

# SureCross MultiHop Radio

Configurable MultiHop Radio with discrete and analog I/O



SureCross® 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 sourcing discrete inputs, four sourcing discrete outputs, two 0 to 20 mA analog inputs, and two 0 to 20 mA analog outputs
- Selectable transmit power levels of 250 mW or 1 Watt and license-free operation up to 4 watt EIRP, with a high-gain antenna, in the U.S. and Canada for 900 MHz
- 10 to 30V dc power input
- 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; selectable network IDs reduce interference from collocated networks

For additional information, the most recent version of all documentation, and a complete list of accessories, refer to Banner Engineering's website, [www.bannerengineering.com/surecross](http://www.bannerengineering.com/surecross).

Models	Frequency	Transmit Power	I/O
DX80DR9M-H2	900 MHz ISM Band	250 mW or 1 Watt (DIP switch selectable)	<b>Inputs:</b> Four sourcing discrete, two 0 to 20 mA analog <b>Outputs:</b> Four sourcing discrete, two 0 to 20 mA analog <b>Serial interface:</b> RS-485
DX80DR2M-H2	2.4 GHz ISM Band	65 mW (100 mW EIRP)	



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-H2C.



### 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.



### Important: Never Operate 1 Watt Radios Without Antennas.

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

## MultiHop Radio Overview

MultiHop networks are made up of one master radio and many repeater and slave radios.

The MultiHop networks are self-forming and self-healing networks constructed around a parent-child communication relationship. The MultiHop Radio architecture creates a hierarchical network of devices to solve the most challenging wireless applications. A MultiHop Radio is either a master radio, a repeater radio, or a slave radio.

- The single master device controls the overall wireless network.
- The repeater mode allows for range extension of the wireless network.

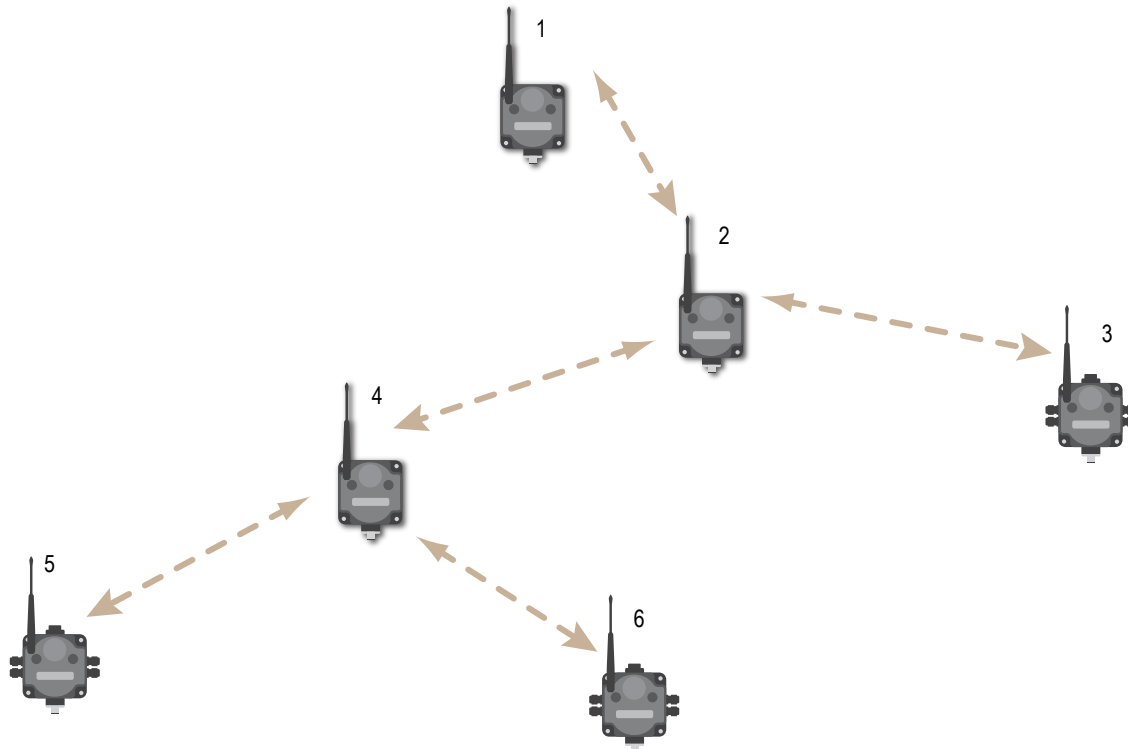


- The slave radios are the end point of the wireless network.

