the Click 201/202) to the top screw terminal of the 5-position connector.
- 2 Connect -DC (the black wire) to the second screw terminal.

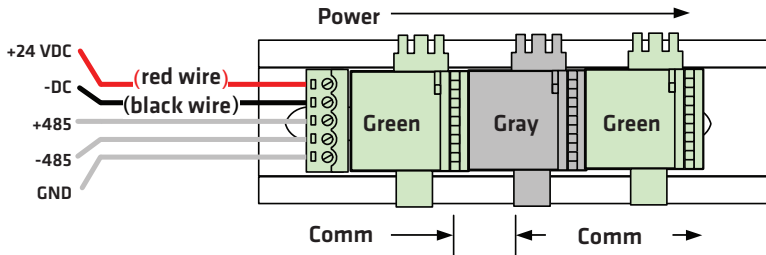


Figure 2.7 – Power and Communication on the T-bus

Note

Green T-bus connectors provide power and communication connectivity on the T-bus backplane; gray T-bus connectors only provide power connectivity and are used to distribute power without connecting communication. Modules with a gray T-bus connector between them will not communicate. A module on a gray T-bus connector will not communicate with a module to the left, but can connect to a module on the right (if it's on green connector), as shown in the figure above.

Connecting Power through the Screw Terminals

Power from the Click 201/202 can also be connected through the screw terminals on the PROTECTED side of the Click 200 (the side that the homerun cable is not connected to). Because it's mounted on the T-bus, powering the Click 200 itself will also cause power to be sent over the T-bus to all other devices needing DC power.

As shown in Figure 2.8, the last screw terminal block on the PROTECTED side of the Click 200 module contains a +DC, -DC and two surge ground connections. To wire into this block:

- 1 Connect +DC (the red wire from the Click 201/202) to the +DC screw terminal.
- 2 Connect -DC (the black wire from the Click 201/202) to the GND screw terminal next to the +DC terminal.

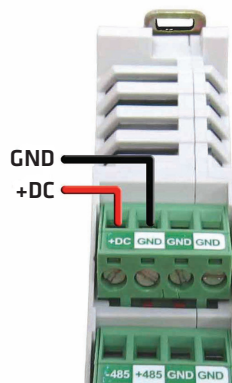


Figure 2.8 – Wiring DC Power into the Click 200

Wiring Communication

The Click 200 has two isolated serial connections, RS-232 and RS-485.

Note

The Click 200 does not convert RS-232 communication to RS-485. It simply provides surge protection for these two independent connections.

The RS-232 line is available via the DB-9 connector on the faceplate and the appropriate screw terminals (CTS, RTS, TD, and RD).

The RS-485 connection is via the RJ-11 connector on the faceplate, the T-bus connector in the back of the device, and the appropriate screw terminals (+485 and -485).

Because the Click 200 is connected via homerun cable back to the sensor, these two communication connections on the Click 200 provide access to the RS-232 and RS-485 ports on the sensor.

The question then becomes what communication options will best suit the installation. Wavetronix Click products facilitate a wide variety of additional wired and wireless communication options. Contact a Wavetronix-authorized technical representative to find out which options are best suited for your application.

Contact Closure Connections

One common communication application to use is to connect the Click 200 to contact closure cords. While any of the RS-485 ports on the Click 200 can be connected to contact closure modules, it is often easiest to connect from the RJ-11 port. If necessary, several contact closure cards can be daisy-chained together. However, the chain should not be connected until each card has been independently programmed (see Figure 2.9).



Figure 2.9 - Connecting Contact Closure Modules

Note

Wait to connect contact closure communications until after the sensor is programmed using the configuration software.

See Chapter 9 for more information on contact closure communications.

Part II

Using SmartSensor Manager

Chapter 3 - Getting Started with SmartSensor Manager

Chapter 4 - Communication

Chapter 5 - Sensor Settings

Chapter 6 - Lane Setup

Chapter 7 - Data Collection

Chapter 8 - Tools

Chapter 9 - Contact Closure Communications

Getting Started with SmartSensor Manager

3

In this chapter

- Installing SmartSensor Manager
- About Screen
- Table of Contents

After the SmartSensor is installed, it must be configured to the roadway for proper operation. The SmartSensor Manager (SSM) software is used to perform this configuration.

SmartSensor Manager brings increased user-friendliness and improved functionality to the ITS industry's only patented auto-configuration and auto-calibration process.

Installing SmartSensor Manager

Follow these steps to install SSM on a PC:

- 1 To download the install file, go to the Wavetronix website at www.wavetronix.com.
- 2 Click the **Support** link near the top of the page. This will bring up a page with icons from the three different Wavetronix product lines.
- 3 Click the SmartSensor icon. This will bring up drop-down menus allowing you to select a product by name or part number.
- 4 Select **SmartSensor V** or **WX-SS-105V**. A list of links will appear.
- 5 Select the **SmartSensor Manager** link (it will be near the top) to download the SSM install file.
- 6 A File Download window will pop up. Click **Save**.
- 7 In the Save As window, select where you would like the file to be saved, then click **Save**.

8 Once you've downloaded the file, double-click on it to open SmartSensor Manager.

About Screen

To access information about the version of SmartSensor Manager you are using, as well as copyright information, go to **Help > About SmartSensor Manager** (see Figure 3.1).

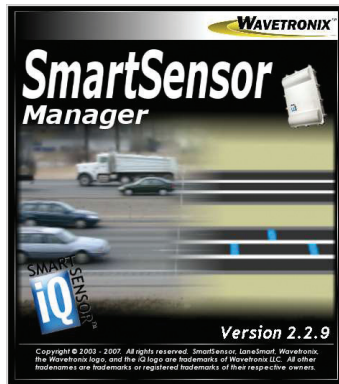


Figure 3.1 – About SmartSensor Manager

Note

The newest version of SSM is always available on the Wavetronix website.

Table of Contents

This user guide presents the features of SmartSensor Manager in the order that they should be used when setting up and using your sensor. If you'd like to access information about features organized according to the way the software is laid out, however, you can use the Table of Contents feature.

To access the Table of Contents, go to **Help > Table of Contents**. This will open the Table of Contents, which is a list of help subjects organized according to the layout of the SSM menu bar. The list is divided into the following three columns (see Figure 3.2):

Topic	Available	Type
SmartSensor Manager	Y	Tutorial
Side Fire Configuration	Y	Tutorial
File		
New Connection	Y	Context Sensitive
Serial Connection	Y	Context Sensitive
Modern Connection	Y	Context Sensitive
Internet Connection	Y	Context Sensitive
Advanced Connection Settings	Y	Context Sensitive
Sensor ID Detection	Y	Context Sensitive
Firmware/Software Compatibility	Y	Context Sensitive
Connection Properties	Y	Context Sensitive
Sensor Info	Y	Context Sensitive
Close Connection		
Address Book...	Y	Context Sensitive
Entity	Y	Context Sensitive
Delta Logs...		
Export	Y	Context Sensitive
3 Card	Y	Context Sensitive
Exit		
Edit		
Lane Configuration	Y	Context Sensitive
Sensor Settings		
General	Y	Context Sensitive
Communication	Y	Context Sensitive
Data Collection	Y	Context Sensitive

Figure 3.2 – Table of Contents Page

- **Topic** – Lists the available topics according to the setup of the software.
- **Availability** – Shows whether the information is available. If it is available, this will show a Y. If it is not, this and the one to the right of it will be blank.
- **Type** – Shows the type of information contained on the page. Pages marked Tutorial provide overview information; pages marked Context Sensitive have information specific to a particular function or operation.

Open the desired information from the Table of Contents by either double-clicking on the subject in the list, or by highlighting the item and clicking the **Display Help Topic** button (see Figure 3.3).

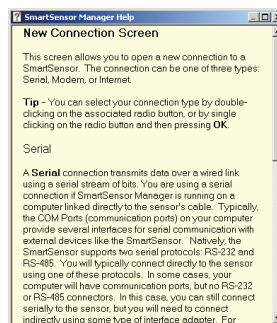


Figure 3.3 – Help Screen

Note

You can also access the Table of Contents help information for a given page by pressing the **F1** key while on that page. Additionally, some pages have question marks in the upper right-hand corner that lead to their Table of Contents help pages.

You can access the Table of Contents page from anywhere in SmartSensor Manager; an active sensor connection is not needed. This enables you to get help information at any time, especially if information about connecting to a sensor is needed.

Release Notes

The last entry in the Table of Contents is Release Notes, which, when selected, displays information on the current and previous versions of SSM. This information includes the version number, date of release (in YY/MM/DD format), and the new features added and issues resolved in each release.

In this chapter

- Serial Connection
- Modem Connection
- Internet Connection
- Firmware Upload
- Connection Properties
- Address Book
- Communication Error

When the SmartSensor Manager application is opened, you will be taken to the New Connection page, where you will be able to connect using one of three connection options: serial, modem, or Internet. Choose the desired method of connection and click **OK**. The Serial (COM Port) radio button will be selected by default (see Figure 4.1).

You can also access the three connection options at any time by going to **File > New Connection**.

Note

Selecting a connection type under **File > New Connection** while you are already connected will terminate your current connection. You can also end a connection by going to **File > Close Connection**.



Figure 4.1 – New Connection Page

Clicking **OK** opens a connection page unique to each connection option. Each connection page contains three function buttons: **Advanced**, **Cancel**, and one that allows you to connect or dial. The advanced functions for each connection option are specific for each option.

Serial Connection

To make a serial connection, click the **Serial (COM Port)** radio button and then **OK**. The message below will appear (see Figure 4.2):

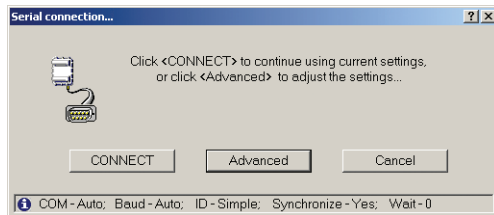


Figure 4.2 – Serial Connection

The three action buttons appear near the bottom of the page. The **CONNECT** button will attempt to connect to the sensor using the current settings. The **Cancel** button cancels the action and returns you to the New Connection page.

A message bar at the bottom, identified by the **i** icon, displays the serial settings being used for this connection. If the default settings are used, then the message bar will display the following:

COM - Auto; Baud - Auto; ID - Simple; Synchronize - Yes; Wait - 0

Advanced Serial Settings

Click the **Advanced** button to change the Advanced Connection settings (see Figure 4.3).

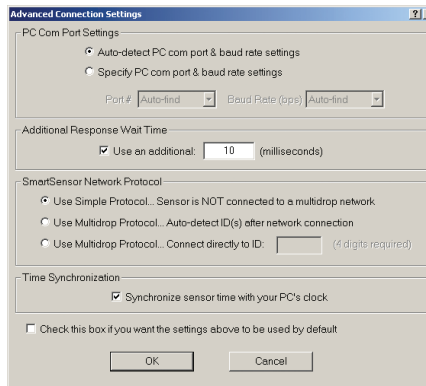


Figure 4.3 – Advanced Connection Settings

- **PC Com Port Settings** – By default, SSM is set to automatically detect PC com port & baud rate settings. To manually configure these settings, click the **Specify PC com port & baud rate settings** radio button. This will activate the **Port #** and **Baud Rate (bps)** drop-down lists.
- **Additional Response Wait Time** – By default, SmartSensor Manager waits a few milliseconds to receive a response from the sensor before timing out and displaying a communication error message. You can add additional milliseconds to the response wait time to give the program more time to make a connection. Click the **Use an additional:** check box to activate the milliseconds text field and enter the number of additional milliseconds SmartSensor Manager should wait for a response from the sensor.
- **SmartSensor Network Protocol** – These options can be used to identify sensors that are part of a multi-drop network. The Simple protocol option refers to sensors that are not part of a multi-drop environment. If the sensor is part of a multi-drop network, SmartSensor Manager can either auto-detect the multi-drop ID, or you can enter the four-digit ID. Clicking the **Use Multidrop Protocol... Connect Directly to ID:** radio button will activate the text box so you can enter the ID number.
- **Time Synchronization** – Click the check box to have SmartSensor automatically synchronize with the PC clock.

Click on the check box at the bottom of the Advanced Connection Settings page to use the new settings as default. Click **OK** to save the new settings or **Cancel** to return to default; both buttons will return you to the Serial Connection page. The new settings will be reflected in the message bar at the bottom of the page.

Modem Connection

Clicking the **Modem (Phone #)** radio button on the New Connection page and then clicking **OK** will allow you to connect to the SmartSensor using a modem. The Modem Connection page has a text box in which you can enter the phone number for the sensor's modem (see Figure 4.4).

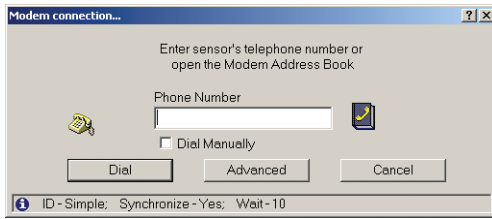



Figure 4.4 - Modem Connection

The phone book icon to the right of the text field allows you to browse for numbers previously saved in the SmartSensor Manager address book (for more information, see the Address Book section later in this chapter). If you'd prefer to dial manually, click the **Dial Manually** check box beneath the text field, then click on **Dial**. At this point you will need to pick up the telephone receiver and manually dial the phone number.

Note

When this window is first opened, the modem connection phone number you used most recently will automatically appear in the text field.

Once the number is entered, click **Dial** to make a connection. Click **Cancel** to stop the action and return to the New Connection page.

