DXM150-Sx Wireless Modbus Slave

Instruction Manual

Original Instructions
195455 Rev. D
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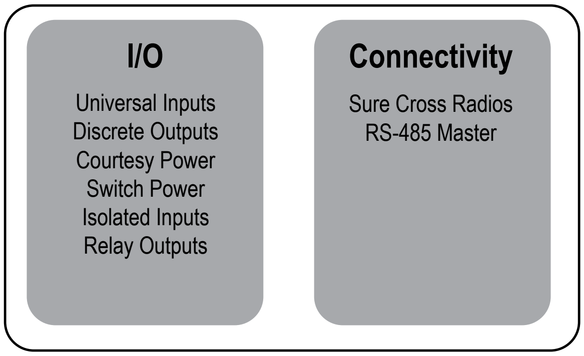
195455

Contents

1 System Overview

1.1 DXM150-S1 System Overview

Banner's DXM Logic Controller integrates Banner's wireless radio and local I/O for a remote I/O device.



Inputs/Outputs—On-board universal and programmable I/O ports connect to local sensors, indicators, and control equipment.

- Universal Inputs
- Discrete outputs
- Courtesy power
- Switch power
- Isolated inputs
- Relay outputs
- Battery backup
- Solar controller

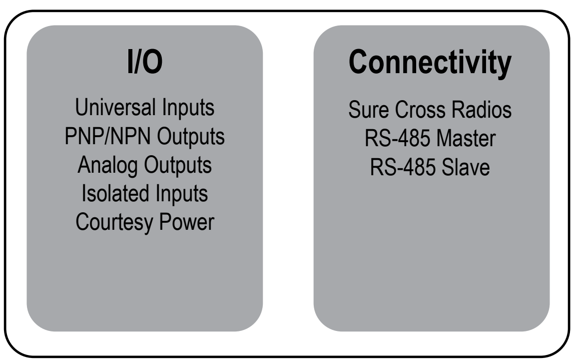
Connectivity—The integrated Sure Cross® wireless radio enables Modbus connectivity to remote sensors, indicators, and control equipment.

Wired Connectivity
Field Bus: Modbus RS-485 Master

Wireless Connectivity
Sure Cross MultiHop 900 MHz, or MultiHop 2.4 GHz

1.2 DXM150-S2 System Overview

Banner's DXM Logic Controller integrates Banner's wireless radio and local I/O for a remote I/O device.



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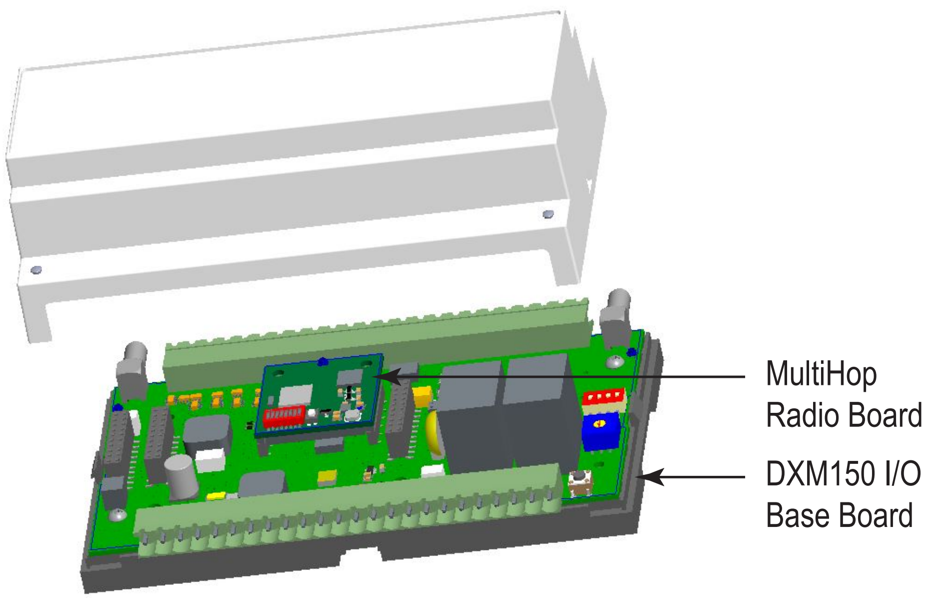
1.3 DXM150-Sx Hardware Configuration Overview

The DXM can have multiple configurations. The DXM will have a model number label on the housing. Use the model number and model table in the datasheet to identify which boards are included in the controller.

