SmartSensor 105

USER GUIDE

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This document is intended for informational and instructional purposes only. The Company reserves the right to make changes in the specifications and other information contained in this document without prior notification.

FCC Part 15 Compliance: This device complies with Part 15 of the Federal Communications Commission (FCC) rules which states that operation is subject to the following two conditions: (1) this device may not cause harmful interference, and (2) this device must accept any interference received, including interference that may cause undesirable operation. FCC compliance statements for applicable optional modules are to be found in the module specifications. Unauthorized changes or modifications not expressly approved by the party responsible for compliance with the FCC rules could void the user's authority to operate this equipment.

Do not shorten supplied cable less than manufacturer's recommended length. Sensor cable must be at least 2 m long to maintain FCC compliance.

Disclaimer: The advertised detection accuracy of the company's sensors is based on both external and internal testing, as outlined in each product's specification document. Although our sensors are very accurate by industry standards, like all other sensor manufacturers we cannot guarantee perfection or assure that no errors will ever occur in any particular applications of our technology. Therefore, beyond the express Limited Warranty that accompanies each sensor sold by the company, we offer no additional representations, warranties, guarantees or remedies to our customers. It is recommended that purchasers and integrators evaluate the accuracy of each sensor to determine the acceptable margin of error for each application within their particular system(s).

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The Wavetronix SmartSensor 105 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 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 reconfigured. 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.

Caution

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 105 Package

A typical sensor package contains the following items:

- 10.525 GHz SmartSensor Radar Traffic Sensor
- SmartSensor mounting kit
- SmartSensor cable
- SmartSensor Manager software
- SmartSensor User Guide

> **Caution**
> 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™ 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 ±2° 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.

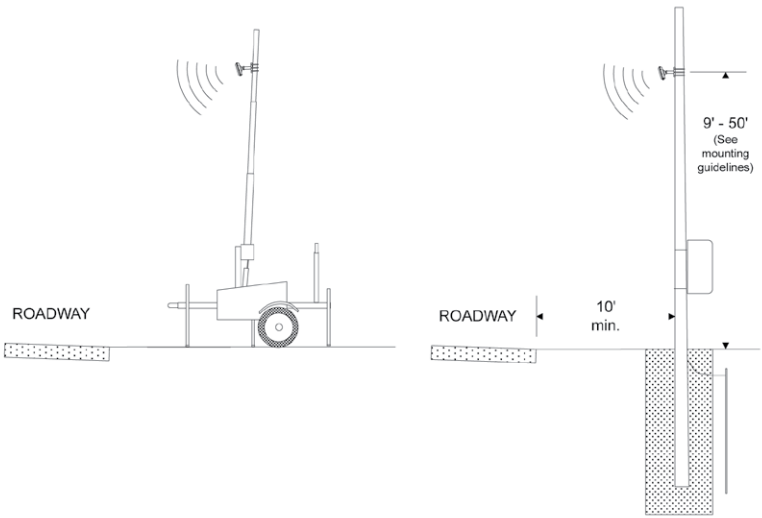

Figure I.1 – Portable (left) and Permanent (right) Sensor Stations

- **Freeway Locations –** SmartSensor 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 105

1 Installing the SmartSensor 105

In this Chapter

Installing the SmartSensor 105 is quick and easy. Once installed, the SmartSensor 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.