The message bar at the bottom of the page, identified by the  icon, shows the modem settings being used. If the default settings are used, the message bar will display the following:

ID - Simple; Synchronize - Yes; Wait - 0

Advanced Modem Settings

The following settings are part of the modem connection's advanced functions and can be found by clicking the **Advanced** button (see Figure 4.5):

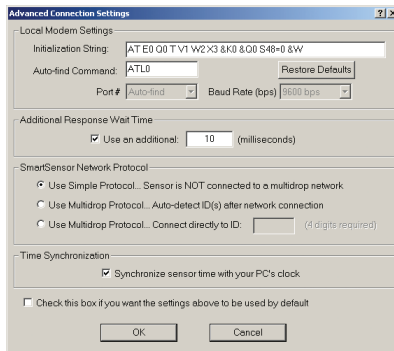


Figure 4.5 - Advanced Modem Settings

- **Local Modem Settings** - The initialization string and auto-find command can be entered in their respective text fields in the Local Modem Settings section. The **Restore Defaults** button will return these functions to their default settings. The port number and baud rate will be automatically detected by SmartSensor Manager, so these settings cannot be changed.
- **Additional Response Wait Time** - By default, SmartSensor Manager waits a few milliseconds to receive a response from the sensor before timing out and displaying a communication error message. You can add additional milliseconds to the response wait time to give the program more time to make a connection. Click the **Use an additional:** check box to activate the milliseconds text field and enter the number of additional milliseconds SmartSensor Manager should wait for a response from the sensor.
- **SmartSensor Network Protocol** - These options can be used to identify sensors that are part of a multi-drop network. The Simple protocol option refers to sensors that are not part of a multi-drop environment. If the sensor is part of a multi-drop network, SmartSensor Manager can either auto-detect the multi-drop ID, or you can enter the four-digit ID. Clicking the **Use Multidrop Protocol... Connect Directly to ID:** radio button will activate the text box so you can enter the ID number.
- **Time Synchronization** - Click the check box to have SmartSensor automatically synchronize with the PC clock.

Click the check box near the bottom of the Advanced Connection Settings page to use the new settings as default. The **OK** button saves the new settings and the **Cancel** button cancels the changes; both buttons return you to the Modem Connection page. The new settings will be displayed in the message bar at the bottom of the page.

Internet Connection

The **Internet (TCP/IP)** option will allow you to connect to the SmartSensor using the sensor's IP address. The Internet Connection page has two text boxes in which you can enter the sensor IP address and port number (see Figure 4.6). The **Connect** button does not become active until both the IP address and port number boxes are filled. You can also establish an Internet connection using a domain name by entering that domain name in the IP address text field.

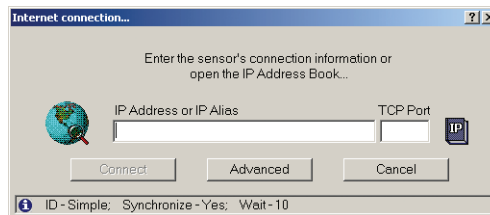



Figure 4.6 - Internet Connection

Note

When this window is first opened, the connection properties for the Internet connection you used most recently will automatically appear in the text fields.

The IP icon next to the text fields allows you to browse through previously saved addresses in the SSM address book, which is especially useful if you are connecting to more than one sensor using an Internet connection. For more information, see the Address Book section of this chapter.

Once the IP address and port number are entered, click **Connect** to make a connection. Click **Cancel** to stop the action and return to the New Connection page.

The message bar at the bottom of the page, identified by the  icon, shows the Internet settings being used. If the default settings are used, the message bar will display the following:

ID - Simple; Synchronize - Yes; Wait - 0

Advanced Internet Settings

The following settings are part of the Internet connection advanced functions and can be found by clicking the **Advanced** button (see Figure 4.7):

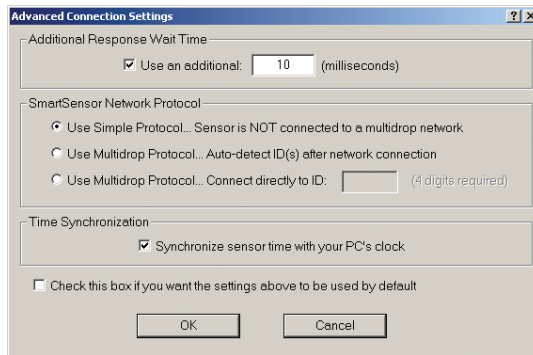


Figure 4.7 – Advanced Internet Settings

- **Additional Response Wait Time** – By default, SmartSensor Manager waits a few milliseconds to receive a response from the sensor before timing out and displaying a communication error message. You can add additional milliseconds to the response wait time to give the program more time to make a connection. Click the **Use an additional:** check box to activate the milliseconds text field and enter the number of additional milliseconds SmartSensor Manager should wait for a response from the sensor.
- **SmartSensor Network Protocol** – These options can be used to identify sensors that

are part of a multi-drop network. The Simple protocol option refers to sensors that are not part of a multi-drop environment. If the sensor is part of a multi-drop network, SmartSensor Manager can either auto-detect the multi-drop ID, or you can enter the four-digit ID. Clicking the **Use Multidrop Protocol... Connect Directly to ID:** radio button will activate the text box so you can enter the ID number.

- **Time Synchronization** – Click the check box to have SmartSensor automatically synchronize with the PC clock.

Click the check box near the bottom of the Advanced Connection Settings page to use the new settings as default. The **OK** button saves the new settings and the **Cancel** button cancels the changes; both buttons return you to the Internet Connection page. The new settings will be displayed in the message bar at the bottom of the page.

Firmware Upload

If the firmware installed onboard the SmartSensor is not the same as the firmware bundled with the SSM software, the Firmware/Software Compatibility screen may appear after you've finished connecting. This screen gives you four options: **Upload**, **Exit SmartSensor Manager**, **Continue w/o upload**, and **View Details** (see Figure 4.8).

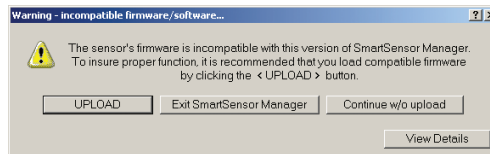


Figure 4.8 – Firmware/Software Compatibility Screen

Upload

Selecting **Upload** will upload the bundled firmware to the sensor, thereby eliminating any compatibility problems. The amount of time it takes to complete the upload depends primarily on your connection speed, but usually varies from 1 to 10 minutes.

During the upload process, you can cancel at any time. However, if the FPGA firmware was incompatible and the new version was not fully loaded before you clicked **Cancel**, the sensor will revert back to a factory-installed version of the FPGA firmware upon reboot of the sensor. The factory-installed version of the FPGA firmware may not be the same as the last version you were running on the sensor. In this case, you will need to re-upload the version of FPGA firmware you'd like to have on the sensor (see chapter 8 for information on how to do this). This does not occur when you cancel an upload of DSP firmware.

If the upload completes successfully, the sensor will need to reboot and restart before the new firmware will take effect. The restart should take about 15 seconds.

Exit SmartSensor Manager

If you are unsure what to do, you should click the **Exit SmartSensor Manager** button. When you have decided what to do, you can reconnect to the sensor.

In some cases, you may have simply connected to the sensor with the wrong version of SmartSensor Manager. Click the **Exit SmartSensor Manager** button to close your current connection and quit the program. Once you have quit this version of SmartSensor Manager, you can then connect up with the version you originally intended.

Continue w/o upload

If you are determined to continue using this version of SmartSensor Manager to interact with the sensor, but have good reason not to upload the bundled firmware, you can click the **Continue w/o Upload** button. With this choice, SmartSensor Manager finishes establishing the connection and continues normal execution. However, depending on the nature of incompatibilities between the sensor's firmware and SmartSensor Manager, unexpected errors may result.

View Details

Differences between the sensor's firmware and the firmware bundled with SmartSensor Manager can be viewed by clicking on **View Details**. The differences between the two versions will be highlighted in red. Knowing the details of the detected differences may help you make a more informed decision about how to proceed (see Figure 4.9).

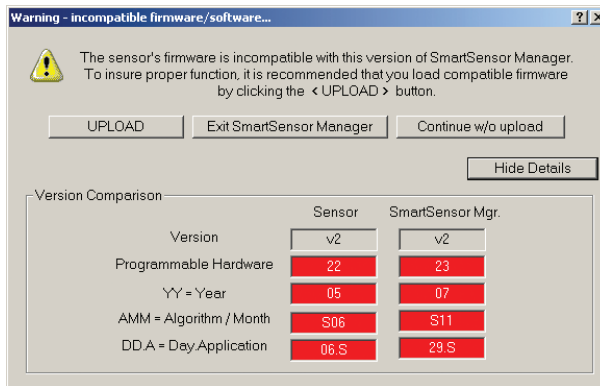


Figure 4.9 - View Details

- **Version** - Shows the software version.
- **Programmable Hardware** - Shows the FPGA version.
- **Year** - Shows the year of the version's release in YY format.
- **Algorithm/Month** - Shows the month of the version's release in MM format, as well as the operating mode; this will appear as an S for side fire mode and an F for forward fire mode.

- **Day.Application** - Shows the day of the version's release in DD format as well as the current application; this will appear as an S for sensor or a D for diagnostic.

Connection Properties

Information about the current connection can be accessed on the Current Connection Properties page, which is found under **File>Properties** (see Figure 4.10).

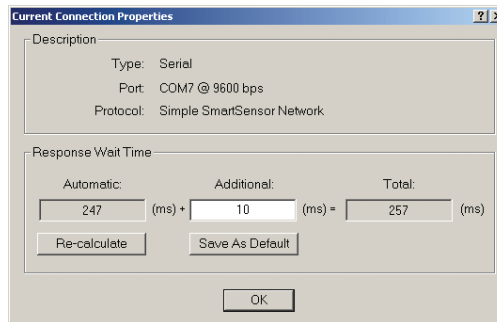


Figure 4.10 - Current Connection Properties

The page shows the following information about your connection:

- **Type** - Shows the type of connection (serial, modem or Internet). This will say Disconnected if the software is not currently connected to a sensor.
- **Port / Phone # / Address** - Displays information about the connection endpoint. This will vary based on the kind of connection made.
- **Protocol** - Indicates whether sensor is on a multi-drop network or a simple sensor network.
- **Response Wait Time** - Shows the wait time information for each sensor. The first box shows the number of milliseconds SmartSensor Manager will automatically wait for a response from a specific sensor. SmartSensor Manager determines this number by averaging recent sensor response times, so this number may fluctuate slightly when the **Re-calculate** button is clicked. The second box shows the number of additional seconds you have added under the Advanced Settings page for your connection; this number can be changed on this screen. The third box shows the total number of seconds SSM will wait for a response. Click the **Save As Default** button to save the new settings as default.

Click **OK** to close the window.

Address Book

The address book can save connection information for both modem and Internet connections, allowing you to access this information later and connect quickly without reentering IP addresses, modem numbers and so on.

Accessing the Address Book

The address book can be accessed in two ways:

- 1 Go to **File > Address Book**. This will give you two options: **New** and **Open**. Selecting **New** will open a directory box where you can create a new address book file (.abf). Creating an address book file will not immediately open the new file.

Select **Open** to access the most recently created or accessed address book file. This option is divided into two choices, **Modem Entries** and **Internet Entries** (see Figure 4.11). Selecting these will allow you to access all the modem or Internet entries in the address book. If you have not yet created an address book file, you will be prompted to do so now.

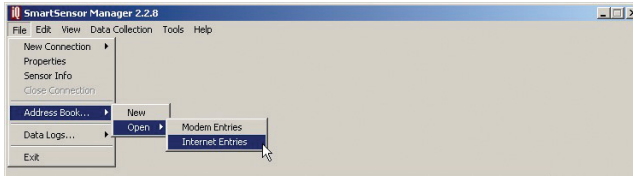


Figure 4.11 – Accessing Address Book through the Menu Bar

- 2 Begin to make a new modem or Internet connection, either through **File > New Connection** or the New Connection screen. In the connection screen that comes up, click the book icon next to the text field. This will access the address book specific to that type of connection. If you have not yet created an address book file, you will be asked to do so.

Note

By default, accessing the address book will open the address book file (.abf) that you most recently had open. As a single .abf can store both modem and Internet connection information, it will usually not be necessary to have multiple address book files stored on your computer. If you do have more than one file, however, you can switch back and forth by going to **File > Address Book > New**. Instead of creating a new file, however, select the file you wish to access and click **OK**. Now when you go to **File > Address Book > Open** or you select the address book icon on a connection screen, it will default to this most recently opened file.

Using the Address Book

No matter how you access the address book, using it is the same. The information available and visible will differ, however, based on what kind of connection you're making. If you're looking at modem entries, the screen will display three columns: Phone Number, Sensor ID and Description (see Figure 4.12). The Internet entries have five columns: IP Alias, IP Address, TCP Port, Sensor ID and Description.

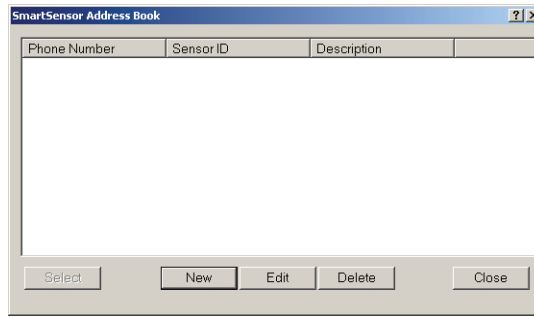


Figure 4.12 - Address Book for Modem Entries

Use the buttons in the address book to work with entries and make connections:

- **Select** - Selects an entry to use to connect. When you have chosen the entry you would like to use to connect, highlight it in the list and click **Select**. This will close the address book and enter the desired information into the connection page.