When opening the DXM, follow proper ESD grounding procedures.

Important:
- **Electrostatic discharge (ESD) sensitive device**
- ESD can damage the device. Damage from inappropriate handling is not covered by warranty.
- Use proper handling procedures to prevent ESD damage. Proper handling procedures include leaving devices in their anti-static packaging until ready for use; wearing anti-static wrist straps; and assembling units on a grounded, static-dissipative surface.

Figure 1. DXM150-Sx hardware



The DXM I/O base board provides connections for all inputs, outputs and power. The base board also contains a 12 V solar controller that accepts connections to a solar panel and sealed lead acid (SLA) battery. The battery connection can also be used with line power to provide a battery backup in case of line power outages.

The ISM radio fits on the I/O base board in the parallel sockets. Install the ISM radio so the U.FL antenna connection is to the side with the SMA antenna connectors. Connect the U.FL cable from the ISM radio U.FL to the right side U.FL connector. The ISM radio boards are available with either a 900 MHz (North America) or a 2.4 GHz (International) radio.

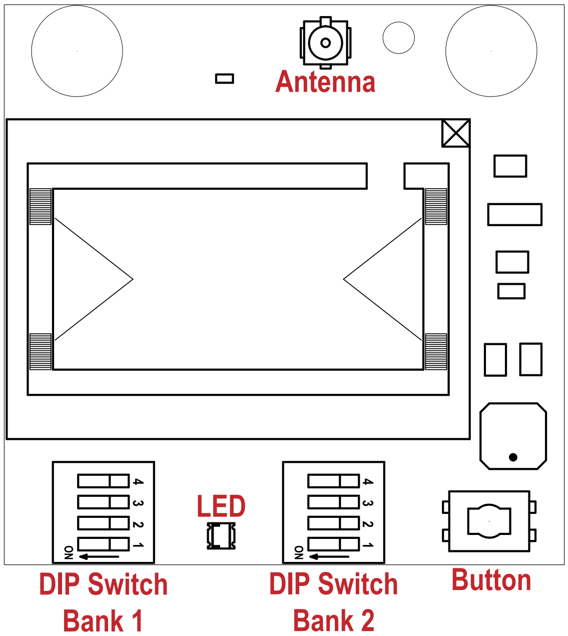
2 ISM Radio

2.1 ISM Radio Board (Slave ID 1)

Plug the ISM radio into the I/O base board with the U.FL antenna connector closest to the SMA connectors. Typically, users will not need to adjust the DIP switch settings on the physical radio modules.

For the DXM1200 models, set the radio options using the LCD menu.

Figure 2. ISM radio board



Button Operation

For DXM models without a LCD display, use the button to bind the ISM radio. For models with a LCD display, use the ISM menu to bind the radio.

LED Operation

The LED located on the ISM radio module indicates power and communications traffic. ISM board LED operations also display on the LED on the right side of the I/O base board.

- Solid green DX80 ISM radio LED indicates power.
- Flashing green MultiHop ISM radio LED indicates operation.
- Red and green combined: Communications traffic and binding.

2.2 DIP Switch Settings for the MultiHop HE5 Board Module

	D1 Switches				D2 Switches			
Device Settings	**1**	**2**	**3**	**4**	**1**	**2**	**3**	**4**
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				

	D1 Switches				D2 Switches			
Device Settings	**1**	**2**	**3**	**4**	**1**	**2**	**3**	**4**
Disable serial (low power mode) and enable the receiver slots select for switches 1-2			ON	ON				
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

2.2.1 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.