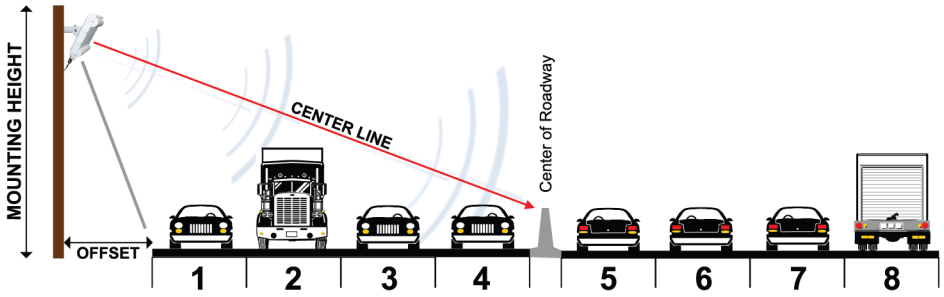

Figure 1.1 – Mounting and Aiming a SmartSensor

Recommended Offset

Offset from 1st Detection Lane (ft / m)	Recommended Mounting Height (ft / m)	Minimum Mounting Height (ft / m)	Maximum Mounting Height (ft / m)
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
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.

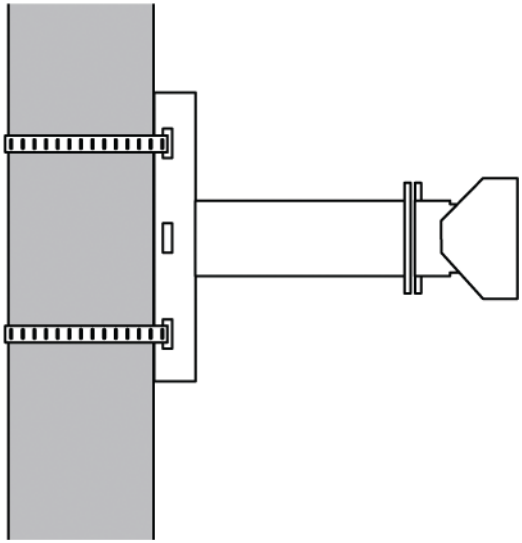

Figure 1.2 – Attaching the Mount Bracket to the Pole

> **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 with the holes in the mounting bracket. The large 25-pin connector on the SmartSensor 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.

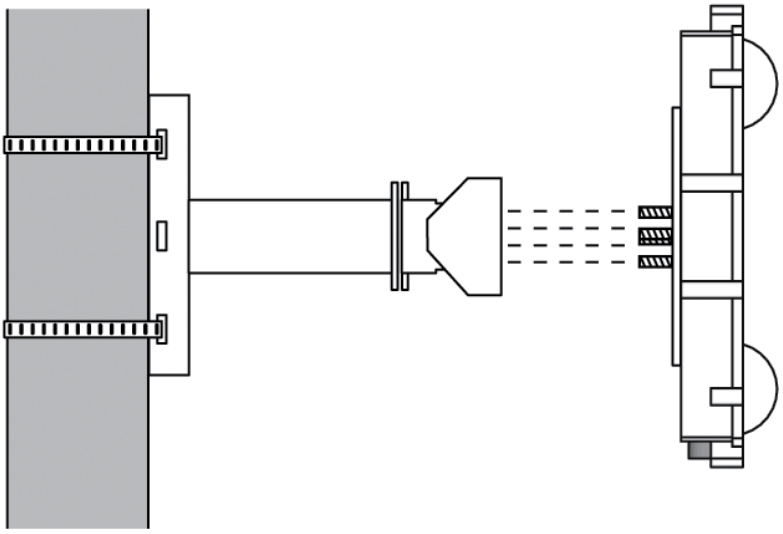

Figure 1.3 – Attaching the Sensor to the Mounting Bracket

Aligning the Sensor to the Roadway

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

Figure 1.4 – Aiming the SmartSensor

1. Aim the front of the sensor at the center of the detection area. You may also refer to Figure 1.1 as an illustration of where to aim the sensor.
2. Adjust the side-to-side angle to within approximately ±2° 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 as shown in Figure 1.5. Be sure to wipe off any excess compound.