Note

When accessing the Address Book screen using the menu options, the **Select** button is disabled. You will be able to edit the address book entries, but will not be able to connect unless you use the Modem or Internet Connection Screens.

- **New** - Creates a new entry. Select **New** and enter the desired information. In a modem connection, this is the phone number of the modem, the sensor ID number and a description of the connection for your own information.

If you are adding an Internet connection entry, you have two options for the address: an IP address or a domain name. With both options you must also specify the TCP port number. If you use a domain name, the domain name must be entered as the IP alias and you should not enter an IP address, since the domain name may resolve to one or more dynamic IP addresses. When you enter both an IP address and an IP alias, SmartSensor Manager will add an entry to the Windows HOSTS file on your computer. In this case, the IP alias can be a simple text string (or a domain name that is tied to a fixed IP address). You may want to use a simple text string to help identify IP addresses that do not have a domain name.

- **Edit** - Allows you to edit the information contained in a highlighted entry.
- **Delete** - Deletes the selected entry.
- **Close** - Exits out of the address book.

Communication Error

The Communication Error screen will appear if SmartSensor Manager can no longer com-

municate with the sensor. If such an error occurs, the Communication Error screen will give you the following options (see Figure 4.13):

- **Retry** - Tells SSM to try to communicate with the sensor again.
- **Cancel** - Stops the current operation as well as other operations that may be in process.
- **Details** - Shows error details.

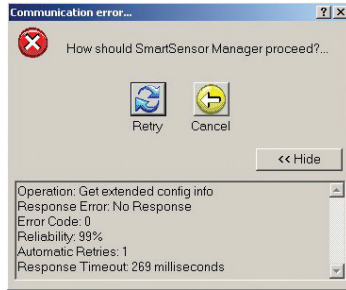


Figure 4.13 – Communication Error with Details Screen

Clicking the **Details** button will access additional information specific to this problem:

- **Operation** - Shows the operation SSM is trying to accomplish.
- **Response Error** - Shows the response error SSM has encountered.
- **Error Code** - Gives the error code related to the specific error.
- **Reliability** - Indicates the percentage of communication attempts that were successfully completed.
- **Automatic Retries** - Shows the number of times the SSM automatically attempts to reconnect before showing the communication error screen.
- **Response Timeout** - Displays the total number of milliseconds that SSM waited before timing out the requested operation.

If you retry multiple times to communicate with the sensor and it still doesn't work, the problem can often be fixed by editing the additional response wait time, found in the Advanced Settings page for your connection.

In this chapter

- Sensor Info
- Sensor Settings
- Sensor Date & Time
- Operating Mode

There are several ways to access and change sensor settings using SSM.

Sensor Info

Going to **File>Sensor Info** opens the Sensor Information page, which displays the properties unique to each sensor (see Figure 5.1).

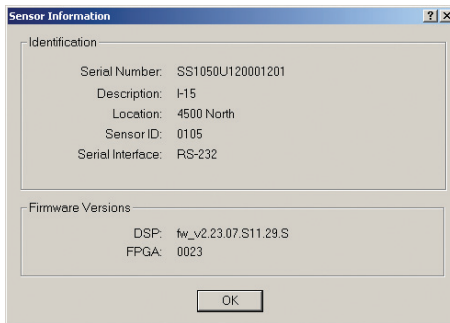


Figure 5.1 – Sensor Information

Although the information cannot be edited, there must be an active connection to view

the Sensor Information page. The page is divided into two sections, Identification and Firmware Versions.

The Identification section information includes the following:

- **Serial Number** – Shows the 16-digit serial number given to the sensor by the manufacturer. It can be used to uniquely identify the sensor.
- **Description** – Shows the 32-character, user-created sensor description as set using the Sensor Settings screen (for more information, see the Sensor Settings section later in this chapter). It is used to describe the sensor and/or the installation site.
- **Location** – Displays the 32-character, user-created location description as set using the Sensor Settings screen (for more information, see the Sensor Settings section later in this chapter). It is used to describe the location of the sensor.
- **Sensor ID** – Shows the 4-digit numeric string used to identify the sensor on a multi-drop network. You can set this ID number using the Sensor Settings screen (for more information, see the Sensor Settings section later in this chapter). The SmartSensor Multi-drop protocol uses the sensor ID to uniquely address sensors on a shared bus.
- **Serial Interface** – Indicates which of the sensor's four ports it is using to communicate. The four ports are RS-232, RS-485, EXP-A, and EXP-B.

Note

The two expansion ports (EXP-A and B) are currently not available for use.

The Firmware Versions section shows on which versions of DSP (Digital Field Processing) and FPGA (Field Programmable Gain Amplifier) the sensor is operating.

Sensor Settings

You can both view and change certain sensor options and information in the Sensor Settings page. To access this page, go to **Edit > Sensor Settings**. If no sensor connection is active, selecting this will open a directory box, allowing you to find SmartSensor configuration (.ssc) files that are saved on your computer. You can also use this directory box to create a new .ssc file.

The Sensor Settings page is divided into three tabs: General, Communication and Data Collection. Only the General and Communication tabs will be discussed here; the Data Collection tab will be discussed in chapter 7.

General Tab

The General tab allows you to edit the following settings (see Figure 5.2):

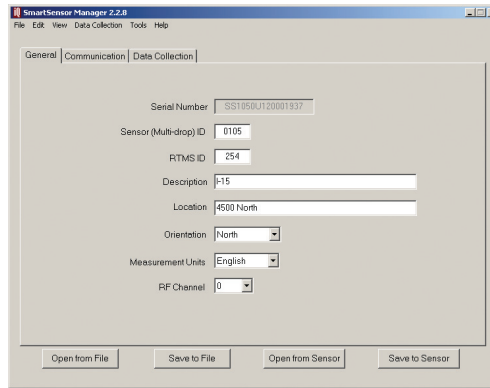


Figure 5.2 – General Tab

- **Serial Number** – Shows the 16-digit serial number given to the sensor by the manufacturer, used to uniquely identify the sensor. This is the only setting on this screen that cannot be edited.
- **SmartSensor (Multidrop) ID** – Allows you to enter a 4-character ID number. This number is used to identify the sensor on a multi-drop network. Each sensor on such a network must have a unique ID number. This number is referred to on the Sensor Information page as the sensor ID.
- **RTMS ID** – Lets you change the RTMS ID. The SmartSensor has been designed to utilize other protocols for those cases when there might already be a project built around another type of sensor. If you choose to communicate using the RTMS protocol, all you need is the RTMS ID.

Note

The RTMS ID number 13 cannot be used for polled communications.

- **Description** – Allows you to create a description of the sensor and/or installation site for identification purposes. The description may be up to 32 characters long and will be displayed on the Sensor Information page.
- **Location** – Allows you to enter the location of the sensor for identification purposes. The location may be up to 32 characters long and will be displayed on the Sensor Information page.
- **Orientation** – Lets you select, from a drop-down menu, the direction the sensor is facing. The orientation does not affect sensor operation or alignment and is simply for your information.
- **Measurement Units** – Allows you to choose between English and metric measurements. Metric units are entered in decimeters so that the metric and English units can be converted more accurately.
- **RF Channel** – This allows you to assign specific RF channels to sensors that are in-

stalled in close proximity to each other to prevent the sensors from interfering with each other.

Communication Tab

The Communication tab allow you to change the following settings (see Figure 5.3):

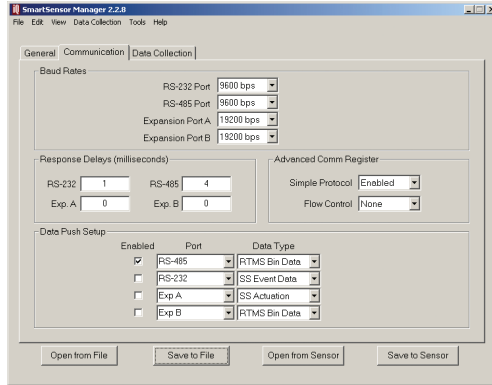


Figure 5.3 – Communications Tab

- **Baud Rates** – Allows you to set the baud rate for the each of the sensor’s four connection ports. To change the baud rate, simply click on the drop-down menu and select the desired rate. Besides the standard RS-232 and RS-485 ports, there are also two other expansion ports. These expansion ports are currently not available for use.
- **Response Delays (milliseconds)** – Allows you to change the number of milliseconds that the sensor will delay before responding. This is useful if you ever attach the sensor to communication equipment that cannot handle the speed with which the sensor responds to message requests. You can change the response delay for each of the four connection ports separately by entering the desired number of milliseconds. If you are not able to determine the amount of delay required by consulting the communication equipment’s documentation, you will need to determine this number by trial and error.

Note

If you increase the response delay, you should also increase the additional response wait time that SmartSensor Manager uses when communicating to the sensor.

- **Advanced Comm Register** – The Advanced Comm Register on the SmartSensor holds two settings: Simple Protocol and Flow Control.

The first setting selects whether Simple SmartSensor protocol is enabled or disabled. By default Simple protocol is enabled. Networks comprised of simply one sensor can use the Simple protocol. However, if there is more than one sensor on the network, this

protocol can cause communication messages to be broadcast unintentionally. These messages can result in collisions and even ongoing chatter between sensors on a multi-drop network. If you are setting up a multi-drop network of sensors, you should connect to them one by one and disable Simple protocol. To disable Simple protocol, select Disabled from the drop-down list. Simple protocol must also be disabled if you plan on using RTMS protocol.

The second setting selects whether flow control handshaking is enabled or disabled on the sensor. Flow control is a hardware handshaking protocol used by some communication equipment. If your communication equipment requires handshaking, you will need to enable this by selecting RTS/CTS from the drop down menu.

Note

If you have established a serial connection, enabling RTS/CTS handshaking will cause you to lose communication with SmartSensor Manager unless you first short the RTS/CTS lines on the sensor.

- **Data Push Setup** – Allows you to enable and configure data push. SmartSensor communicates traffic data in either Data Polled mode or Data Push mode. By default the SmartSensor is in Data Polled mode. In Data Polled mode, a traffic data collection device must periodically poll the sensor to retrieve the most recent information. Data Polled mode is preferred if multiple sensors share the same data bus, so that the data transmitted over the connection will not be corrupted or lost by collisions.

In Data Push mode, the sensor is set up to transmit any new data it generates automatically (without any prompting by the collection device). In Data Push mode there is no arbitration of the data bus, and data messages sent by different sensors can collide, causing information to be lost. However, if there is only one sensor connected to the data bus, there should be no collisions in data push mode.

Before you change to Data Push mode, select the desired port and data type from the drop-down lists provided. You can set the sensor up to push data over more than one port. You can also set it up to push multiple types of data over the same port. To change to Data Push mode, click on the **Enabled** checkbox next to each one of the four ports you wish to enable.

Data Collection Tab

The **Data Collection** tab allows you to edit the following settings (see Figure 5.7):

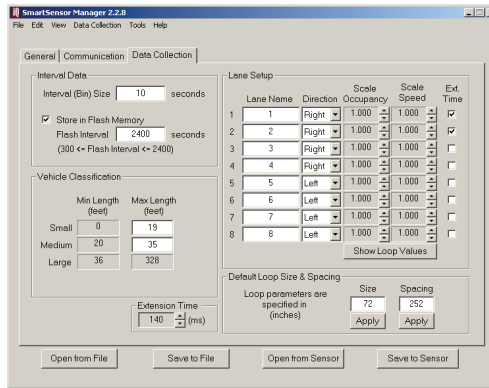


Figure 5.4 – Data Collection Tab

- Interval Data** – Allows you to specify the length of your intervals as well as how those intervals are stored. The interval refers to the time (in seconds) that traffic data is aggregated (minimum interval is five seconds). Interval data is stored directly into the sensor's SRAM memory, which is volatile and will not persist after a power cycle. The number of intervals is limited to 246. You can also tell the sensor to move the data from SRAM to the sensor's flash memory by clicking the **Store in Flash Memory** check box. This protects the data because flash memory persists after power cycles. The capacity in flash is about ten times greater than SRAM. If the **Store in Flash Memory** box is not checked, the interval data will remain in SRAM until it is overwritten. Flash storage management features are explained in greater depth in the Data Collection Setup section of chapter 7.
- Vehicle Classification** – Lets you customize vehicle classifications by length. Enter the maximum length amounts for small and medium class vehicles in the active text boxes and SmartSensor Manager will automatically determine the minimum lengths.
- Lane Setup** – Allows you to change specific lane information such as lane name and direction of travel, for your own information and for identification.

You can also change scale occupancy (loop size) and scale speed (loop spacing). The entry in these columns for each lane represents the manual scaling applied to the occupancy/duration and speed data. The occupancy scale factor is the ratio of each lane's loop size to the default loop size. The speed scale factor is the ratio of each lane's loop spacing to that of the default loop spacing. You can modify the scale factors by clicking on the arrows to the right of each box.

Unlike the SmartSensor HD, it is often necessary to calibrate the SmartSensor V for vehicle length classification and occupancy measurements. This calibration should be done on a site-by-site basis and is dependent upon detection thresholds.

The following table provides some generic guidance on scale factor values. In general, lanes further away should have a lower scale factor. Also, a SmartSensor V will tend to have lower scale factors than a SmartSensor 105 at the same location. Below are some example values for lane centers every 10 feet:

Feet	SmartSensor 105	SmartSensor V
10	1.10	1.08
20	1.07	1.04
30	1.04	1.00
40	1.01	0.96
50	0.98	0.92
60	0.96	0.89
70	0.94	0.86
80	0.91	0.83
90	0.89	0.81
100	0.87	0.78
110	0.85	0.76
120	0.83	0.74
130	0.81	0.72
140	0.80	0.70
150	0.78	0.68
160	0.77	0.66
170	0.75	0.64
180	0.74	0.63
190	0.72	0.61
200	0.71	0.60

Table 5.1 – Examples of Lane Centers

Keep in mind that the numbers above are approximate values. If you leave the Default Loop Size and Spacing at 72 and 240 feet respectively, these exact values might not be selectable. For example, the screenshot below shows the closest values for a SmartSensor V with 8 lanes at 10,20,30,40,50,60,70 and 80 feet from the sensor respectively (see Figure 5.5).