At the root of the wireless network is the master radio. All repeater or slave radios within range of the master radio connect as children of the master radio, which serves as their parent. After repeater radios synchronize to the master radio, additional radios within range of the repeater can join the network. The radios that synchronize to the repeater radio form the same parent/child relationship the repeater has with the master radio: the repeater is the parent and the new radios are children of the repeater.

The network formation continues to build the hierarchical structure until all MultiHop radios connect to a parent radio. A MultiHop radio can only have one designated parent radio. If a radio loses synchronization to the wireless network it may reconnect to the network through a different parent radio.

For the simple example network shown below, the following relationships exist:



- Radio 1 is the master radio and is parent to radio 2 (repeater).
- Radio 2 (repeater) is child to radio 1 (master), but is parent to radios 3 (slave) and 4 (repeater).
- Radio 4 (repeater) is child to radio 2 (repeater), but is parent to radios 5 and 6 (both slaves).

On the LCD of each device, the parent device address (PADR) and local device address (DADR) are shown.

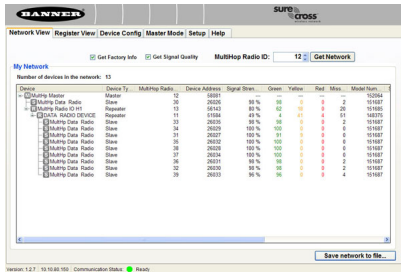
**MultiHop Master Radio.** Within a network of MultiHop data radios, there is only one master radio. The master radio controls the overall timing of the network and is always the parent device for other MultiHop radios. The host system connects to this master radio.

**MultiHop Repeater Radio.** When a MultiHop radio is set to repeater mode, it acts as both a parent and a child. The repeater receives data packets from its parent, then re-transmits the data packet to the children within the repeater's network. The incoming packet of information is re-transmitted on both the radio link and the local serial link.

**MultiHop Slave Radio.** The slave radio is the end device of the MultiHop radio network. A radio in slave mode does not re-transmit the data packet on the radio link, only on the local serial (wired) bus.

## 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 requires that you connect your master radio to your computer using either a USB to RS-485 (for RS-485 radios) or a USB to RS-232 (for RS-232 radios) converter cable. For RS-485 models, Banner recommends using cable model 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.

If you use an adapter cable that does not also supply 10-30V dc to your radio, use the DIP switches to set the MultiHop Radio to transmit at 250 mW.

When the MultiHop Configuration Tool launches, it automatically checks to see if a newer version of the software is available. If a newer version is available, a dialog box displays on the screen to ask you if you want to download the new version or ignore the new version. If you select download, the newer version automatically downloads, installs, and relaunches the program for you.

## 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. For binding instructions, refer to the 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. For site survey instructions, refer to the product manual.
8. Install your wireless sensor network components. For installation instructions, 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 Radio Quick Start Guide: [152653](#)
- MultiHop Radio Product Manual: [151317](#)
- MultiHop Register Guide (End User Edition): [155289](#)

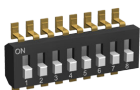
## Configuring the DIP Switches

Before making any changes to the DIP switch positions, disconnect the power. For devices with batteries integrated into the housing, remove the battery for at least one minute. 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. For integrated battery models (no ribbon cable) and Class I, Division 2 certified devices (ribbon cable is glued down), skip this step.
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)

Switches								
Device Settings	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				
900 MHz: 1.00 Watt (30 dBm) transmit power ** 2.4 GHz models: 40 ms frame					OFF*			
900 MHz: 0.25 Watts (24 dBm) transmit power ** 2.4 GHz models: 20 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

\*\* For 2.4 GHz radios, the transmit power is fixed at 0.065 Watts (18 dBm). DIP switch 5 is used instead to set the frame timing.