Figure 1.5 – Applying Silicon Dielectric Compound

Connecting the SmartSensor Cable

1. Attach the cable connector to the 25-pin connector at the base of the SmartSensor as shown in Figure 1.6. The SmartSensor 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

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-start 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

It is strongly recommended that the sensor be connected to a surge protection device. The Wavetronix Click! 200 and equivalent devices are designed to prevent electrical surges conducted along underground cables from damaging the sensor and/or the cabinet. The service end of the sensor cable should be connected to the PROTECTED side of the Click! 200 in a cabinet mounted on the sensor pole. This will help protect the sensor when lightning strikes the ground in the vicinity of the cabinet (see Figure 2.1).

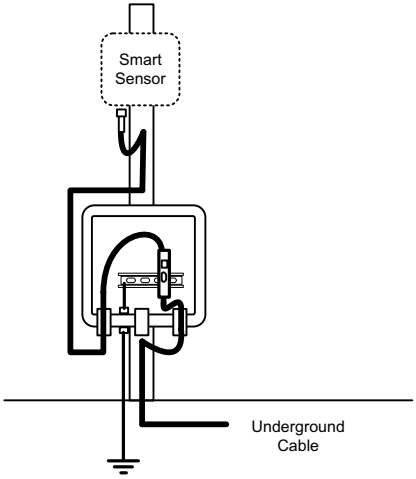

Figure 2.1 – Protecting the Sensor

> **Note**
> If you choose not to use surge protection in your installation, please contact Wavetronix Technical Services for assistance.

In many installations, the pole-mount cabinet is also connected to a main traffic cabinet via an underground homerun cable. To protect the traffic cabinet, a second surge device is strongly recommended. Follow the steps below to include surge protection using Click! 200 devices (see Figure 2.2):

1. Install one Click! 200 device in a pole-mount box on the same pole as the sensor being protected.
2. Install another Click! 200 in the main traffic cabinet.
3. Connect the SmartSensor cable from the sensor to the PROTECTED side of the Click! 200 in the pole-mount cabinet. The SmartSensor cable should be kept as short as possible.
4. Connect a SmartSensor cable from the UNPROTECTED side of the Click! 200 on the pole to the UNPROTECTED side of the Click! 200 in the main traffic cabinet.

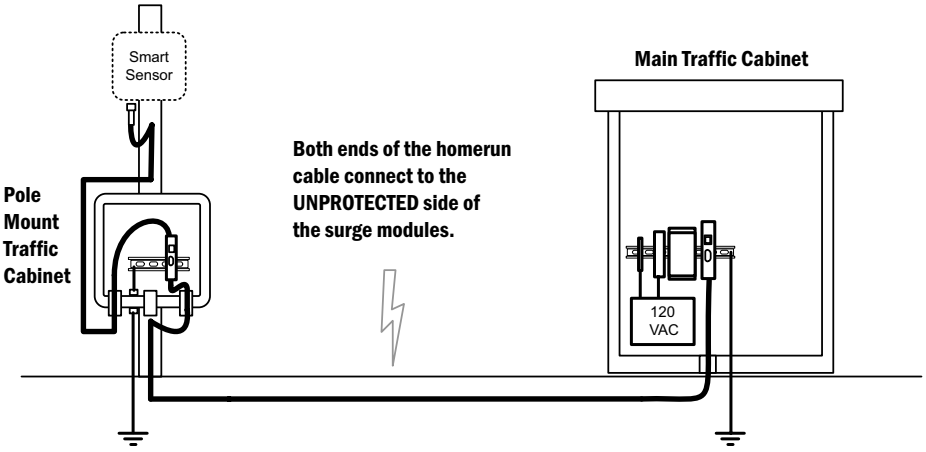

Figure 2.2 – Typical Cable Run

The Click! 200 contains three terminal connectors on both the top and the bottom of the module (see Figure 2.3). 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.