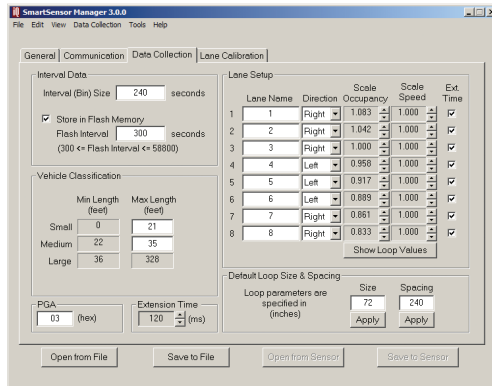


Figure 5.5 – Scale Factors

Note

Interval occupancy is derived from event duration, so the occupancy scale factor scales both the duration and the occupancy. Additionally, the length-based event classification is derived from the event duration and the event speed, so scaling either the speed or the duration will impact the classification results.

The **Show Loop Values** button allows you to toggle quickly between the loop values and the corresponding scale factors.

- **Default Loop Size & Spacing** - Lets you enter default values which, when applied, will automatically update the information for each lane. The terms “loop size” and “loop spacing” are used since in many cases you will be using these values to scale the occupancy and speed to match those of dual loops. The loop size and loop spacing (space between loops) are specified in inches or centimeters.
- **Extension Time** - Allows you to increase the time, in milliseconds, on the countdown timer that the sensor uses in detection. Adding time can help reduce the occurrence of vehicles with trailers being detected twice. However, increasing the time also increases the likelihood that one vehicle being tailgated by another will result in a single detection.

Note

The lane name, lane direction, and interval data settings on this page can also be changed on other pages. The rest of the settings can only be changed here.

Saving and Restoring Sensor Settings

Once you have made changes to your settings, use the four buttons at the bottom of the screen to save the changes from all three tabs. You can also use these buttons to discard all your changes and return to the old settings.

- **Save to Sensor** - Saves the changes you've just made to the sensor. If you do not push this button after making changes, they will be lost when you navigate away from this page.
- **Open from Sensor** - Returns all settings to those currently saved on the sensor.
- **Save to File** - Saves the settings currently entered in the Sensor Settings screens to a SmartSensor configuration file (.ssc) on your computer. This setting can be used to back up your settings; additionally, if you're not connected to your sensor, you can change settings, save them to a file, and use the file to update your sensor once you're connected again.

Note

Using the **Save to File** function does not save the changes to your sensor. If you want to update and then back up your sensor, you need to use both **Save to File** and **Save to Sensor**.

- **Open from File** - Restores settings from an existing .ssc file. Once the settings have been restored, you must click **Save to Sensor** if you want the sensor updated with the restored settings.

Note

Return to this page to back up your sensor after you've completed the steps to configure your lanes and data collection.

Sensor Date & Time

To ensure that the data collected is timestamped correctly, use the Sensor Date & Time screen, located at **Edit > Sensor Date & Time** (see Figure 5.5).

Change the date by selecting the correct date from the drop-down lists (month, day, and year) or use the calendar to scroll to the correct date. Change the time by selecting the correct time (hour, minutes, and seconds) from the drop-down lists.

Click the check box below the calendar to automatically adjust for local computer time and daylight savings time settings. The check box at the bottom of the page will automatically

synchronize sensor to PC UTC time at a certain interval you can define in the text field.

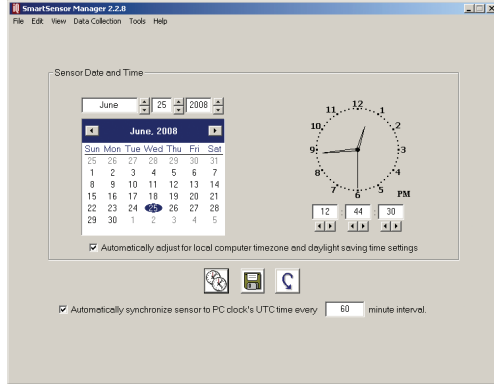


Figure 5.6 – Sensor Date & Time

The Sensor Date & Time page includes the following three function buttons:

- **Clocks icon** – Performs a one-time synch of the sensor to the PC's UTC time.
- **Disk icon** – Saves the new settings.
- **Arrow icon** – Undoes the changes.

Operating Mode

Selecting **Edit > Operating Mode** allows you to switch between Side Fire and Forward Fire operation modes. While Side Fire mode is standard, Forward Fire mode allows you to detect traffic from a forward-facing position, such as when the sensor is mounted on a bridge across the road. With this setup, however, the sensor can only detect one lane at a time and cannot detect cars until after they've passed the mounting location. If you're interested in a forward-facing sensor, consider the SmartSensor Advance, which can detect vehicles in multiple lanes up to 500 ft. (152.4 m) in advance.

If you would like to use the SmartSensor V in Forward Fire mode, call Wavetronix Technical Services at 801-764-0277 for assistance and further instruction.

In this chapter

- Lane Configuration - Automatic
- Lane Configuration - Manual
- Verifying Lane Configuration

Setting up lanes is simple in SmartSensor Manager because the software will do it for you with the click of a button. Additionally, if SmartSensor Manager is unable to correctly configure due to barriers, obstacles or irregular lanes, you can use the Manual Configuration mode to adjust.

Note

Free-flowing traffic in each lane is required for proper configuration. Light or sporadic traffic may result in slower configurations.

Lane Configuration - Automatic

Follow the steps below to automatically configure lanes in SmartSensor Manager:

- 1 Select **Edit > Lane Configuration**.
- 2 Once the Lane Configuration page opens, click on the **Automatic** button.
- 3 If you would like to set constraints on the configuration through the **Edit Range Blinders** or **Manage Gain** buttons, do so now. For more information on these options see the sections on them in the following pages.

- 4 Click the **Restart** button at the lower right.
- 5 Confirm the configuration restart by clicking **Yes** in the box that appears (see Figure 6.1). SmartSensor Manager will now automatically begin detecting and configuring lanes, and the screen will show a visual depiction of the lanes and vehicle detections in real time.

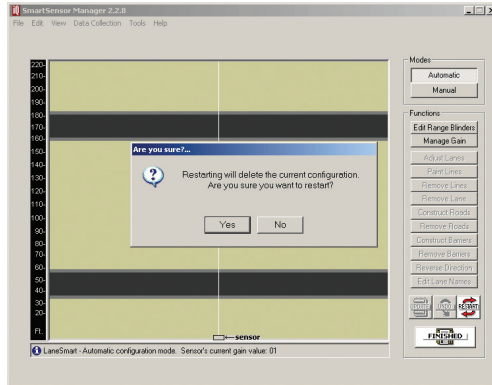


Figure 6.1 – Confirming Automatic Lane Configuration

- 6 After the lanes have been detected and configured correctly, save the configuration by clicking the **Finished** button. The time required for configuration depends on the volume of traffic present in the lanes, but is typically only a few minutes.

Note

After clicking the **Finished** button, wait for one minute before turning off the sensor. During this time the sensor is completing adjustments of the configuration thresholds. Typically this is not a problem because verification may be needed in Traffic View after clicking **Finished**. The verification process will normally be longer than one minute.

Edit Range Blinders

Range blinders are an optional setting available in Automatic mode. Using range blinders will narrow the search area of the automatic lane configuration process (range blinders have no effect in Manual Configuration mode), allowing you to configure faster and avoid configuring undesired lanes such as frontage roads. Use the steps below to successfully edit the range blinders:

- 1 Click the **Range Blinders** button. Red bars (range blinders) will appear at the top and bottom of the roadway display and any previously displayed roadways will be cleared.
- 2 Click on one of the range blinders and drag its edge to the desired range (refer to the range markers on the left side of the screen).
- 3 Repeat Step 2 for the other range blinder if necessary.

- 4 Click the **Restart** button to apply the range blinders. When the range blinders are applied, they will turn from a red color to a dark khaki color. To cancel and use the default ranges, or to start over, or click the **Range Blinders** button again.
- 5 After the lanes are detected and configured correctly, save the configuration by clicking the **Finished** button. After clicking the **Finished** button, the SmartSensor will begin storing vehicle data. The time required for configuration depends on the volume of traffic present in the lanes, but is typically only a few minutes.

Note

After clicking the **Restart** button, detected vehicles (represented by moving blue rectangles) will be displayed only if a range blinder does not cover the lane center. If the edge of a range blinder lies between two lanes of the same road, some manual adjustment of the gray line (usually reserved to indicate a road shoulder) may need to be made. The edge of the road shown in the display is really a lane divider.

Manage Gain

Managing gain is an optional setting available in Automatic mode. During the automatic configuration process, the sensor's gain is automatically adjusted in order to best process the radar signal at that particular installation site. In some locations the reflections from vehicles may be stronger than in other locations, and the gain will need to be lowered in order to optimize detection accuracy.

For the gain to be optimally adjusted by the automatic process, the sensor needs to be:

- Aligned almost exactly perpendicular to all the lanes of the roadway.
- Still configuring while several large vehicles (that return strong reflections) pass through the beam in the lanes closest to the sensor.

In some locations, and at particular times of the day, it may be difficult to meet these two requirements. In these cases, click the **Manage Gain** button to change the starting point of the automatic gain adjustment process. The default starting point is a gain value of 5. The adjustment process never increases the gain value; it only decreases it. The starting point is therefore also the maximum gain value.

A new starting point will only be applied after clicking the **Restart** button. During the automatic configuration process, the sensor's current gain value is displayed in the status bar at the bottom of the screen.

No adjustments to the gain can be made once the configuration is saved to the sensor. However, the detection thresholds configured for the sensor during the automatic configuration process are based upon the current level of the gain and will continue to adapt for up to one minute after clicking the **Finished** button.

Note

The default starting point of 5 is also the largest starting point allowed. If you enter a value larger than 5 the default starting point of 5 will be used. If you are managing the gain, you should generally change the starting point to a 3 or 4.

Lane Configuration – Manual

If the sensor is unable to automatically configure itself to your satisfaction, you can manually configure it by adding, removing or adjusting lanes, lane dividers and lane centers.

To make changes in Manual mode:

- 1 With the Lane Configuration page open, select the **Manual** button; the buttons in the toolbar on the right of the screen will change from gray to black (see Figure 6.2).

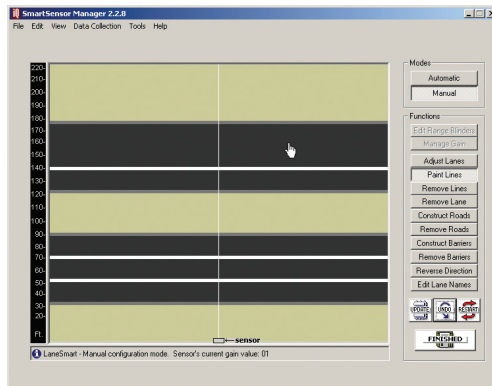


Figure 6.2 – Manual Lane Configuration

- 2 Selecting a button in the toolbar will allow you to make changes using the roadview window on the left.
- 3 Once you've made the necessary adjustments, hit Finished to save your changes.

Adjust Lanes

The **Adjust Lanes** button allows you to click your cursor on any visible shoulder (gray line), lane divider (white line) or lane center (pink line) and drag it to the desired position (see Figure 6.3). The cursor will change from an arrow to a hand when it is positioned over a “draggable” line. Lane centers (pink lines) only appear when the cursor is placed directly over them. To adjust the lane center, click and hold the mouse and move the line up or down on the screen, but only within the area between the shoulders. Notice that shoulders, dividers, or centers cannot be dragged past each other.

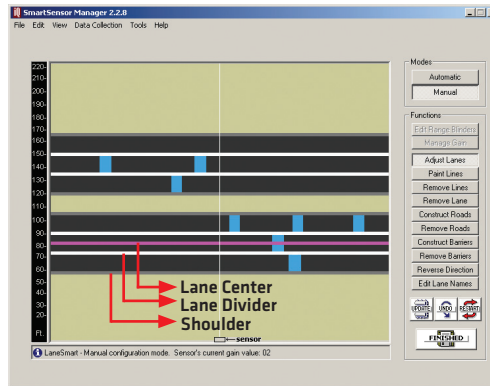


Figure 6.3 – Adjusting Lanes

Paint and Remove Lines

The **Paint Lines** button allows you to add new lanes by inserting lane dividers in paved (black) areas. SmartSensor Manager allows a maximum of eight lanes.

Again, the cursor will change from an arrow to a hand when it is positioned directly over a location where it is possible to paint a lane divider. When the cursor appears as a hand, click and a white line will appear.

To remove a lane divider, click on the **Remove Lines** button, select the white line you want to remove and click the left mouse button (again, wait for the cursor to become a hand).

Remove Lane

The **Remove Lane** button allows you to remove entire lanes by moving the cursor to the desired lane. When the arrow changes to a hand, click and the selected lane will disappear.

Construct and Remove Roads

To insert a new road, click on the **Construct Roads** button and select a location anywhere in the background (khaki-colored) area. Make sure the cursor appears as a hand and then click to draw the road.

Because new roads are initially drawn with an upper shoulder line, a centerline and a lower shoulder line, you will usually need to adjust your road to the desired width using the **Adjust Lanes** function.