### 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

Use the DIP switches to select the baud rate and the parity. The options for baud rate are: 19200, 38400, or 9600. For parity, select None, Even, or Odd.

### 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.

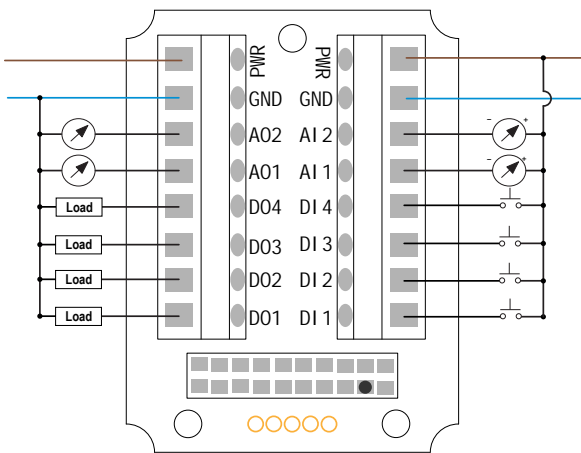
For 2.4 GHz radios, the transmit power is fixed at 0.065 watt (18 dBm) and DIP switch 5 is used to set the frame timing. The default position (OFF) sets the frame timing to 40 milliseconds. To increase throughput, set the frame timing to 20 milliseconds. Note that increasing the throughput decreases the battery life.

### Wiring Your SureCross® Device

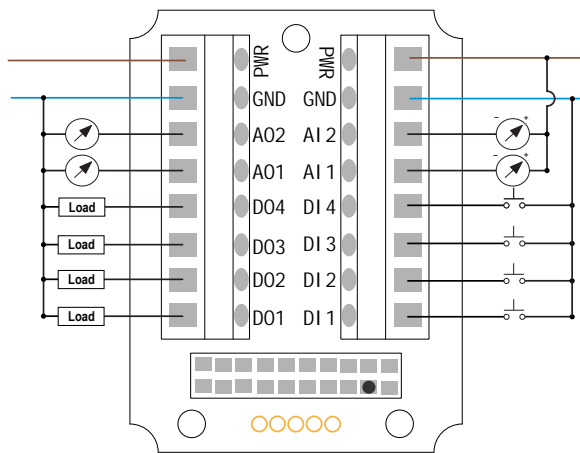
Use the following wiring diagrams to first wire the sensors and then apply power to the SureCross devices.

#### Wiring Diagrams (IP67 Models)

##### Discrete Input Wiring for PNP Sensors



##### Discrete Input Wiring for NPN Sensors



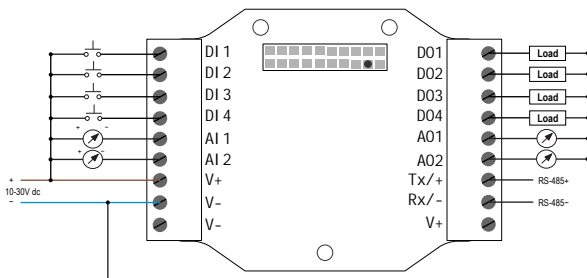
AIx or Ax. Analog IN x.  
AOx. Analog OUT x.  
DIx. Discrete IN x.

DOx. Discrete OUT x.  
GND. Ground/dc common connection.  
PWR. Power, 10 to 30V dc power connection.

#### Wiring Diagrams (IP20 Models)

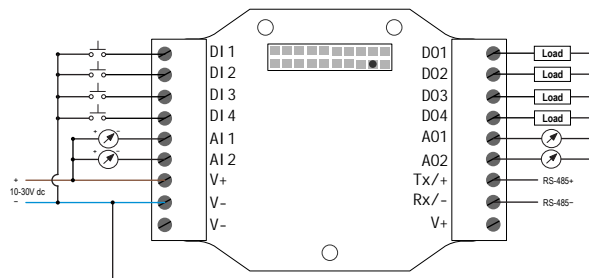
Connecting dc power to the communication pins will cause permanent damage.

##### PNP Discrete Inputs



AIx or Ax. Analog IN x.  
AOx. Analog OUT x.  
DIx. Discrete IN x.