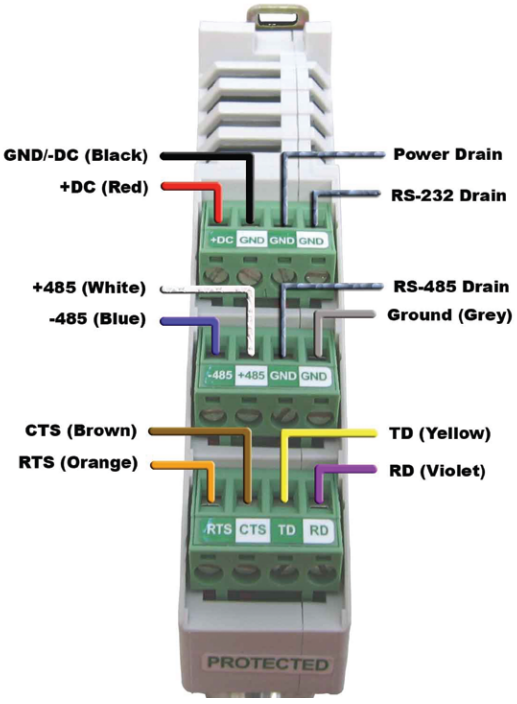

Figure 2.3 – Surge Protected Terminal Connections (Top)

Figure 2.3 above shows the PROTECTED side of the Click! 200. The UNPROTECTED side of the Click! 200 contains the same screw terminal connections, but are reversed from left to right.

> **Note**
>
> See Appendix B for a description of how to wire the Click! 200 using the old SmartSensor cable as well as for a cable connector pin out diagram.

Wiring to Earth Ground

ALL Click! 200 devices should be mounted on a DIN rail that is connected to earth ground either through an earth-grounded chassis or a 16 AWG or larger grounding wire attached to a 7-ft. (2.1-m) grounding rod. Follow the steps below to correctly wire to earth ground:

1. Connect the grounding wire from either the DIN rail or a GND screw terminal on the UNPROTECTED side of the Click! 200 to the lug bolt on the inside of the pole-mount box.
2. Connect another grounding wire from the exterior lug bolt to earth ground (see Figure 2.4).

Figure 2.4 – Earth Ground Connections

Connecting AC Power Conversion

Since the sensor operates on 10-30 VDC, it is necessary to provide AC power conversion when reliable DC power is not already available. Wavetronix recommends using the following three Click! components:

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

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

A Click! 201 provides 1 amp of power and is capable of powering a single sensor, while a Click! 202 provides 2 amps and can power two sensors. 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.

Depending on your configuration, these Click! modules may be mounted in the pole-mount cabinet or the main traffic cabinet. When mounted in the main traffic cabinet, a homerun cable is used to conduct DC power and communication signals to the pole-mount cabinet. For connections shorter than 600 ft. (182.9 m), use the SmartSensor cable as your homerun cable. This will simplify the wiring process and ensure reliable connections.

Caution

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 2.5):

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.

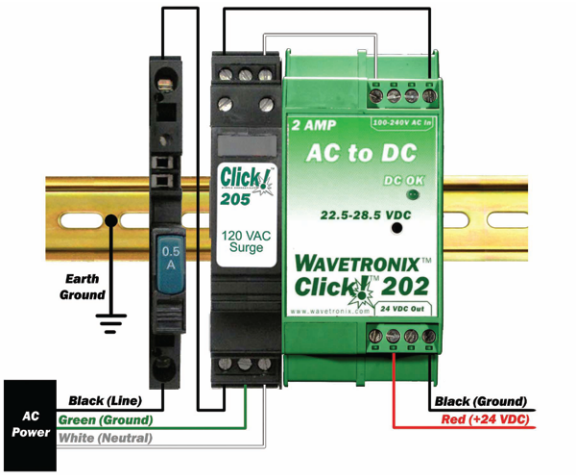

Figure 2.5 – AC Surge Protection

Wiring AC Surge Protection

To include AC surge protection in your installation (see Figure 2.3):

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 from the AC terminal block or cord to the terminal marked 1 on the Click! 230.