To remove an entire road, including all lanes, click on the **Remove Roads** button and click on the road you wish to remove.

Construct and Remove Barriers

Constructing a barrier or median is essentially the act of dividing a single road into two separate roads. SmartSensor Manager defines a barrier or median as two adjacent shoulder lines or two shoulder lines with only background (khaki-colored) areas in between them.

To construct a barrier or median, click on the **Construct Barriers** button and move the cursor to the paved area where you want to insert the barrier. When the cursor changes from an arrow to a hand, click and the barrier will appear.

Initially, the new barrier is only two shoulder lines wide. To widen the barrier, use the **Adjust Lanes** feature as explained earlier.

You may also remove a barrier, or convert two roads into a single road, by clicking on the **Remove Barrier** button and selecting the barrier you wish to delete.

Reverse Direction

Once the configuration process has been completed, you will notice that SmartSensor Manager shows all detected vehicles moving in the same direction. The **Reverse Direction** button enables you to change the direction of travel depicted in SmartSensor Manager so that each lane reflects the actual direction traveled by detected vehicles.

To do this, press the **Reverse Direction** button and move the cursor over the lane you wish to change. Once the cursor is in place, the cursor will again change from an arrow to a hand and a tiny arrow will appear below the hand to indicate the current direction of that lane (see Figure 6.4).

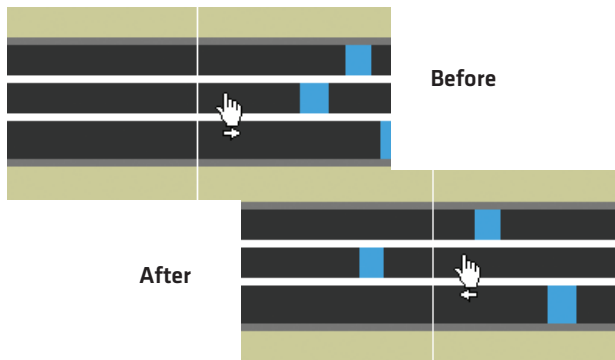


Figure 6.4 - Reverse Direction

Click the mouse, and the arrow will reverse direction to verify the change has occurred. Using the **Reverse Direction** button only affects the SmartSensor Manager display, not the sensor or any detections, and is useful for verifying performance.

Edit Lane Names

By default, the SmartSensor V identifies the lanes it configures as lane 1 up to lane 8, where lane 1 is located closest to the sensor. However, you may wish to assign lane numbers differently with the Edit Lane Names window (see Figure 6.5).

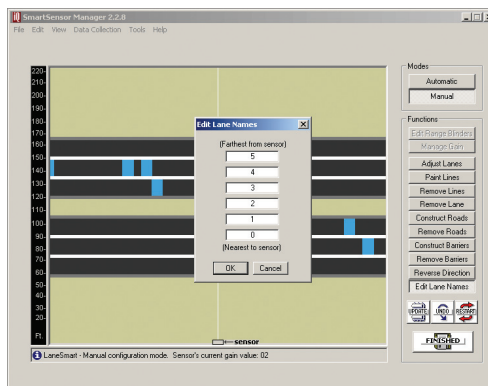


Figure 6.5 - Editing Lane Names

To do this, click on the **Edit Lane Name** button and the Edit Lane Names window will appear. Highlight the current lane name by double-clicking on it, then type in the lane's new alphanumeric identification of up to eight characters.

To reorder the lanes, you will first need to enter a “#” sign and then the lane number. Once you enter “#1,” for example, you can add “NB” or any other name with the remaining characters.

Note

The RTMS protocol can report up to eight zones. By default the first zone is associated with the lane closest to the sensor; the second zone is associated with the next closest lane and so on. To map the lanes in a different order, enter the “#” sign followed by a unique number character between 1 and 8. (Unused lanes do not need to be named.) The other characters are ignored but may be used for clarification purposes. Remember, a lane with the name “#1” will be reported first in the RTMS protocol, corresponding to zone 1; a lane with the name “#2” will be reported second, corresponding to zone 2.

Lane names can also be changed by going to Sensor Settings and clicking on the **Data Collection** tab (see chapter 7 for more information).

Saving the Configuration

Once all configurations are completed, the changes must be updated in the SmartSensor's

flash memory (lane changes won't take effect until after the sensor has been updated). Update all manual changes by clicking the **Update** button located below the manual tool buttons (see Figure 6.6). The process of updating the configuration takes only seconds. Once the process is completed, SmartSensor Manager will remain on the Lane Configuration page so that any manual changes made may be viewed and easily changed if needed.



Figure 6.6 - Update, Undo, and Restart Buttons

Undoing Manual Changes

Unsaved changes may be undone without repeating the manual configuration process. Click on the **Undo** button found below the manual tool buttons (see Figure 6.6). This tool retrieves the last saved configuration from the SmartSensor V, effectively undoing any unsaved changes that were made.

Restarting Lane Configurations

To completely erase the sensor's current configuration and restart the lane configuration routine, change from Manual back to Automatic mode by clicking on the **Automatic** button and then clicking on the **Restart** button located near the **Update** and **Undo** buttons below the Manual toolbar (see Figure 6.6).

This erases all manual changes that have been made, and the SmartSensor Manager will automatically reconfigure the road for you. After clicking on the **Restart** button, a window will be displayed asking whether you want to proceed (see Figure 6.7). Click on **Yes** to continue or on **No** to quit this procedure.

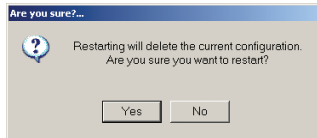


Figure 6.7 - Confirmation of Restart

Exiting the Lane Configuration Page

Once all automatic and manual configurations have been completed, you may perform a final save and exit the Lane Configuration page by clicking on the **Finished** button located at the bottom right of the screen.

A window will appear indicating that the changes are being saved to the SmartSensor V. After the changes have been saved, SmartSensor Manager will automatically change from Lane Configuration to Traffic (Event) Data View mode so that you can verify lane configuration.

Verifying Lane Configuration

After you click **Finished** on the Lane Configuration page, SmartSensor Manager will take you immediately to the View Traffic (Event Data) page. Here you can view your saved lane configuration and see traffic in real time, allowing you to verify that the lanes have been configured correctly.

The other way to view data is the Interval Data screen, which shows numerical data gathered per lane by the sensor. You can switch back and forth between the two screens with the toggle button in the lower right corner of each screen; this button will be marked with the name of the screen you're going to switch to.

The Traffic (Event) Data and Interval Data screens can both also be accessed through the **View** menu.

Note

If the connection's additional response wait time is greater than 500 ms, event and actuation information is not displayed on the screen.

Traffic (Event) Data

In Event mode, this screen allows you to verify the SmartSensor V's configuration by comparing the traffic on the road to event information shown in the window (see Figure 6.8). In order to keep a record of your verification results, the event data can also be saved to a log file while you remain on this screen.

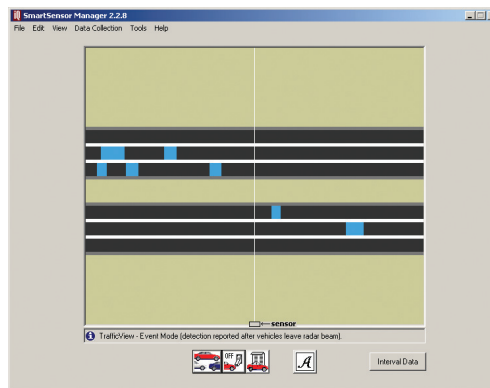


Figure 6.8 - View Traffic (Event) Data

The window can also be used to verify true presence information by switching to Actuation mode (click the A icon).

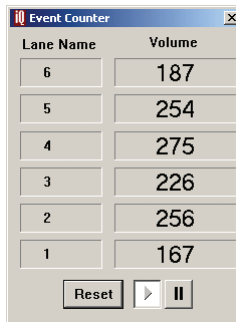
Note

A status bar below the Traffic View window indicates whether you are in Event mode or Actuation mode.

By default, Traffic View launches in Event mode. In Event mode, the vehicles (represented by the blue rectangles) appear after having passed through the radar detection zone.

The four icons located at the bottom of the screen are active in this mode. They are, from left to right:

- **View Event Counter** – Brings up a real-time volume counter lane by lane (see Figure 6.9). Each time a vehicle enters and leaves the radar detection zone, the volume for the corresponding lane will increment accordingly. If counting needs to be paused for any reason, click on the **Pause** button; click the **Play** button to resume counting. Any vehicles that were detected by the SmartSensor while the event counter was paused will not be shown in Volume. Clicking the **Reset** button will clear the volume count and will begin a fresh count.

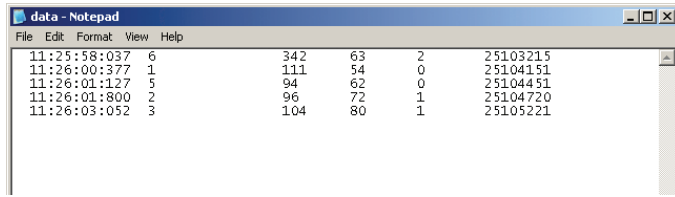


Lane Name	Volume
6	187
5	254
4	275
3	226
2	256
1	167

Reset [Play] [Pause]

Figure 6.9 – Event Counter

- **Turn Event Logging On and Off** – Allows you to log the information you're currently seeing. When you switch event logging on, you will be prompted to create a new log file if there is not already an existing one. With event logging turned on, all of the event data is written to a log file on the computer that can then be viewed later. To turn event logging off, click on the icon again. No other visible changes occur while turning event logging on and off. Event logging remains on as long as you are in the Traffic View screen. If you switch to another screen of SmartSensor Manager, and then come back to the Traffic View window, event logging will have been turned off.
- **View Event Log** – Opens the current event log file in a text editor, such as Notepad (see Figure 6.10).



Timestamp	Lane Name	Duration	Event Speed	Class	Count
11:25:58:037	6	342	63	2	25103215
11:26:00:377	1	111	54	0	25104151
11:26:01:127	5	94	62	0	25104451
11:26:01:800	2	96	72	1	25104720
11:26:03:052	3	104	80	1	25105221

Figure 6.10 – Event Log

The event log file breaks down each event and reports back the event Timestamp, Lane Name, Duration, Event Speed, Class, and Count. The timestamp, which is formatted using the local time zone settings on your computer in hours, minutes, seconds and milliseconds, is the time the vehicle entered the detection zone. The lane name is a string of eight alphanumeric characters that describe the lane. The duration is the number of 2.5ms ticks that elapsed while the vehicle was in the sensor’s detection zone. The event speed represents the speed of the vehicle, displayed either in miles per hour (mph) or kilometers per hour (kph). The class indicates into which one of three length-based classification groupings (0=Small, 1=Medium, and 2=Large) the vehicle fits. The count is the time the vehicle entered the detection zone encoded as the number of 2.5ms ticks counted on the sensor since the beginning of the day (UTC time).

Note

Each time the **Turn Event Logging On and Off** button is clicked, a new header is created in the log file.

- **Actuation/Event Toggle** – Changes between Actuation and Event modes. Clicking on the icon when an “A” is displayed changes the mode from Event to Actuation. Clicking on the icon when an “E” is displayed changes the mode from Actuation to Event mode.

In Actuation mode, the three leftmost icons are inactive, and the vehicles are displayed as long as they are present in the detection zone.

Interval Data

This screen allows you to verify interval data accuracy. The most recent interval data is displayed on the screen (see Figure 6.11). In order to keep a record of your verification results, the interval data can also be saved to a log file while you remain on this screen.

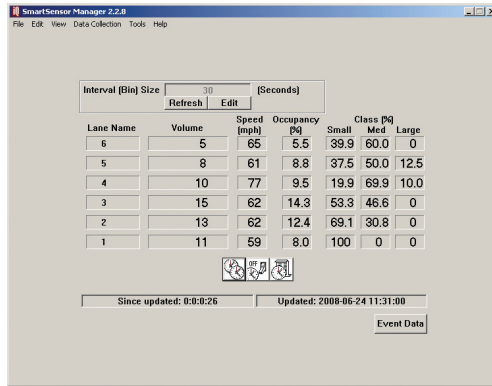


Figure 6.11 – View Interval Data

Before interval data verification is performed, do the following:

- 1 Specify the desired interval length in the Interval (Bin) Size edit box. To do this, enable the edit box by clicking **Edit**, then type the desired length of the interval in seconds and click **Submit**. The minimum interval allowed is five seconds. If you must cancel your changes, click **Cancel** and **Refresh**. Clicking the **Refresh** button will restore the current interval length.
- 2 Synchronize the sensor time to your computer's UTC time. This will ensure that intervals will begin and end at the expected time. Intervals are timestamped at the end of the interval. To synchronize the sensor time, click the **Synchronize** icon, which shows two overlapping clocks.

The other two icons near the bottom of the page are for logging data:

- **Turn Interval Data Logging On/Off** – Turns event logging on and off. Click on the icon (it shows a clock and light switch) to toggle the switch on and off. Once you've turned it on, you will be prompted to create a new log file if there is not already an existing one. Now all of the data shown on the screen will be written to a standard text file that can be viewed at any time.
- **View Interval Data Log** – Opens the log file in a text editor such as Notepad (see Figure 6.12). The icon shows a clock and paper.