2.2.2 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.

2.2.3 Disable Serial

Disable an unused local serial connection to reduce the power consumption of a data radio powered from the solar assembly or from batteries. All radio communications remain operational.

2.2.4 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. For battery-powered devices, increasing the throughput decreases battery life.

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

2.3 Binding the ISM Radio of a Modbus Slave

A DXM (for example, model **DXM1x0-S*R2**) contains two boards: a MultiHop ISM radio and an I/O base board. Each board is a separate Modbus device and requires a unique Modbus ID.

- The ISM radio is not required to have a Modbus ID because there are no registers to manage, but it generally does have a Modbus ID assigned to it.
- The I/O board must have a Modbus ID to access the I/O register data and configuration data.

To bind the DXM (as either a repeater or slave radio) to its master radio, follow the MultiHop binding instructions. If the binding instructions are not included in the master radio datasheet, refer to the MultiHop Quick Start Guide (p/n 152653) or Instruction Manual (p/n 151317).

The ISM radio board's Modbus ID is assigned from the master radio during binding using the master radio's rotary dials or the DXM Controller's LCD Binding menu. For example, if the master's binding number is 25, the DXM Slave ISM radio's Modbus ID is set to 25.

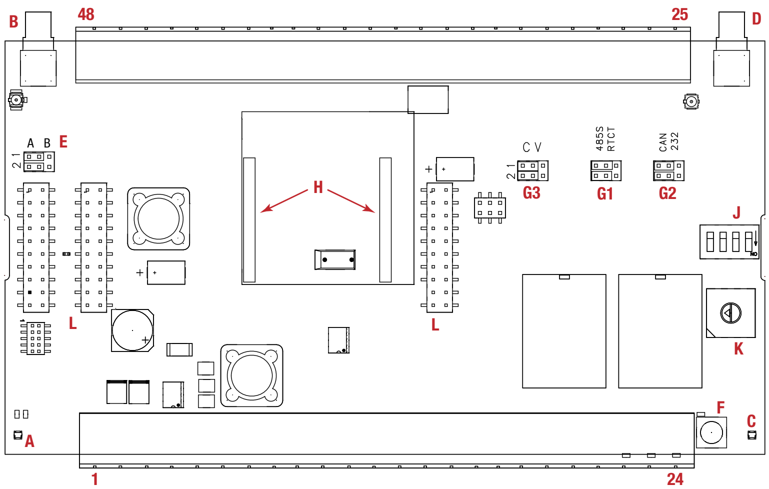
By default, the I/O board's Modbus ID is set to 11. To change the Modbus ID, use the I/O board DIP switches. For applications requiring Modbus IDs outside the range of the DIP switches, write a Modbus ID to a Modbus register on the I/O board. (See Setting the Modbus Slave ID on the I/O Base Board on page 16.)

Use the MultiHop Configuration Software to display and configure a MultiHop radio network. With the DXM, only the ISM radio displays on the Network View screen. The Modbus ID of the I/O board is a separate device that is not a part of the radio network. Although the I/O board does not show up in the Network View, it is accessible when using the Register View functions.

