

Datasheet

Sure Cross® MultiHop data radios are wireless industrial communication devices used to extend the range of a Modbus or other serial communication network.



- Wireless industrial I/O device with four sinking discrete inputs, two NMOS discrete outputs, four 0 to 20 mA analog inputs, and two switch power outputs
- Selectable transmit power levels of 250 mW or 1 Watt for 900 MHz models and 65 mW for 2.4 GHz models
- *FlexPower*® power options allow for 10 to 30 V dc, solar, and battery power sources for low power applications.
- Self-healing, auto-routing RF network with multiple hops extends the network's range
- Serial and I/O communication on a Modbus platform
- Message routing improves link performance
- DIP switches select operational modes: master, repeater, or slave
- Built-in site survey mode enables rapid assessment of a location's RF transmission properties
- FHSS radios operate and synchronize automatically

For additional information, updated documentation, and accessories, refer to Banner Engineering's website, www.bannerengineering.com/surecross.

| Models | Frequency | I/O |
|-------------|------------------|----------------------------------------------------------------------------------------------------------------------------------|
| DX80DR9M-H5 | 900 MHz ISM Band | Inputs: Four NPN discrete, four 0 to 20 mA analog Outputs: Two NMOS discrete Switch Power: Two Serial interface: RS-485 |
| DX80DR2M-H5 | 2.4 GHz ISM Band | |



DX80...C (IP20; NEMA 1) models are also available. To order this model with an IP20 housing, add a C to the end of the model number: DX80DR9M-H5C.



WARNING: Not To Be Used for Personnel Protection

Never use this device as a sensing device for personnel protection. Doing so could lead to serious injury or death. This device does not include the self-checking redundant circuitry necessary to allow its use in personnel safety applications. A sensor failure or malfunction can cause either an energized or de-energized sensor output condition.



CAUTION: Never Operate 1 Watt Radios Without Antennas

To avoid damaging the radio circuitry, never power up Sure Cross® Performance or Sure Cross MultiHop (1 Watt) radios without an antenna.



CAUTION: Electrostatic Discharge (ESD)

ESD Sensitive Device. This product uses semiconductors that can be damaged by electrostatic discharge (ESD). When performing maintenance, care must be taken so the device is not damaged. Disconnect power from the device when accessing the internal DIP switches. Proper handling procedures include wearing anti-static wrist straps. Damage from inappropriate handling is not covered by warranty.



Configuration Instructions

Setting Up Your MultiHop Network

To set up and install your wireless MultiHop network, follow these steps:

1. If your radios have DIP switches, configure the DIP switches of all devices.
2. Connect the sensors to the MultiHop radios if applicable.
3. Apply power to all devices.
4. If your MultiHop radio has rotary dials, set the MultiHop Radio (Slave) ID. If your MultiHop radio has no rotary dials, continue to the next step.
5. Form the wireless network by binding the slave and repeater radios to the master radio. If the binding instructions are not included in this datasheet, refer to the quick start guide or product manual.
6. Observe the LED behavior to verify the devices are communicating with each other.
7. Conduct a site survey between the MultiHop radios. If the site survey instructions are not included in this datasheet, refer to the product manual.
8. Install your wireless sensor network components. If the installation instructions are not included in this datasheet, refer to the product manual.

For additional information, including installation and setup, weatherproofing, device menu maps, troubleshooting, and a list of accessories, refer to one of the following product manuals:

- MultiHop Data Radio Quick Start Guide: [152653](#)
- MultiHop Data Radio Instruction Manual: [151317](#)
- MultiHop Register Guide (End User Edition): [155289](#)

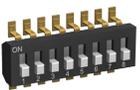
Configure the DIP Switches

Before making any changes to the DIP switch positions, disconnect the power. DIP switch changes will not be recognized if power isn't cycled to the device.