The screenshot shows a Notepad window titled 'intervaldata - Notepad'. The text inside the window is as follows:

```

2008-06-24 11:43:30 1 7 62 5.1 100 0 0 267644610
2008-06-24 11:43:30 2 6 68 5.1 50.0 50.0 0 267644610
2008-06-24 11:43:30 3 1 73 1.0 0 100 0 267644610
2008-06-24 11:43:30 4 8 68 6.7 62.5 37.5 0 267644610
2008-06-24 11:43:30 5 7 66 6.5 42.8 57.1 0 267644610

```

Figure 6.12 – Interval Data Log

The interval data in the Interval Data Screen is displayed in a table that contains the lane name, volume, speed, occupancy, and class. The lane at the top of the table is the lane closest to the sensor. At the bottom of the screen is a status bar that indicates the time the interval data table was last updated. It also displays the amount of time that has elapsed since this update.

- **Lane Name** - Displays the string of eight alphanumeric characters that describes the lane.
- **Volume** - Shows the number of events during the interval.
- **Interval Lane Speed** - Represents the average speed of the lane during the time of the interval. The speed is displayed either in miles per hour (mph) or kilometers per hour (kph), depending on your settings.
- **Occupancy** - Displays the percentage of time vehicles occupied the sensor's detection zone during the selected interval.
- **Class** - Represents the percentage of vehicles detected as fitting in one of three length-based classification groupings (Small, Medium, and Large).

Note

To open data logs from anywhere in the SmartSensor Manager program, go to **File > Data Logs > Open** and select the type of log. This will open the most recently used log.

Data Collection

In this chapter

- Data Collection Setup
- Data Download
- Data Logs

Once you've set up your sensor and lanes, you can collect data for studies. This chapter outlines the steps necessary for data collection

Data Collection Setup

Go to **Data Collection > Setup** to prepare your sensor for a study. The screen that appears is divided into two steps: Configure Data Storage and Configure the Sensor (see Figure 7.1).

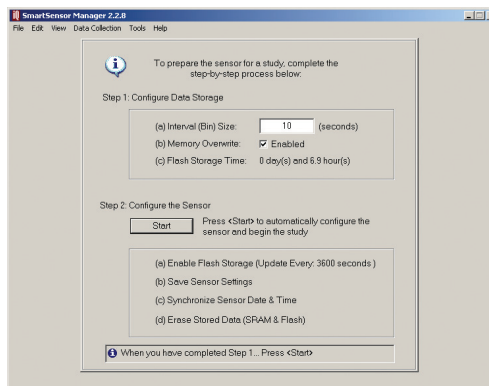


Figure 7.1 – Data Collection Setup

Step 1: Configure Data Storage

The Interval (Bin) Size option specifies the interval of time over which traffic variables like volume, speed, occupancy and classification are aggregated. This type of data is called interval data. The minimum interval allowed is five seconds.

By default, the checkbox next to Memory Overwrite is checked. This means that your study will run indefinitely and repeatedly overwrite the flash memory onboard storage. This means that in order to not lose collected data, you must download it to a log on your computer before it is overwritten.

Alternatively, you can uncheck the Memory Overwrite checkbox. In this case, the study will run only until the sensor's flash memory has been filled with interval data.

Note

Once the flash memory buffer is full, it must be erased before it can be reused. Before you erase the stored data, you will want to download the data to a log file on your computer.

The third line under Step 1 displays the Flash Storage Time. This shows the duration of interval data that a full flash buffer holds, calculated for you as a number of days and hours. Because of the way flash memory is managed, the Flash Storage Time will vary based on whether or not you have Memory Overwrite enabled.

Step 2: Configure the Sensor

When you are ready to begin the study, click on the Start button to:

- Enable flash storage
- Save the selected settings to the sensor
- Synchronize the sensor date and time
- Erase stored data from both SRAM and flash memory

It will take several seconds before the study actually begins. When the study does begin, the start time will be displayed in the status bar at the bottom of the screen.

Note

If the start time does not coincide directly with the beginning of an interval, the first interval in memory will contain a partial aggregation of data.

Interval Data Buffer Status

As soon as the study begins, the View Interval Data Buffer Status window will appear. This window shows you how much of the guaranteed onboard storage space is filled with interval data. If the data collection setup process has just finished, the storage space should be mostly unused. If you leave this window open, the status will be updated every 30 seconds. The blue bars indicate the amount of memory that contains data (see Figure 7.2).

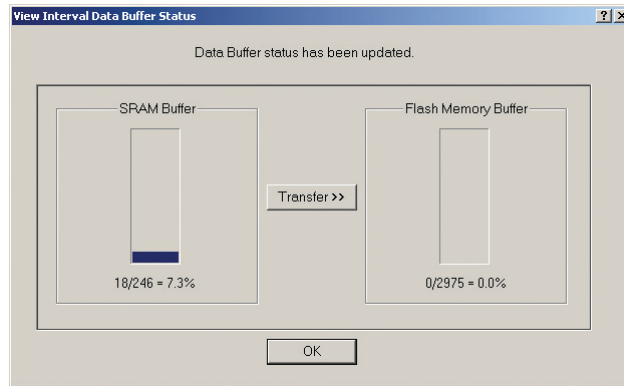


Figure 7.2 – View Interval Data Buffer Status

Note

This screen can be accessed via the Data Collection Download screen by clicking on the **View Data Buffer Status** button.

The sensor's SRAM buffer contains up to 246 of the most recent interval data records. This type of storage is temporary because SRAM is volatile—its contents will be lost if the sensor's power supply is interrupted. The sensor's flash memory buffer contains up to 2975 interval data records. This type of storage is permanent because flash memory is nonvolatile—it will retain its contents even if the sensor's power supply is interrupted.

Note

The smallest amount of flash memory that can be erased at one time represents several interval data records. As a result, if you are collecting data with the Memory Overwrite feature enabled, you will not typically see the buffer fill up 100%. In fact, you may see the usage fall from near 100% to something near 80%. This is because as usage approaches 100%, a portion of the oldest contents are erased in order to make room for newer data.

If you want to force the contents of the sensor's SRAM buffer to be written to flash mem-

ory, click the **Transfer**>> button.

Data Download

To download interval data stored on the sensor in the SRAM and flash memory buffers—such as data collected in a study—go to **Data Collection > Download**. The screen that comes up is divided into two sections, Download Interval Data and Interval Data Buffers (see Figure 7.3).

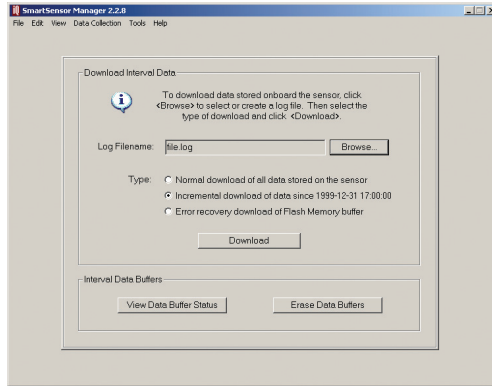


Figure 7.3 – Data Download

Download Interval Data

Under the Download Interval Data section, click the **Browse** button. This will open a directory box where you can either create a new data download file log or locate an existing download file log. Once you’ve selected an existing file or entered the name of the new file, select **Open**.

Next, select the type of download to perform. The following types of download sessions are available:

- **Normal** – Retrieves all interval data from the beginning of the study to the most recent record. The number of lanes per record is determined by the number of lanes currently configured on the sensor.
- **Incremental** – Retrieves only the interval data that was recorded after the indicated date and time. The number of lanes per record is determined by the number of lanes currently configured on the sensor.
- **Error Recovery** – Retrieves the entire contents of the flash memory buffer. The flash memory buffer contains 2976 records and each record has data for eight lanes. The contents of SRAM are not retrieved in this mode. You can perform this type of download to verify the contents of the flash memory buffer in the event that a normal or incremental download does not retrieve all the data that you expect to receive.

Once you have selected the type of download, click **Download**.

Note

Each time a data download is performed, a header is inserted into the log file that indicates the date of the download.

Data in the SRAM buffer contains the most recent information and will be downloaded first. If there is any data in the flash buffer, it will be downloaded second. However, before the data is written to the log file it will be reordered, so that the oldest data intervals will be near the top of the file.

If you want to cancel the download or if you only want to download a certain number of intervals, click the **Stop** button as soon as the desired number of interval data records are downloaded. Once the download process has stopped, a window is displayed that indicates number of interval data records that were downloaded.

Note

If your sensor experienced power cycles during the study, it may have been impossible for SmartSensor Manager to determine the timestamp of some of your intervals. The timestamp entry for these intervals will appear blank. If you have detailed knowledge about the length of the study and when the power cycles occurred (and for how long), you may be able to reconstruct the unknown timestamps. Periodic connection to the sensor is recommended in order to resynchronize the sensor time in case of a power cycle.

Interval Data Buffers

The second section of the download screen is Interval Data Buffers. This section has two options, **View Data Buffer Status** and **Erase Data Buffers**.

Selecting **View Data Buffer Status** takes you to the Interval Data Buffer Status screen; see the Data Collection Setup section of this chapter for more information.

Note

If you are not sure when your storage space will completely fill up with data; you can click on the **View Data Buffer Status** button and monitor its progress. You can also look at the Flash Storage Time entry on the Data Collection Setup screen to see how long you have before the flash memory fills up. Multiply the percentage of remaining storage space by the total Flash Storage Time to approximate the remaining amount of time before the storage space will completely fill up.

Selecting **Erase Stored Data** clears the sensor's memory and starts fresh. If the storage space is full, data must be downloaded or erased in order for the study to continue.

Note

If intervals expire during (or immediately after) your download, you will be prompted to download the new intervals before you erase. If you are presented with the option to download and erase, it is recommended that you do so in order to prevent losing data.

Data Logs

Going to **File > Data Logs** allows you to create new data logs, open existing ones, and export logs into 3 Card format.

Selecting **New** and then the type of log—**Download**, **Interval** or **Event**—opens a directory box where you can create a new log. This file will then be used to log data. If you created an event log, going to **View > Traffic (Event) Data** and turning logging on will fill the log. If you created an interval log, going to **View > Interval Data** and turning logging on will fill the log. If you created a download log, going to **Data Collection > Download** and downloading data will fill the log.

Note

If you haven't created a log file when you go to start logging, the program will prompt you to create one then.

Selecting **Open** and then the type of log will open the most recently used log in a text editor such as Notebook.

Note

You can also open event and interval logs by going to **View > Traffic (Event) Data** or **View > Interval Data** and clicking the **View Log** button; you can view download logs by selecting the **View data file when this window is closed** button after downloading.

Export

Select **File > Data Logs > Export** to export an interval log or download log to another file format (see Figure 7.4).

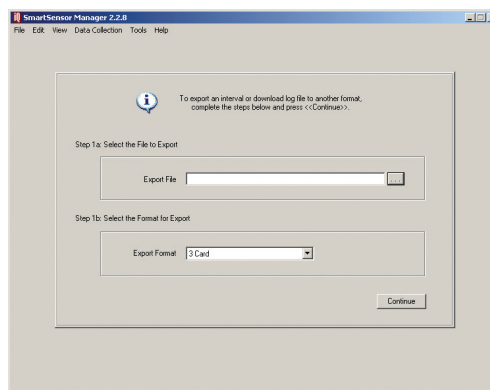


Figure 7.4 – Export Data Logs

First, select the file to export by clicking the “...” button next to the Export File text field. This will open a directory where you can select the log to be exported. Next is a spot to select the format for export. Currently the only supported destination file format is 3 Card (for more information about this format, see the FHWA’s *Traffic Monitoring Guide*, available from fhwa.dot.gov). Click **Continue**.

On the following screen, fill out the requested information, which includes a starting and ending date, a station ID number, the functional classification of the sensor site, the state you’re located in, and any restrictions. Click **Continue** when you’re done.

Note

The starting date and ending date will generally be the first and last day of data in your interval log file. However, you may wish to set your starting date and ending date so that you export only certain days.

On the third page, specify the lane assignment number and lane direction. So that you can

tell which lane you're working with, the lanes are numbered under the Sensor Log File heading, with the lane closest to the sensor at the top of the list. While multiple lanes may have the same direction, no two lanes may have both the same direction and number, unless that number is 0. You can call multiple lanes 0 in order to group them together (see Figure 7.5).

Sensor Log File	3 Card	
Lane Name	Lane	Direction
1	1	N
2	2	N
3	3	N
4	0	S
5	0	S
6	0	S

Open 3 Card export file when finished

Back Finish

Figure 7.5 – Step 3 of Export Process

Click **Finish** to create the 3 Card file. (To see the file immediately, click the **Open 3 Card export file when finished** box.) SmartSensor Manager will take the entered information and format the file according to 3 Card standards.

In this chapter

- Hyperterminal
- Firmware Upload

The Tools menu allows you to view and send messages to and from the sensor, as well as to upload firmware.

Hyperterminal

Hyperterminal allows you to send message requests and view message responses for any commands in either Simple or Multi-drop protocols (see Figure 8.1). Enter the request in the text field marked Command Line located near the top of the screen. Click on the appropriate radio button to either transmit information all at once after you've hit **Enter** on the keyboard or to automatically transmit each character as it is typed. The message response will be returned in the gray scrollable area below the Command Line.

You may also use binary mode to verify operation of binary protocols supported by the SmartSensor V by clicking the **Binary Mode** button.

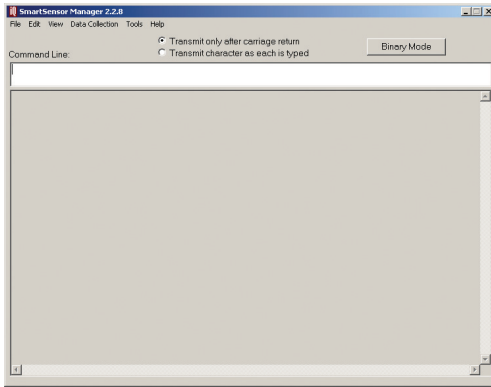


Figure 8.1 - Hyperterminal

Firmware Upload

When you first connect, the program will prompt you to update your firmware if it sees a discrepancy between the software and firmware versions, but you can also go at any time to **Tools > Firmware Upload** and select a firmware file (.hex) stored on your computer to upload to your sensor (see Figure 8.2).