3 I/O Base Boards

3.1 Board Connections for the S1 Models

Figure 3. Board Connections

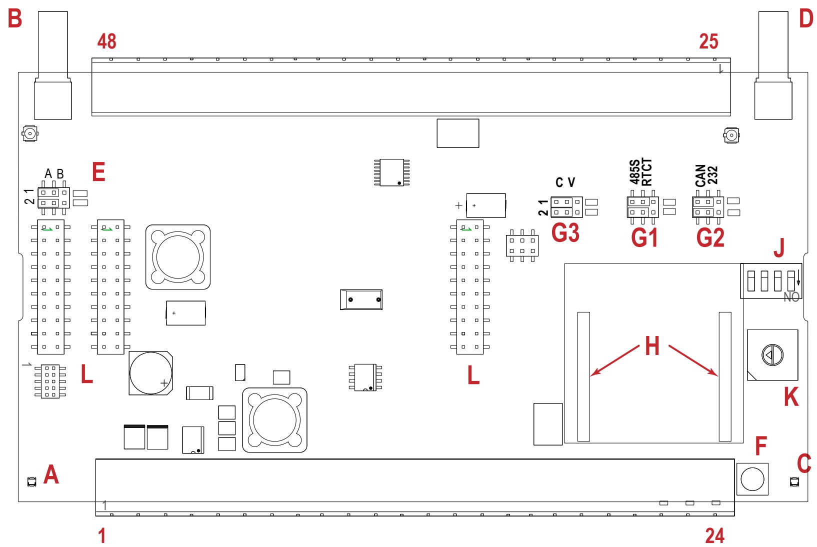


1	NC	17	Input 2B	33	Analog Output 1 (0 to 10 V)
2	12 to 30 V DC or solar power in (+)	18	Ground	34	Ground
3	Ground	19	Output 1 Normally Open	35	PWR Out - Jumper
4	Battery in (< 15 V dc) (must be a sealed lead acid battery)	20	Output 1 Common	36	Ground
5	Ground	21	Output 1 Normally Closed	37	Universal Input 8
6	Primary RS-485 –	22	Output 3 Normally Open	38	Universal Input 7
7	Primary RS-485 +	23	Output 3 Common	39	Universal Input 6
8	Ground	24	Output 3 Normally Closed	40	Universal Input 5
9	Not used	25	NMOS Output 5	41	Ground
10	Not used	26	No connection	42	Universal Input 4
11	Not used	27	NMOS Output 6	43	Universal Input 3
12	Not used	28	NMOS Output 7	44	Ground
13	Ground	29	No connection	45	PWR Out - Jumper
14	Input 1A	30	NMOS Output 8	46	Universal Input 2
15	Input 1B	31	Ground	47	Universal Input 1
16	Input 2A	32	Analog Output 2 (0 to 10 V)	48	Ground

A	Base Board LED	E	PWR Out Jumpers	G3	Analog Output Characteristics Jumpers (Jumper 1 sets analog out 1, jumper 2 sets analog out 2)
B	Not Used	F	Radio Binding Button	H	ISM Radio Connection
C	Radio LED	G1	Not Used	J	Modbus Slave ID DIP Switches
D	Radio Module Antenna	G2	Not Used	K	Rotary Dials
				L	SAM4 Processor Board Connection

3.2 Board Connections for the S2 Models

Figure 4. Board Connections



********* THIS IS THE TABLE FOR THE DXM150-B2. PLEASE MARK THIS UP FOR THE DXM150-S2. *********

1	NC	17	Input 2B	33	Analog Output 1 (0–20 mA or 0–10 V)
2	12 to 30 V DC or solar power in (+)	18	Ground	34	Ground
3	Ground	19	Output 1 PNP/NPN	35	PWR Out - Jumper
4	Battery in (< 15 V dc) (must be a sealed lead acid battery)	20	Output 2 PNP/NPN	36	Ground
5	Ground	21	Output 3 PNP/NPN	37	Universal Input 8
6	Primary RS-485 –	22	Output 4 PNP/NPN	38	Universal Input 7
7	Primary RS-485 +	23	PWR Out OR	39	Universal Input 6
8	Ground	24	Ground	40	Universal Input 5
9	RS-232 Tx / CAN	25	Ground	41	Ground
10	RS-232 Rx / CAN	26	PWR OUT OR	42	Universal Input 4
11	Secondary RS-485 – or RS-232 RXRDY	27	Output 8 PNP/NPN	43	Universal Input 3
12	Secondary RS-485 + or RS-232 TXRDY	28	Output 7 PNP/NPN	44	Ground
13	Ground	29	Output 6 PNP/NPN	45	PWR Out - Jumper
14	Input 1A	30	Output 5 PNP/NPN	46	Universal Input 2
15	Input 1B	31	Ground	47	Universal Input 1
16	Input 2A	32	Analog Output 2 (0–20 mA or 0–10 V)	48	Ground