##### NPN Discrete Inputs



PWR. Power, 10 to 30V dc power connection.  
RX/-. Serial comms line  
TX/+. Serial comms line

DOx. Discrete OUT x.

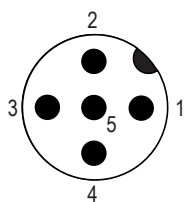
GND. Ground/dc common connection.

V+. Power, 10 to 30V dc power connection.

V-. Ground/dc common connection.

### Wiring for RS-485 MultiHop Radios

Connecting dc power to the communication pins will cause permanent damage. For FlexPower devices, do not apply more than 5.5V 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 30V dc used to power the radio.

	Wire No.	Wire Color	10 to 30V dc (RS-485)	FlexPower (RS-485)
	1	Brown	10 to 30V dc	10 to 30V dc
	2	White	RS-485 / D1 / B / +	RS-485 / D1 / B / +
	3	Blue	dc common (GND)	dc common (GND)
	4	Black	RS-485 / D0 / A / -	RS-485 / D0 / A / -
	5	Gray	-	3.6 to 5.5V dc

### Wiring for DX80...M-HxC RS-485 MultiHop Models

Connecting dc power to the communication pins will cause permanent damage. For FlexPower devices, do not apply more than 5.5V 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 30V dc used to power the radio.

Wire No.	10 to 30V dc (RS-485)	FlexPower (RS-485)
V+	10 to 30V dc	10 to 30V dc
Tx/+	RS-485 / D1 / B / +	RS-485 / D1 / B / +
V-	dc common (GND)	dc common (GND)
Rx/-	RS-485 / D0 / A / -	RS-485 / D0 / A / -
B+	-	3.6 to 5.5V dc

### 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 61 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 61.

### Modbus Register Table

#### Inputs

Register (4xxx)	Input #	I/O 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

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

### Outputs

Register (4xxxx)	Output #	I/O 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	Discrete OUT 3	-	0	1	0	1	DO3
504	4	Discrete OUT 4	-	0	1	0	1	DO4
505	5	Analog OUT 1	mA	0.0	20.0	0	65535	AO1
506	6	Analog OUT 2	mA	0.0	20.0	0	65535	AO2

### 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. (Because Modbus numbering begins at 1, users need to subtract 1 from the register address given to form the numeric value entered into the “address” field of the Modbus RTU protocol command string.) Parameter description headings refer to addresses in the range of 40000 as is customary with Modbus convention.

### Modbus Register Configuration

The factory default settings for the inputs, outputs, and device operations can be changed by the user through the device Modbus registers.

To change parameters, the data radio network must be set to Modbus mode and the data radio must be assigned 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 data sheet.

**For more information about registers, refer to the MultiHop Product Manual, Banner part number 151317.**

### Factory Default Configuration

#### Discrete Inputs (PNP)

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

## Analog Inputs

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

## Discrete Outputs

Enable	Flash Enable
ON	OFF

## Analog Outputs

Enable	Analog Max	Analog Min	Enable Fullscale	Hold Last State Enable	Default Output State
ON	20000	0	ON	OFF	0