Accessing the Internal DIP Switches

To access the internal DIP switches, follow these steps:

1. Unscrew the four screws that mount the cover to the bottom housing.
2. Remove the cover from the housing without damaging the ribbon cable or the pins the cable plugs into.
3. Gently unplug the ribbon cable from the board mounted into the bottom housing.
4. Remove the black cover plate from the bottom of the device's cover.
The DIP switches are located behind the rotary dials.



After making the necessary changes to the DIP switches, place the black cover plate back into position and gently push into place. Plug the ribbon cable in after verifying that the blocked hole lines up with the missing pin. Mount the cover back onto the housing.

DIP Switch Settings (MultiHop)

| Device Settings | Switches | | | | | | | |
|---------------------------------------------------------------------------------------|----------|------|------|------|---|---|---|---|
| | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 |
| Serial line baud rate 19200 OR User defined receiver slots | OFF* | OFF* | | | | | | |
| Serial line baud rate 38400 OR 32 receiver slots | OFF | ON | | | | | | |
| Serial line baud rate 9600 OR 128 receiver slots | ON | OFF | | | | | | |
| Serial line baud rate Custom OR 4 receiver slots | ON | ON | | | | | | |
| Parity: None | | | OFF* | OFF* | | | | |
| Parity: Even | | | OFF | ON | | | | |
| Parity: Odd | | | ON | OFF | | | | |
| Disable serial (low power mode) and enable the receiver slots select for switches 1-2 | | | ON | ON | | | | |

| Device Settings | Switches | | | | | | | |
|---------------------------------------------------------------------------------------------------------------|----------|---|---|---|------|------|------|------|
| | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 |
| Transmit power 900 MHz radios: 1.00 Watt (30 dBm) 2.4 GHz radios: 0.065 Watts (18 dBm) and 60 ms frame | | | | | OFF* | | | |
| Transmit power 900 MHz radios: 0.25 Watts (24 dBm) 2.4 GHz radios: 0.065 Watts (18 dBm) and 40 ms frame | | | | | ON | | | |
| Application mode: Modbus | | | | | | OFF* | | |
| Application mode: Transparent | | | | | | ON | | |
| MultiHop radio setting: Repeater | | | | | | | OFF* | OFF* |
| MultiHop radio setting: Master | | | | | | | OFF | ON |
| MultiHop radio setting: Slave | | | | | | | ON | OFF |
| MultiHop radio setting: Reserved | | | | | | | ON | ON |

* Default configuration

Application Mode

The MultiHop radio operates in either Modbus mode or transparent mode. Use the internal DIP switches to select the mode of operation. All MultiHop radios within a wireless network must be in the same mode.

Modbus mode uses the Modbus protocol for routing packets. In Modbus mode, a routing table is stored in each parent device to optimize the radio traffic. This allows for point to point communication in a multiple data radio network and acknowledgement/retry of radio packets. To access a radio's I/O, the radios must be running in Modbus mode.

In transparent application mode, all incoming packets are stored, then broadcast to all connected data radios. The data communication is packet based and not specific to any protocol. The application layer is responsible for data integrity. For one to one data radios it is possible to enable broadcast acknowledgement of the data packets to provide better throughput. In transparent mode, there is no access to the radio's I/O.

Baud Rate and Parity

The baud rate (bits per second) is the data transmission rate between the device and whatever it is physically wired to. Set the parity to match the parity of the device you are wired to.

Disable Serial

If the local serial connection is not needed, disable it to reduce the power consumption of a data radio powered from the solar assembly or from batteries. All radio communications remain operational.

Receiver Slots

The number of receiver slots indicates the number of times out of 128 slots/frames the radio can transmit to its parent radio. Setting a slave's receiver slots to 4 reduces the total power consumption by establishing that the slave can only transmit to its parent four times per 128 slots.

Transmit Power Levels/Frame Size

The 900 MHz data radios can be operated at 1 watt (30 dBm) or 0.250 watt (24 dBm). For most models, the default transmit power is 1 watt.