A	Base Board LED	E	PWR Out Jumpers	G3	Analog Output Characteristics Jumpers (Jumper 1 sets analog out 1, jumper 2 sets analog out 2)
B	Cellular Antenna	F	Radio Binding Button	H	ISM Radio Connection

C	Radio LED	G1	RS-485 Jumpers	J	Modbus Slave ID DIP Switches
D	Radio Module Antenna	G2	RS-232 Jumpers	K	Rotary Dials
				L	SAM4 Processor Board Connection

3.3 DIP Switches for the I/O Board

The DXM150-Sx Wireless Modbus Slave I/O board DIP switches are set from the factory to Modbus Slave ID 11.

3.4 I/O Board Jumpers

Hardware jumpers on the DXM I/O board allow the user to select alternative pin operations. Turn the power off to the device before changing jumper positions.

Table 1: I/O board jumpers

Jumper	Function	Positions
E	Courtesy power output	Courtesy power outputs provide continuous power and cannot be turned on or off. Jumper 2 is the power jumper for pin 45. Jumper 1 is the power jumper for pin 35. • The pin 45 jumper selects 2.7 V when in the "a" position and 12 V battery in the "b" position. • The pin 35 jumper selects 4.2 V when in the "a" position and device power on pin 2 in the "b" position.
G1	RS-485 Modbus Slave or RS-232 Flow Control	Defines the operation of pins 11 and 12. Set the jumpers to use pins 11 and 12 as a secondary Modbus RS-485 slave port or flow control pins for the RS-232 port. Both jumpers must be set to the same operation, RS-485 Modbus Slave or Flow control. The default setting is RS-485.
G2	Generic RS-232 Serial Port or CAN Serial Port	Defines the operation of pins 9 and 10. Set the jumpers to use pins 9 and 10 as a CAN serial port or a generic RS-232 serial port. Both jumpers must be set to the same operation, CAN or RS232. The default setting is CAN serial port.
G3	Analog output characteristics for AO2 (pin 32) and AO1 (pin 33)	Defines current (0–20 mA) or voltage (0–10 V) for analog output 1 and 2. By default, current (0–20 mA) is selected using jumpers 1 and 2 and registers 4008 and 4028 contain a value of 2. To select voltage (0–10 V) for output Aout1, set jumper 1 in the voltage position (V) and set Modbus register 4008 on the I/O board (SID 200) to 3. To select voltage (0–10 V) for output Aout2, set jumper 2 in the voltage position (V) and set Modbus register 4028 on the I/O board (SID 200) to 3.

3.5 Applying Power to the S1 Model

Apply power using either 12 to 30 V DC or a 12 V DC solar panel and 12 V sealed lead acid battery.

Pin	Description
Pin 1	No connection
Pin 2	12 to 30 V DC input (+) or solar panel connection (+)
Pins 3, 5, 8, 13, 18, 31, 34, 36, 41, 44, 48	Main logic ground for the DXM150-S1
Pin 4	Solar or backup battery positive input. Battery voltage must be less than 15 V dc. Use only a sealed lead acid (SLA) battery.
Pin 35, Pin 45	These outputs are controlled by hardware jumpers. Jumper 2 is the power jumper for pin 45. Jumper 1 is the power jumper for pin 35. Refer to the wiring board for more information. • The pin 45 jumper selects 2.7 V when in the "a" position and 12 V battery in the "b" position. • The pin 35 jumper selects 4.2 V when in the "a" position and device power on pin 2 in the "b" position.

3.6 Applying Power to the B2 or S2 Models

Apply power using either 12 to 30 V DC or a 12 V DC solar panel and 12 V sealed lead acid battery.