4 Connect the ground wire from the AC terminal block or cord 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 2.6):

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. 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 2.6 – 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 2.7).

2 Connect a -DC conductor (usually a black wire) to either of the - screw terminals on the bottom of the Click! 201/202.

Figure 2.7 – 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

To power the sensor, 10-30 VDC needs to be connected to the Click! 200 in the pole-mount cabinet. Additionally, if there is a main traffic cabinet connected by a homerun cable, you will need to connect DC power to the Click! 200 in that cabinet.

In the Pole-Mount Cabinet

Whether DC voltage comes from a homerun cable or from a Click! 201/202 within the pole-mount cabinet, you can always wire the DC wires to the last screw terminal on the UNPROTECTED side of the Click! 200 module. This will protect your sensor from surges.

To wire DC power into the Click! 200:

1 Connect +DC (usually a red wire) to the +DC screw terminal.
2 Connect -DC (usually a black wire) to the GND screw terminal next to the +DC terminal.

If the DC power comes from a Click! 201/202 in the pole-mount cabinet that is surge protected using a Click! 230, you can also connect power to the T-bus using a 5-position screw terminal. To wire DC power directly into a 5-position screw terminal (see Figure 2.8):

1. Connect +DC (24 VDC) to the top screw terminal.
2. Connect –DC to the second screw terminal.

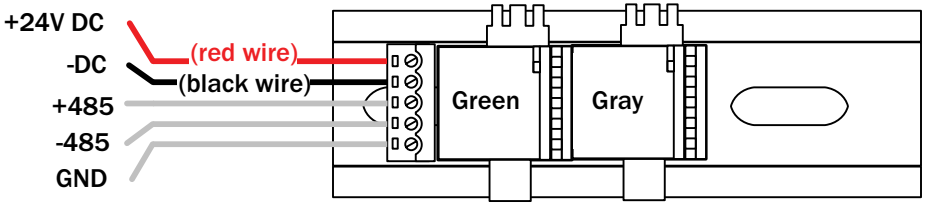

Figure 2.8 – Connecting Power Directly to the T-bus

> **Note**
>
> Green T-bus connectors provide power and communication connectivity on the DIN rail backplane; gray T-bus connectors only provide power connectivity and are used to distribute power without connecting communication.

In the Main Traffic Cabinet

If DC voltage is sent across a homerun connection, AC power conversion is provided in the main cabinet. In the main cabinet, the DC wires out of the Click! 201/202 should be wired to the PROTECTED side and the homerun cable should be connected to the UNPROTECTED side of the Click! 200.

> **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 last screw terminal block on the PROTECTED side of the Click! 200 module contains a +DC, -DC and two surge ground connections (see Figure 2.9).

1. Connect +DC (usually a red wire) to the +DC screw terminal.
2. Connect -DC (usually a black wire) to the GND screw terminal next to the +DC terminal.

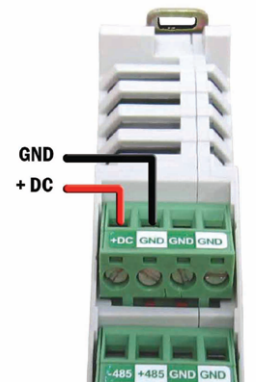

Figure 2.9 – Wiring DC Power into the Click! 200

Wiring Communication

After wiring the sensor cable into the PROTECTED side of the Click! 200 in the pole mount cabinet, two isolated serial connections are available. The sensor's native RS-232 port is available via the DB-9 connector on the faceplate.

In addition, the sensor's native RS-485 connection is available in the pole mount cabinet via the following three ports on the Click! 200:

- Screw terminals on the bottom
- RJ-11 connector on the faceplate
- T-bus backplane

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

One common way to connect communications back to a main cabinet is to use a SmartSensor cable as your homerun cable. See Appendix C for information about maximum cable lengths for wired communication. 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

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. In some cases, 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 2.10).

Figure 2.10 – 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.