For 2.4 GHz radios, the transmit power is fixed at 0.065 watt (18 dBm) and DIP switch 5 is used to set the frame timing. The default position (OFF) sets the frame timing to 60 milliseconds. To increase throughput, set the frame timing to 40 milliseconds. Note that increasing the throughput decreases the battery life.

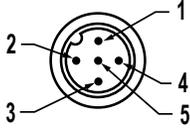
Prior to date code 15341 and radio firmware version 3.6, the frame timing was 40 ms (OFF) or 20 ms (ON).

Wiring Your Sure Cross® Device

Use the following wiring diagrams to first wire the sensors and then apply power to the Sure Cross devices.

Wiring Power and Ground

Connecting dc power to the communication pins will cause permanent damage. For FlexPower devices, do not apply more than 5.5 V to the gray wire. The FlexPower MultiHop radios operate equally well when powered from the brown or gray wire; it is not necessary to supply both. The power for the sensors can be supplied by the radio's SPx terminals or from the 10 to 30 V dc used to power the radio.

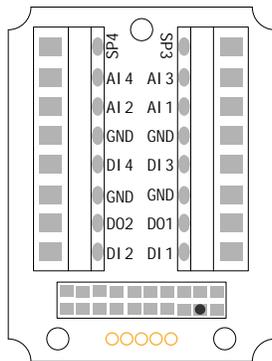
| 5-pin M12/Euro-style Male Connector | Pin | Wire Color | Wiring Description |
|-----------------------------------------------------------------------------------|-----|------------|---------------------|
|  | 1 | Brown | 10 to 30 V dc |
| | 2 | White | RS-485 / D1 / B / + |
| | 3 | Blue | dc common (GND) |
| | 4 | Black | RS-485 / D0 / A / - |
| | 5 | Gray | 3.6 to 5.5 V dc |

Wiring for DX80...M-HxC Models for Power and Ground

Connecting dc power to the communication pins will cause permanent damage. For FlexPower devices, do not apply more than 5.5 V to the gray wire. The FlexPower MultiHop radios operate equally well when powered from the brown or gray wire; it is not necessary to supply both. The power for the sensors can be supplied by the radio's SPx terminals or from the 10 to 30 V dc used to power the radio.

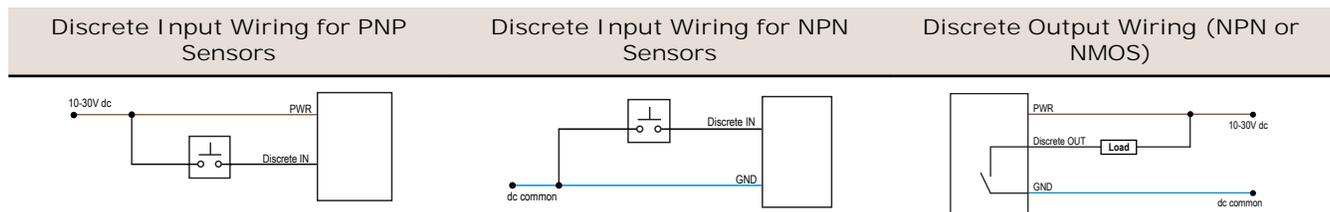
| Terminal | Wiring Description |
|----------|---------------------|
| V+ | 10 to 30 V dc |
| Tx/+ | RS-485 / D1 / B / + |
| V- | dc common (GND) |
| Rx/- | RS-485 / D0 / A / - |
| B+ | 3.6 to 5.5 V dc |

Terminal Blocks (M-H5)



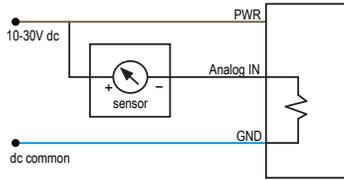
- AIx or Ax. Analog IN x
- DIx. Discrete IN x
- DOx. Discrete OUT x
- GND. Ground/dc common connection
- SPx. Switch Power; provides variable power sources for external devices
- B+. 3.6 to 5.5 V dc (use for battery powered models only)
- PWR. 10 to 30 V dc power connection
- RX/-. Serial communication line for the Gateway. No connection for Nodes
- TX/+. Serial communication line for the Gateway; no connection for Nodes

Connecting dc power to the communication pins will cause permanent damage. For the DX8x...C models, PWR in the wiring diagram refers to V+ on the wiring board and GND in the wiring diagram refers to V- on the wiring board. To power the sensor using the switch power output (SPx), replace the PWR with SPx in these wiring diagrams. Refer to the Class I Division 2/Zone 2 control drawings (p/n [143086](#)) for wiring specifications or limitations.