Table 2: Power pins for the B2 and S2 models

Pin	Description
Pin 1	No connection
Pin 2	12 to 30 V DC input (+) or solar panel connection (+)
Pins 3, 5, 8, 13, 18, 31, 34, 36, 41, 44, and 48	Main logic ground for the DXM
Pin 4	Solar or backup battery positive input. Battery voltage must be less than 15 V DC. Use only a sealed lead acid (SLA) battery.
Pin 23, 26, 35, and 45	Courtesy power output, configuration based on jumper block E (see I/O Board Jumpers on page 10)

3.7 Supplying Power from a Solar Panel

To power the DXM150-Sx Wireless Modbus Slave from a 12 V dc solar panel, connect the solar panel to power pins 2(+) and 3(-). Connect a 12 V dc sealed lead acid (SLA) rechargeable battery to pins 4(+) and 5(-).

The factory default setting for the battery charging configuration assumes you are using 12 to 30 V DC power to recharge the battery. If the incoming power is from a solar panel, you must change the charging configuration.

The battery charging configuration defaults to a battery backup configuration. To change the charging configuration from the menu system:

1. From the DXM LCD menu, navigate to **System Config** > **I/O Board** > **Charger**.
2. Select **Solar** for solar panel configurations or **DC** for battery backup configurations.

To change the charging configuration by writing to Modbus register 6071 on the I/O base board (Slave ID 11):

1. Write a 0 to select the solar power charging configuration.

3.8 Connecting a Battery

When attaching a battery to the DXM as a backup battery or as a solar battery, verify the charging algorithm is set properly. The factory default setting for the battery charging algorithm assumes you are using 12 to 30 V DC to recharge the battery.

The charging algorithm is designed to work with a sealed lead acid (SLA) battery only.

- When using 12 to 30 V DC, connect the 12 to 30 V DC + to pin 2 and connect the ground to pin 3.
- When using main dc power with a back up battery (default configuration), connect the incoming main power pin 2 (+) and to pin 3 (-). Connect the 12 V sealed lead acid battery to pin 4 (+) and pin 5 (-). The incoming main power must be 15 to 30 V dc to charge the battery.

3.9 Connecting the Communication Pins

The base board communications connection for external Modbus device uses the primary RS-485.

RS-485. The primary RS-485 bus is a common bus shared with the ISM radio board (Modbus Slave ID 1).

RS-232. The RS-232 bus is not currently defined.

Pin	Parameter	Description
Pin 6	Primary RS-485 –	Use this bus to connect other Modbus Slave devices into the wireless network. Modbus Register 6101 = Baud Rate 0 = 19.2k 1 = 9600 2 = 38400 Modbus Register 6103 = Parity 0 = no parity 1 = odd 2 = even
Pin 7	Primary RS-485 +	

Pin	Parameter	Description
Pin 9	RS-232 Tx	Serial RS-232 connection. This bus must use a ground connection between devices to operate correctly.
Pin 10	RS-232 Rx	
Pin 13	Secondary RS-485 –	Not used
Pin 14	Secondary RS-485 +	
Pin 15	CANL –	
Pin 16	CANH +	

3.10 Inputs and Outputs

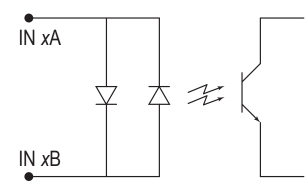
The I/O base board is a Modbus slave device that communicates using Modbus commands. Refer to the Modbus Registers section for more descriptions of each Modbus register on the DXM150-Sx Wireless Modbus Slave.

3.10.1 Isolated Discrete Inputs

The DXM has two (2) optically isolated inputs. The inputs signals are electrically isolated forming a barrier to protect the DXM from different ground potentials of the input signals.

Input 1 uses terminals 1A and 1B and the second input uses 2A and 2B. An input voltage should be applied between the terminals between 0 and 30 V DC, the on/off transition threshold is approximately 2.6 V.