## Specifications

Radio	General
<p><b>Radio Range</b>            900 MHz: Up to 9.6 kilometers (6 miles) *            2.4 GHz: Up to 3.2 kilometers (2 miles) *</p> <p><b>Radio Transmit Power</b>            900 MHz: 30 dBm conducted (up to 36 dBm EIRP)            2.4 GHz: 18 dBm conducted, less than or equal to 20 dBm EIRP</p> <p><b>900 MHz Compliance (1 Watt Radios)</b>            FCC ID UE3RM1809: This device complies with FCC Part 15, Subpart C, 15.247            IC: 7044A-RM1809</p> <p><b>2.4 GHz Compliance</b>            FCC ID UE300DX80-2400 - This device complies with FCC Part 15, Subpart C, 15.247            ETSI/EN: In accordance with EN 300 328: V1.7.1 (2006-05)            IC: 7044A-DX8024</p> <p><b>Spread Spectrum Technology</b>            FHSS (Frequency Hopping Spread Spectrum)</p> <p>* 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. To determine the range of your wireless network, perform a Site Survey.</p>	<p><b>Power*</b>            Requirements: +10 to 30V dc (For European applications: +10 to 24V dc, <math>\pm 10\%</math>). (See UL section below for any applicable UL specifications)            Master radio consumption (900 MHz): Maximum current draw is &lt;100 mA and typical current draw is &lt;30 mA at 24V dc. (2.4 GHz consumption is less.)            Repeater/slave radio consumption (900 MHz): Maximum current draw is &lt;40 mA and typical current draw is &lt;20 mA at 24V dc. (2.4 GHz consumption is less.)</p> <p><b>Housing</b>            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)</p> <p><b>Antenna Connection</b>            Ext. Reverse Polarity SMA, 50 Ohms            Max Tightening Torque: 0.45 N·m (4 lbf·in)</p> <p><b>Interface</b>            Indicators: Two bi-color LEDs            Buttons: Two            Display: Six character LCD</p> <p><b>Wiring Access</b>            M-Hx models: Four PG-7, One 1/2-inch NPT, One 5-pin Euro-style male connector            M-HxC models: External terminals</p> <p>* For European applications, power the DX80 from a Limited Power Source as defined in EN 60950-1.</p>

Notice: This equipment must be professionally installed. The output power must be limited, through the use of firmware or a hardware attenuator, when using high-gain antennas such that the +36 dBm EIRP limit is not exceeded.



Inputs	Outputs
<p><b>Discrete Inputs</b>            Rating: 3 mA max current at 30V dc            Sample Rate: 40 milliseconds</p> <p><b>Discrete Input ON Condition</b>            PNP: Greater than 8V            NPN: Less than 0.7V</p> <p><b>Discrete Input OFF Condition</b>            PNP: Less than 5V            NPN: Greater than 2V or open</p> <p><b>Analog Inputs</b>            Rating: 24 mA            Impedance: 100 Ohms            Sample Rate: 1 second            Accuracy: 0.1% of full scale +0.01% per °C            Resolution: 12-bit</p> <p>To verify the analog input's impedance, use an Ohm meter to measure the resistance between the analog input terminal (Alx) and the ground (GND) terminal.</p>	<p><b>Discrete Outputs</b>            Update Rate: 125 milliseconds            ON Condition: Supply minus 2V            OFF Condition: Less than 2V            Output State Following Timeout: OFF</p> <p><b>Discrete Output Rating (PNP)</b>            100 mA max current at 30V dc            ON-State Saturation: Less than 3V at 100 mA            OFF-state Leakage: Less than 10 µA</p> <p><b>Analog Outputs</b>            Update Rate: 125 milliseconds            Accuracy: 0.1% of full scale +0.01% per °C            Resolution: 12-bit</p>

Communication	Environmental
<p><b>Hardware (MultiHop RS-485)</b>            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</p> <p><b>Packet Size (MultiHop)</b>            900 MHz: 175 bytes (85 Modbus registers)            2.4 GHz: 125 bytes (60 Modbus registers)</p> <p><b>Intercharacter Timing (MultiHop)</b>            3.5 milliseconds</p>	<p><b>Ratings</b>            M-Hx models: IEC IP67; NEMA 6; (See UL section below for any applicable UL specifications)            M-HxC models: IEC IP20; NEMA 1</p> <p><b>Conditions</b>            Operating Temperature: -40 to +85° C (Electronics); -20 to +80° C (LCD)            Operating Humidity: 95% max. relative (non-condensing)            Radiated Immunity: 10 V/m, 80-2700 MHz (EN61000-6-2)</p> <p><b>Shock and Vibration</b>            IEC 68-2-6 and IEC 68-2-7            Shock: 30g, 11 millisecond half sine wave, 18 shocks            Vibration: 0.5 mm p-p, 10 to 60 Hz</p>

Refer to the SureCross® MultiHop product manual, Banner p/n 151317, for installation and waterproofing instructions. Operating the devices at the maximum operating conditions for extended periods can shorten the life of the device.

## Certifications



## 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)

## Warnings

The manufacturer does not take responsibility for the violation of any warning listed in this document.

**Make no modifications to this product.** Any modifications to this product not expressly approved by Banner Engineering could void the user's authority to operate the product. Contact the Factory for more information.

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