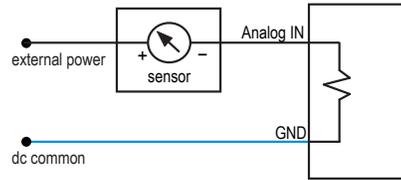


Do not exceed analog input ratings for analog inputs. Only connect sensor outputs to analog inputs.

Analog Input Wiring (10–30 V dc Power)



Analog Input Wiring (4–20 mA, 2-Wire, Externally-Powered Sensors)



Set the MultiHop Radio (Slave) ID

On a MultiHop radio, use the rotary dials to set the device's MultiHop Radio ID.

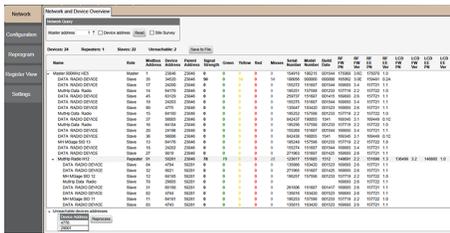
Modbus Slave IDs 01 through 10 are reserved for slaves directly connected to the host (local I/O). Polling messages addressed to these devices are not relayed over the wireless link. Use Modbus Slave IDs 11 through 60 for MultiHop master, repeater, and slave radios. Up to 50 devices (local slaves and remote slaves) may be used in this system.



With the left dial acting as the left digit and the right dial acting as the right digit, the MultiHop Radio ID can be set from 01 through 60.

MultiHop Configuration Tool

Use Banner's MultiHop Configuration Tool software to view your MultiHop radio network and configure the radio and its I/O.



The MultiHop Configuration Tool connects to a MultiHop master radio using one of four methods.

- Serial; using a USB to RS-485 (for RS-485 radios) or a USB to RS-232 (for RS-232 radios) converter cable.
- Modbus TCP; using an Ethernet connection to an Ethernet radio master.
- Serial DXM; using a USB cable to a DXM controller to access a MultiHop master radio.
- TCP DXM; using an Ethernet connection to a DXM controller to access a MultiHop master radio.

For MultiHop DX80DR* models, Banner recommends using BWA-UCT-900, an RS-485 to USB adapter cable with a wall plug that can power your 1 Watt MultiHop radio while you are configuring it. The adapter cable is not required when connecting to a DXM controller.

Download the most recent revisions of the UCT software from Banner Engineering's website: <http://www.bannerengineering.com/wireless>.

Installing Your Sure Cross® Radios

Please refer to one of the following instruction manuals for details about successfully installing your wireless network components.

- MultiHop Data Radio Instruction Manual: [151317](#)

Modbus Registers

| Register (4xxxx) | Input # | Input Type | Units | I/O Range | | Holding Register Representation | | Terminal Block Labels |
|------------------|---------|---------------|-------|------------|------------|---------------------------------|-------------|-----------------------|
| | | | | Min. Value | Max. Value | Min. (Dec.) | Max. (Dec.) | |
| 1 | 1 | Discrete IN 1 | - | 0 | 1 | 0 | 1 | DI1 |
| 2 | 2 | Discrete IN 2 | - | 0 | 1 | 0 | 1 | DI2 |
| 3 | 3 | Discrete IN 3 | - | 0 | 1 | 0 | 1 | DI3 |
| 4 | 4 | Discrete IN 4 | - | 0 | 1 | 0 | 1 | DI4 |