Before using something other than the most current firmware version, please contact Watvetronix Technical Services for assistance.

To upload firmware, click the appropriate radio button for either **DSP** or **FPGA** firmware. Click the **Browse . . .** button to locate the firmware stored on your computer; click the **UPLOAD** button to transfer the firmware to the sensor.

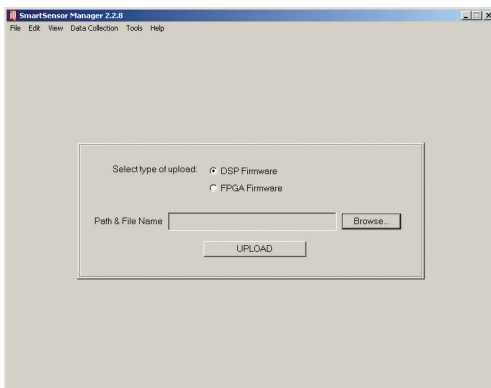


Figure 8.2 - Firmware Upload

In this chapter

- Selecting the Contact Closure Model
- Programming Sensors for Contact Closures
- Programming Contact Closures

In many applications, you will not need to use your SmartSensor V with contact closure cards. Often traffic data is collected directly from the sensor via a serial, modem or Internet connection. However, a contact closure module is often needed to use a SmartSensor with a traffic controller, traffic data recorder or other type of data logger.

Selecting the Contact Closure Model

In some applications, all of the contact closure modules listed in Table 9.1 below could be used, but one model may have major advantages over the others; for example, the Click 101 is better for midblock applications.

Model Number	Form Factor	Major Advantages
Click 100	Din rail	Screw terminals for easy wiring to automatic traffic recorders or data loggers
Click 101	Din rail	Collection from multiple sensors
Click 172/174	Rack card	Works with standard ITS and intersection detector racks (NEMA TS1/TS2, 170, 2070)

Click 500	Din rail	User-programmable contact closure development platform for virtually any application.
-----------	----------	---

Table 9.1 – Advantages of Contact Closure Models

- **Click 100** – The Click 100 is a DIN rail–mounted contact closure that can be used in cabinets without detector racks and simplifies integration into automatic data recorders and data loggers. The wiring harness of the automatic data recorders can connect directly to the screw terminals of the Click 100. Application notes for wiring to common automatic traffic recorders can be obtained by contacting your authorized Wavetronix dealer or Wavetronix Technical Services.
- **Click 101** – The Click 101 has the built-in capability of collecting from multiple SmartSensor units simultaneously, making it an excellent choice for midblock applications. This allows one Click 101 to collect traffic data from all the SmartSensor stations pertaining to an intersection. For arterial management, the resulting system is very cost-effective and can be rapidly deployed, especially when wireless communications is included.

Each SmartSensor V uses its two communication ports to send real-time traffic data to both cabinets for which it is collecting data (see Figure 9.1). The real-time data is used to control the intersection using either local control strategies or closed-loop control systems like ACS-lite.

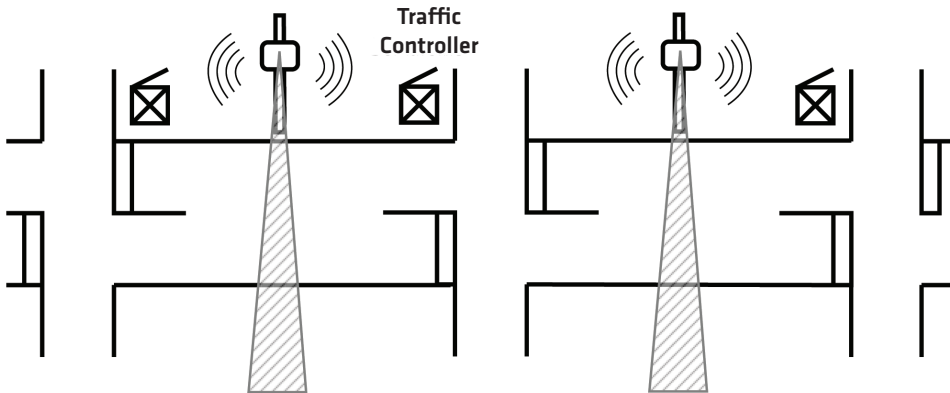


Figure 9.1 – SmartSensor Sending Real-time Data to Multiple Approaches Using Dual Ports

- **Click 172/174** – The Click 172/174 are contact closure cards that allow the SmartSensor V to integrate into standard ITS and intersection detector racks. The Click 172 has two contact closure outputs and the Click 174 has four. The Click 172/174 are commonly used in legacy ITS cabinets or for midblock intersection detection. Multiple modules can be daisy-chained together to collect data from all eight lanes possible with SmartSensor V.

Unlike the Click 101, which actively collects information from multiple sensors, each Click 172/174 is dedicated to a single sensor. During programming, the Click 172/174

cards transmit configuration information to the SmartSensor V to set up the mode of operation. Once the mode is set up, the rack cards stop transmitting messages and passively listen for data pushed by the sensor.

Tip

In many cases, the traffic data detected by the SmartSensor V is valuable to both operations and planning departments. However, when legacy systems are used, often there is no mechanism to directly share the data. Even with the limitations of legacy systems, contact closures can sometimes provide a way for operations and planning to both get what they need from a single sensor. For example, the operations department can collect traffic data into a traffic controller via a Click 172/174 over one of the SmartSensor V's two ports. Then the planning department can use the second port to send data to an automatic traffic data recorder via a Click 100.

- **Click 500** - The Click 500 is a user-programmable contact closure platform for virtually any application. For example, the Click 500 can be programmed to activate a contact closure output when vehicles over a specified speed and length are detected. To accelerate development, the Click 500 will provide developers with SmartSensor V communication drivers.

For a full description of each module refer to the Click quick-start guides, user manuals and bid specifications. Or contact your authorized Wavetronix dealer or Wavetronix Technical Services for more information.

Programming Sensors for Contact Closures

- **Click 100** - The Click 100 supports baud rates from 9600 to 57600 bps. When using a Click 100, make sure your SmartSensor V is set to operate at a baud rate in this range.
- **Click 101** - The Click 101 modules support baud rates from 9600 to 115200 bps. The Click 101 identifies each sensor by its sensor ID. Before you configure the Click 101, you can retrieve the sensor ID using SmartSensor Manager over communication link.
- **Click 172/174** - The Click 172/174 modules support baud rates from 9600 to 57600 bps. When using a Click 172/174 device, make sure the SmartSensor V is set to operate at a baud rate in this range. To select which SmartSensor V lanes are mapped to the Click 172/174 outputs, the lane names of the SmartSensor need to be set up correctly using SmartSensor Manager. The first character of the lane name should take on the value 0 to 9. The second character can take on a value R or L to represent the direction traffic is flowing. For example, lane names could be 1R (right to left) or 1L (left to right).

Tip

The SmartSensor V default loop size and spacing will change the values of SmartSensor V data. The default loop size is used in the calculation of lane occupancy, vehicle duration and vehicle length. The default loop spacing is used in the calculation of vehicle speed and length. The Click 100 and 172/174 also use these settings to change the duration and spacing of contact closures signaled on their output pins. If your SmartSensor V is connected to a contact closure device and you are also retrieving data serially, first adjust the default loop size and spacing to match the inductive loop setup that you're trying to emulate, then adjust the individual lane size and spacing values used to calculate the per lane scale factors.

- **Click 500** - The Click 500 modules support baud rates from 9600 to 115200 bps. Any special programming of SmartSensor for an application running on the Click 500 will be explained in the documentation for that application.

Programming Contact Closures

The contact closure modules have several modes of operation explained in their respective quick-start guides and user manuals. Consult this documentation to determine the mode appropriate for your application. This documentation will explain how to program each mode.

Appendix

In this chapter

- A – 8-conductor Cable Definitions
- B – 9-conductor Cable Definitions
- C – Old Cable Definitions
- D – Cable Lengths
- E – Direct Serial Connections

Appendix A – 8-conductor Cable Definitions

The 8-conductor cable is composed of eight conductors plus a drain wire, all surrounded by a shield. Table A.1 shows the individual wires along with their descriptions.

Wire	Description
Red	+DC
Black	-DC
Blue/White	+485
Blue	-485
Violet	RD
Yellow	TD
Brown	CTS
Orange	RTS

Table A.1 – 8-conductor Cable Description

See Figure A.1 for a diagram of the 8-conductor cable's 10-pin socket assignment. The codes listed in the diagram are to be used to solder wires into the back of the plug where the letters represent the individual solder cups.

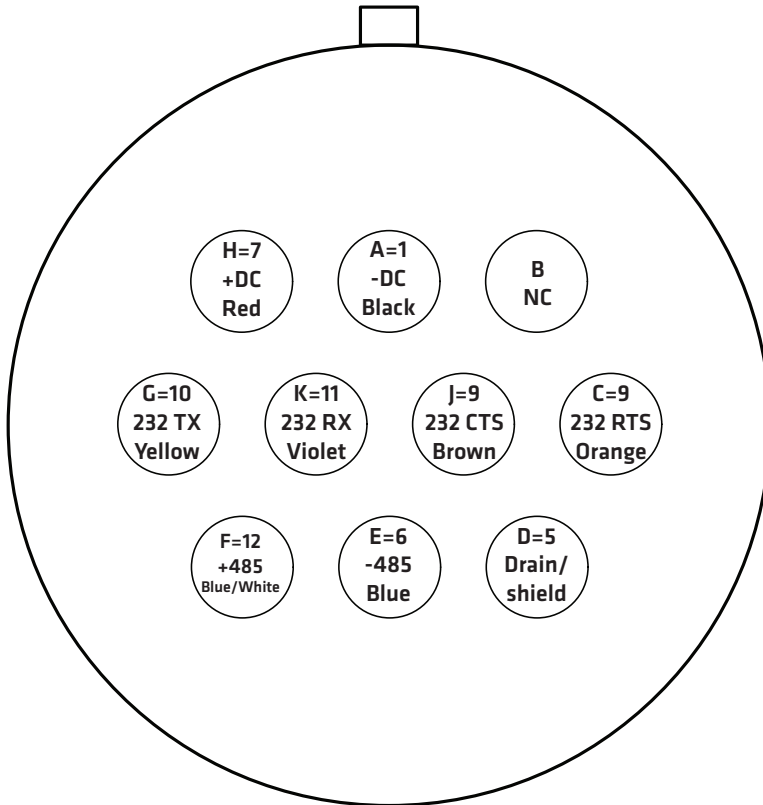


Figure A.1 - 8-conductor Cable Plug Connector Socket Assignment (seen from the solder cup side of the connector)

Figure A.2 shows the 8-conductor cable wire connections into a Click 200 surge protector.

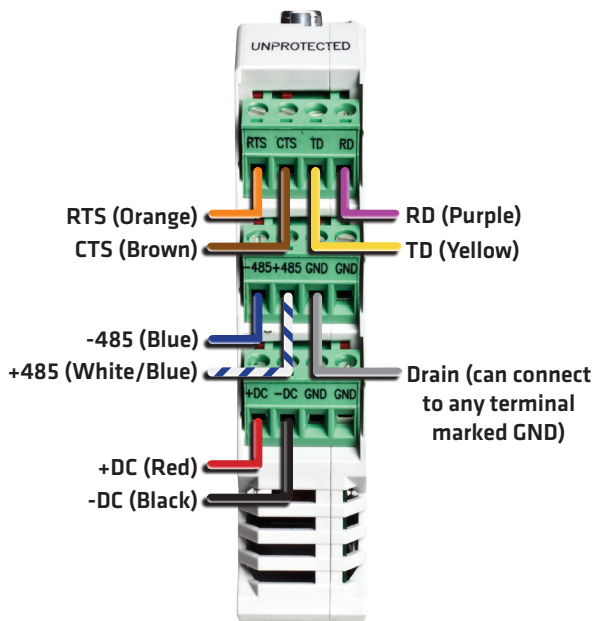


Figure A.2 – 8-conductor Cable into the Click 200

Appendix B – 9-conductor Cable Definitions

The old SmartSensor 105, the predecessor to the SmartSensor V, used the 9-conductor cable. You can also order a retrofit version of the SmartSensor V, which also uses the 9-conductor cable.

The 9-conductor cable is composed of three groups of wires, each containing color-coded wires and a drain wire and surrounded by a shield. Table A.2 shows the individual wires along with their descriptions.

Wire	Description
Red	+DC
Black	-DC
Drain	GND
Blue	-485
White	+485
Drain	485 GND
Yellow	RS-232 (TD)
Violet	RS-232 (RD)
Drain	GND
Orange	RTS

Brown	CTS
Gray	RS-232 GND

Table A.2 – 9-conductor Cable Description

Figure A.3 shows a diagram of the 9-conductor cable's 26-pin socket assignment. The codes listed in the diagram are to be used to solder wires into the back of the plug where the letters represent the individual solder cups.