| Register (4xxxx) | Input # | Input Type | Units | I/O Range | | Holding Register Representation | | Terminal Block Labels |
|------------------|---------|-------------|-------|------------|------------|---------------------------------|-------------|-----------------------|
| | | | | Min. Value | Max. Value | Min. (Dec.) | Max. (Dec.) | |
| 5 | 5 | Analog IN 1 | mA | 0.0 | 20.0 | 0 | 65535 | AI1 |
| 6 | 6 | Analog IN 2 | mA | 0.0 | 20.0 | 0 | 65535 | AI2 |
| 7 | 7 | Analog IN 3 | mA | 0.0 | 20.0 | 0 | 65535 | AI3 |
| 8 | 8 | Analog IN 4 | mA | 0.0 | 20.0 | 0 | 65535 | AI4 |

| Register (4xxxx) | Output # | Output Type | Units | I/O Range | | Holding Register Representation | | Terminal Block Labels |
|------------------|----------|----------------|-------|------------|------------|---------------------------------|-------------|-----------------------|
| | | | | Min. Value | Max. Value | Min. (Dec.) | Max. (Dec.) | |
| 501 | 1 | Discrete OUT 1 | - | 0 | 1 | 0 | 1 | DO1 |
| 502 | 2 | Discrete OUT 2 | - | 0 | 1 | 0 | 1 | DO2 |
| 503 | 3 | | | | | | | |
| 504 | 4 | | | | | | | |
| 505 | 5 | Switch Power 3 | | | | | | SP3 |
| 506 | 6 | Switch Power 4 | | | | | | SP4 |

Modbus Addressing Convention

All Modbus addresses refer to Modbus holding registers. When writing your own Modbus scripts, use the appropriate commands for interfacing to holding registers. Parameter description headings refer to addresses in the range of 40000 as is customary with Modbus convention.

Modbus Register Configuration

Change the factory default settings for the inputs, outputs, and device operations using the device Modbus registers. To change parameters, set the data radio network to Modbus mode and assign the data radio a valid Modbus slave ID.

Generic input or output parameters are grouped together based on the device input or output number: input 1, input 2, output 1 etc. Operation type specific parameters (discrete, counter, analog 4 to 20 mA) are grouped together based on the I/O type number: analog 1, analog 2, counter 1, etc. Not all inputs or outputs may be available for all models. To determine which specific I/O is available on your model, refer to the Modbus Input/Output Register Maps listed in the device's datasheet. For more information about registers, refer to the [MultiHop Product Manual](#) (p/n 151317).

Factory Default Configuration

Discrete Inputs (NPN)

| Enable | Sample | Boost Enable | Boost Warmup | Boost Voltage | Extended Input Read | NPN/PNP | Sample High | Sample Low |
|--------|--------|--------------|--------------|---------------|---------------------|---------|-------------|------------|
| ON | 40 ms | OFF | OFF | OFF | OFF | NPN | OFF | OFF |

Analog Inputs

| Enable | Sample | Boost Enable | Boost Warmup | Boost Voltage | Extended Input Read | Analog Max | Analog Min | Enable Fullscale |
|--------|--------|--------------|--------------|---------------|---------------------|------------|------------|------------------|
| ON | 1 sec | OFF | OFF | OFF | OFF | 20000 | 0 | ON |

Discrete Outputs

| Enable | Flash Enable |
|--------|--------------|
| ON | OFF |

Switch Power

| I/O Group | Continuous Voltage | Default Output Voltage | Hold Last Voltage Enable |
|--------------------|--------------------|------------------------|--------------------------|
| Switch Power (all) | 0 | 0 | OFF |

Included with Model

The following items ship with the DX80 radios.

- BWA-HW-002: DX80 Access Hardware Kit, containing four PG-7 plastic threaded plugs, four PG-7 nylon gland fittings, four PG-7 hex nuts, one 1/2-inch NPT plug, and one 1/2-inch nylon gland fitting. (Not included with IP20 DX80...C models)
- BWA-HW-001: Mounting Hardware Kit, containing four M5-0.8 x 25mm SS screws, four M5-0.8 x 16mm SS screws, four M5-0.8mm SS hex nuts, and four #8-32 x 3/4" SS bolts
- BWA-HW-003: PTFE tape
- BWA-902-C (900 MHz) or BWA-202-C (2.4 GHz): Antenna, 2 dBd Omni, Rubber Swivel RP-SMA Male. (Not included with Internal antenna models)
- Quick Start Guide (128185 for DX80 Gateways or 152653 for MultiHop models)
- MQDC1-506: 5-Euro (single ended) straight cable, 2m (Not included with FlexPower devices)
- BWA-HW-011: IP20 Screw Terminal Headers (2 pack) (Included only with the IP20 DX80...C models)

Specifications

Radio Range¹

900 MHz, 1 Watt: Up to 9.6 km (6 miles)
2.4 GHz, 65 mW: Up to 3.2 km (2 miles)

Minimum Separation Distance

900 MHz, 1 Watt: 4.57 m (15 ft)
2.4 GHz, 65 mW: 0.3 m (1 ft)

Radio Transmit Power

900 MHz, 1 Watt: 30 dBm (1 W) conducted (up to 36 dBm EIRP)
2.4 GHz, 65 mW: 18 dBm (65 mW) conducted, less than or equal to 20 dBm (100 mW) EIRP

Spread Spectrum Technology

FHSS (Frequency Hopping Spread Spectrum)

900 MHz Compliance (1 Watt)

FCC ID UE3RM1809: This device complies with FCC Part 15, Subpart C, 15.247
IC: 7044A-RM1809

2.4 GHz Compliance (MultiHop)

FCC ID UE300DX80-2400 - This device complies with FCC Part 15, Subpart C, 15.247
ETSI EN 300 328: V1.8.1 (2012-04)
IC: 7044A-DX8024

Communication Hardware (MultiHop RS-485)

Interface: 2-wire half-duplex RS-485
Baud rates: 9.6k, 19.2k (default), or 38.4k via DIP switches; 1200 and 2400 via the MultiHop Configuration Tool
Data format: 8 data bits, no parity, 1 stop bit

Packet Size (MultiHop)

900 MHz: 175 bytes (85 Modbus registers)
2.4 GHz: 75 bytes (37 Modbus registers)

Discrete Inputs

Rating: 3 mA max current at 30 V dc
Sample Rate: 40 milliseconds
ON Condition (NPN): Less than 0.7 V
OFF Condition (NPN): Greater than 2 V or open

Analog Inputs

Rating: 24 mA
Impedance: Approximately 22 Ohms³
Sample Rate: 1 second
Accuracy: 0.1% of full scale +0.01% per °C
Resolution: 12-bit

Supply Voltage

10 to 30 V dc (Outside the USA: 12 to 24 V dc, ±10%) on the brown wire, or 3.6 to 5.5 V dc low power option on the gray wire²

Power Consumption

Master radio consumption (900 MHz): Maximum current draw is < 100 mA and typical current draw is < 30 mA at 24 V dc. (2.4 GHz consumption is less.)
Repeater/slave radio consumption (900 MHz): Maximum current draw is < 40 mA and typical current draw is < 20 mA at 24 V dc. (2.4 GHz consumption is less.)

Wiring Access

Four PG-7, One 1/2-inch NPT, One 5-pin threaded M12/Euro-style male quick disconnect

Housing

Polycarbonate housing and rotary dial cover; polyester labels; EDPM rubber cover gasket; nitrile rubber, non-sulphur cured button covers
Weight: 0.26 kg (0.57 lbs)
Mounting: #10 or M5 (SS M5 hardware included)
Max. Tightening Torque: 0.56 N·m (5 lbf·in)

Interface

Indicators: Two bi-color LEDs
Buttons: Two
Display: Six character LCD

Antenna Connection

Ext. Reverse Polarity SMA, 50 Ohms
Max Tightening Torque: 0.45 N·m (4 lbf·in)