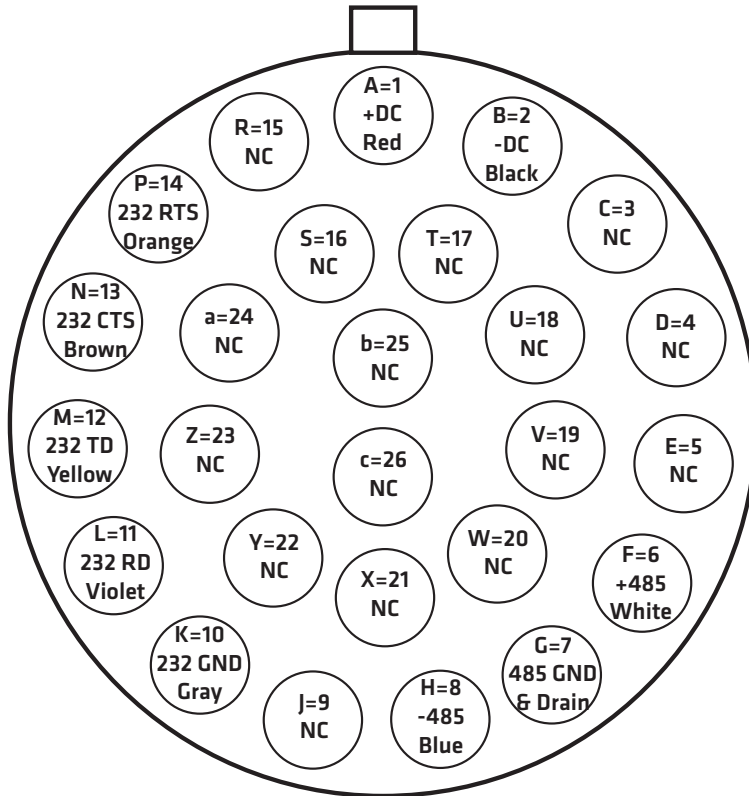


Figure A.3 – SmartSensor V Plug Connector Socket Assignment

Figure A.4 shows the 9-conductor cable wire connections into a Click 200 surge protector.

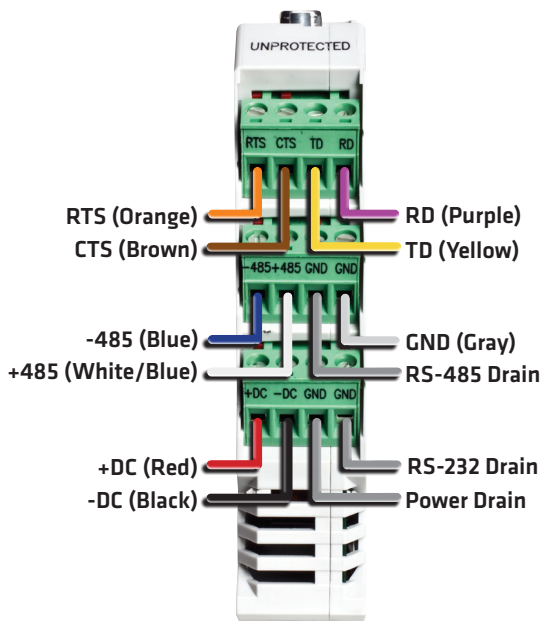


Figure A.4 – 9-conductor Cable into the Click 200

Appendix C – Old Cable Definitions

The previously used SmartSensor cable is composed of six twisted pairs of wire. Each pair is composed of a black and a red wire, accompanied by a drain wire and surrounded by a shield. A numeric label (1 through 6) identifies each pair of black and red wires. Table A.3 details the pinout of the cable and the appropriate connection inside the cabinet for each wire:

Wire	Description
Red 1	+DC
Black 1	-DC
Drain of Pair 1	GND
Red 2	+DC
Black 2	-DC
Drain of Pair 2	GND
Red 3	+485
Black 3	-485
Drain of Pair 3	RS-485 GND
Red 4	232 (TD) output from sensor
Black 4	232 (RD) input to sensor

Drain of Pair 4	RS-232 GND
Pair 5	Reserved for future use
Red 6	CTS flow for RS-232
Black 6	RTS flow for RS-232

Table A.3 – Old Cable Description

Figure A.5 shows a diagram of the old SmartSensor cable's 26-pin socket assignment. The codes listed in the diagram are to be used to solder wires into the back of the plug where the letters represent the individual solder cups.

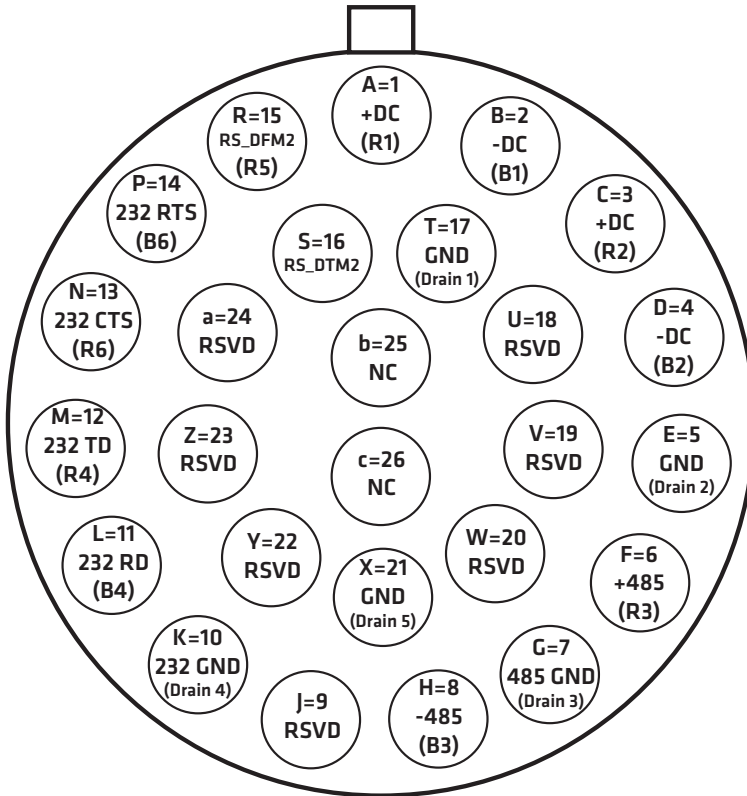


Figure A.5 – Old SmartSensor Plug Connector Socket Assignment

Figure A.6 shows the old SmartSensor cable wire connections into a Click 200 surge protector.

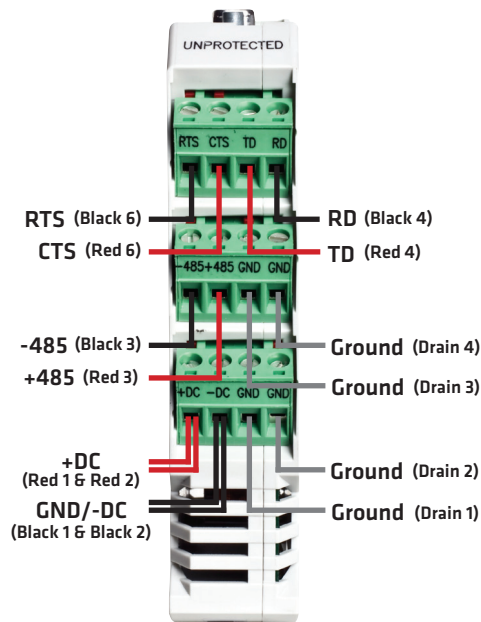


Figure A.6 – Old SmartSensor Cable into the Click 200

Appendix D – Cable Lengths

The recommendations in Table A.4 below allow you to provide reliable power to the SmartSensor V. The 8-conductor cable's power wires provide a 20 AWG wire pair. The other pairs on the 9-conductor cable are 22 AWG and are normally used for communication.

Cable Gauge	24 Volts	12 Volts
20 AWG (8-conductor Cable)	600 ft. (182.9 m)	110 ft. (33.5 m)
Additional 22 AWG	Add 400 ft. (121.9 m)	Add 75 ft. (22.9 m)
22 AWG (9-conductor Cable)	400 ft. (121.9 m)	75 ft. (22.9 m)
Additional 22 AWG	Add 400 ft. (121.9 m)	Add 75 ft. (22.9 m)
14 AWG	2500 ft. (762 m)	450 ft. (137.2 m)
12 AWG	3900 ft. (1188.7 m)	700 ft. (213.4 m)
10 AWG	6000 ft. (1828.8 m)	1050 ft. (320 m)
8 AWG	9900 ft. (3017.5 m)	1750 ft. (533.4 m)
6 AWG	14,000 ft. (4267.2 m)	2500 ft. (762 m)

Table A.4 – Maximum Cable Length for Power

If the cable length is longer than 600 ft. (182.9 m) when operating at 24 V, it is possible to increase the maximum cable length by wiring a pair of lines normally used for RS-232 communications with the red and black wires.

If the cable length is 200 ft. (61 m) or greater you cannot reliably use RS-232 communications. To add 400 ft. (121.9 m) and achieve a maximum cable length of 1000 ft. (304.8 m), connect the orange wire (normally RTS) to the red wire and the brown wire (normally CTS) to the black wire.

If your cable run is longer than 1000 ft. (304.8 m), it is possible to sacrifice additional communication pairs to increase the maximum cable length for power. However, you may desire to communicate to the sensor over two independent channels, in which case you will need to consider an alternate cable for power. The AWG for wire pairs that achieve a 2000 ft. (609.6 m) maximum cable length or greater at 12 and 24 V are listed in Table A.2.

To achieve reliable wired communications, the selected baud rate must be compatible with the length of the cable run. Table A.5 below shows the cable length recommendations for wired communications:

Baud Rate (bps)	RS-232	RS-485
115200	40 ft. (12.2 m)	300 ft. (91.4 m)
57600	60 ft. (18.3 m)	600 ft. (182.9 m)
38400	100 ft. (30.5 m)	800 ft. (243.8)
19200	140 ft. (42.7 m)	1000 ft. (304.8 m)
9600	200 ft. (61 m)	2000 ft. (609.6 m)

Table A.5 – Maximum Cable Length for Wired Communications

To provide two independent communication channels with a homerun cable length over 200 ft. (61 m), convert the RS-232 data into RS-485 using a Click 304 in a pole-mount cabinet mounted next to the sensor. In this case, the homerun connection establishes one RS-485 channel over the normal white/blue wire pair and another RS-485 channel over the yellow/violet wire pair. An additional Click 304 is needed to convert the data sent over the yellow/violet wire pair back to RS-232 before connecting to surge protection.

If you elect to use an alternate cable for power, you may also want to select an alternate cable for RS-485 communications. Some options include the Belden 3105A (Paired – EIA Industrial RS-485 PLTC/CM) or Alpha Wire 6010C 3PR 22 AWG.

There are many reliable options available for wired power and communications connections (see Table A.6).

Length	Cable	Comm. Channel 1	Comm. Channel 2
0-200 ft. (0-61 m)	8-conductor Cable	Native RS-485	Native RS-232
200-1000 ft. (61-304.8 m)	8-conductor Cable	Native RS-485	Click conversion of RS-232 to RS-485
1000-1400 ft. (304.8-426.7 m)	8-conductor Cable	Native RS-485	N/A

1400–2000 ft. (426.7–609.6 m)	Alternate power and communications cable	Native RS-485	Click conversion of RS-485 to RS-232
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Table A.6 – Cable Length Options

Appendix E – Direct Serial Connections

For most applications, the service end of the 8-conductor cable terminates in a surge protection device. However, during demonstrations, troubleshooting, and certain other situations, it is sometimes convenient to bypass surge protection and connect directly to a personal computer or communications device such as a modem.

The sensor is configured as an RS-232 DTE device. To connect the 8-conductor cable’s RS-232 wires directly to another DTE device (such as a PC), you can use a standard 9-pin “D” connector and a null modem cable. To connect directly to a DCE device (such as a modem), you will need a straight-through cable. Figure A.7 illustrates both of these cases.

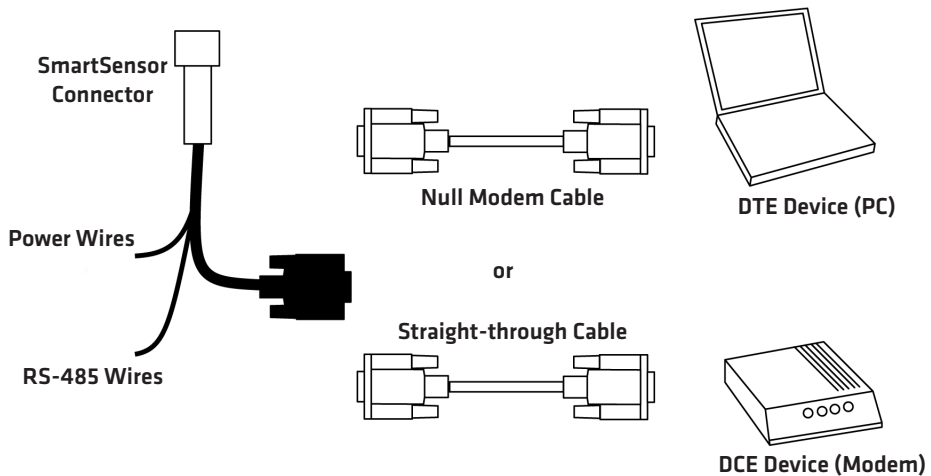


Figure A.7 – Direct Serial Connections

Note

If you do not have the right type of RS-232 physical connection you will not be able to connect using the SmartSensor Manager software. Since null modem cables and straight-through cables look similar, you may want to label them. Alternatively, you may want to use a null modem adapter instead of a null modem cable. If you do, you can turn your straight-through cable into a null modem cable by attaching the adapter on one end.

If you wish to connect the 8-conductor cable's RS-485 wires directly to a PC or modem, this will require that these devices natively support RS-485 communications. Often, modern personal computers do not support RS-485 communications and support USB communications instead. If your computer only supports USB communications, you may want to use a Click serial to USB converter to make a direct connection.