Intercharacter Timing (MultiHop)

3.5 milliseconds

Discrete Outputs

ON Condition: Less than 0.7 V
OFF Condition: Open

Discrete Output Rating (MultiHop NMOS)

Less than 1 A max current at 30 V dc
ON-State Saturation: Less than 0.7 V at 20 mA

Environmental Rating

IEC IP67; NEMA 6⁴

¹ Radio range is with the 2 dB antenna that ships with the product. High-gain antennas are available, but the range depends on the environment and line of sight. Always verify your wireless network's range by performing a Site Survey.

² For European applications, power this device from a Limited Power Source as defined in EN 60950-1.

³ To verify the analog input's impedance, use an Ohm meter to measure the resistance between the analog input terminal (AIx) and the ground (GND) terminal.

⁴ Refer to the *Sure Cross® MultiHop Product Instruction Manual* (p/n 151317) for installation and waterproofing instructions.

Operating Conditions⁵

–40 °C to +85 °C (–40 °F to +185 °F) (Electronics); –20 °C to +80 °C (–4 °F to +176 °F) (LCD)
 95% maximum relative humidity (non-condensing)
 Radiated Immunity: 10 V/m (EN 61000-4-3)

Shock and Vibration

IEC 68-2-6 and IEC 68-2-27
 Shock: 30g, 11 millisecond half sine wave, 18 shocks
 Vibration: 0.5 mm p-p, 10 to 60 Hz

Certifications



Certifications for DX8x...C (External Wiring Terminal) and DX8x...E Models



CSA: Class I Division 2 Groups ABCD, Class I Zone 2 AEx/Ex nA II T4
 — Certificate: 1921239



ATEX: II 3 G Ex nA IIC T4 Gc (Group IIC Zone 2) — Certificate LCIE
 10 ATEX 1012 X

Refer to the Class I Division 2/Zone 2 control drawings (p/n [143086](#)) for wiring specifications or limitations. All battery-powered devices must only use the lithium battery manufactured by Xeno, model XL-205F.

Required Overcurrent Protection



WARNING: Electrical connections must be made by qualified personnel in accordance with local and national electrical codes and regulations.

Overcurrent protection is required to be provided by end product application per the supplied table.

Overcurrent protection may be provided with external fusing or via Current Limiting, Class 2 Power Supply.

Supply wiring leads < 24 AWG shall not be spliced.

For additional product support, go to <http://www.bannerengineering.com>.

| Supply Wiring (AWG) | Required Overcurrent Protection (Amps) |
|---------------------|----------------------------------------|
| 20 | 5.0 |
| 22 | 3.0 |
| 24 | 2.0 |
| 26 | 1.0 |
| 28 | 0.8 |
| 30 | 0.5 |

Warnings

Install and properly ground a qualified surge suppressor when installing a remote antenna system. Remote antenna configurations installed without surge suppressors invalidate the manufacturer's warranty. Keep the ground wire as short as possible and make all ground connections to a single-point ground system to ensure no ground loops are created. No surge suppressor can absorb all lightning strikes; do not touch the Sure Cross® device or any equipment connected to the Sure Cross device during a thunderstorm.

Exporting Sure Cross® Radios. It is our intent to fully comply with all national and regional regulations regarding radio frequency emissions. Customers who want to re-export this product to a country other than that to which it was sold must ensure the device is approved in the destination country. A list of approved countries appears in the *Radio Certifications* section of the product manual. The Sure Cross wireless products were certified for use in these countries using the antenna that ships with the product. When using other antennas, verify you are not exceeding the transmit power levels allowed by local governing agencies. Consult with Banner Engineering Corp. if the destination country is not on this list.

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Banner Engineering Corp. reserves the right to change, modify or improve the design of the product without assuming any obligations or liabilities relating to any product previously manufactured by Banner Engineering Corp.

⁵ Operating the devices at the maximum operating conditions for extended periods can shorten the life of the device.