Table 3: Isolated discrete input pins

Pin	Modbus Register	Input	Description	
Pin 14	501	Input 1A	Optically isolated AC input type, 0 to 12 to 30 V DC Input to output isolation of 2.5 kV	
Pin 15		Input 1B		
Pin 16	503	Input 2A		
Pin 17		Input 2B		

Synchronous Counters—An isolated input can be programmed to count the input signal transitions. When an input is enabled as a counter, the counter value is stored into two 16-bit Modbus registers for a total count of 32-bits (unsigned). To program an input to capture the edge transition counts, follow Example: Configure Input 1 as a Synchronous Counter on page 13.

The counters are synchronous because the inputs are sampled at a 10 ms clock rate. The input logic does not detect rising or falling edges, it samples the input every 10 ms to find level changes. The input signals must be high or low for more than 10 ms or the input will not detect transitions. Because most signals are not perfect, a realistic limit for the synchronous counter would be 30 to 40 Hz.

Universal inputs can also be configured as a synchronous counter. See Modbus Register Summary on page 16 for all the register definitions. The procedure for creating a synchronous counter is the same as a isolated input with the addition of changing the input type to PNP or NPN.

3.10.2 Universal Inputs

The universal inputs can be programmed to accept different types of inputs: discrete NPN/PNP, 0 to 20 mA analog, 0 to 10 V analog, 10k thermistor, potentiometer sense, bridge, and NPN raw fast. Use the DXM Configuration Software tool to write to the appropriate Modbus registers in the I/O board to configure the input type.

The universal inputs are treated as analog inputs. When the universal inputs are defined as mA, V, or temperature, use Modbus registers to configure the operational characteristics of the inputs. These parameters are temperature conversion type, enable full scale, threshold and hysteresis. See Modbus Register Summary on page 16 for the parameter definitions.

When a universal input is configured as an NPN or PNP input type, it can be enabled to be a synchronous counter. Enable the counter function by setting Modbus register 'Enable Rising' or 'Enable Falling' to 1. See Modbus Register Summary on page 16 for the universal input register definitions.

Table 4: Universal input pins

Pin	Univ. Input	Description
Pin 47	Universal Input 1	Program the universal inputs to accept input types NPN, PNP, 10k thermistor, 0 to 10 V, 0 to 20 mA, or potentiometer. The default setting is 8: NPN raw fast. To set the input type, write the following values to the Input Type Modbus registers. 0 = NPN 1 = PNP 2 = 0 to 20 mA 3 = 0 to 10 V DC 4 = 10k Thermistor 5 = Potentiometer Sense (DXM150 only) 6 = Not used 7 = Bridge 8 = NPN Raw Fast (default)
Pin 46	Universal Input 2	
Pin 43	Universal Input 3	
Pin 42	Universal Input 4	
Pin 40	Universal Input 5	
Pin 39	Universal Input 6	
Pin 38	Universal Input 7	
Pin 37	Universal Input 8	

Bridge Input

The bridge input is not implemented yet.

NPN vs NPN Raw Fast

The difference between NPN and NPN Raw Fast is the amount of settling time given to the input. Switch the input type to NPN if the input is not detecting a transition.

Potentiometer Sense (DXM150 only)

A potentiometer input is created from two inputs: a voltage source (pin 45) that supplies a voltage to the potentiometer and an input sense (Potentiometer Sense) to read the resistance. See Using Universal Inputs to Read a Potentiometer (p/n b_4462775) for more information.

Thermistor Input

A thermistor input must use a 10k thermistor between ground and the universal input. The thermistor must be a 10k NTC (Banner model number **BWA-THERMISTOR-002**) or equivalent. Select the temperature conversion of degrees C (default) or degrees F by writing to the Modbus registers defined in .

Example: Configure Input 1 as a Synchronous Counter

1. Connect the DXM to the PC.
2. Launch the DXM Configuration Software software.
3. Connect to the DXM by selecting the **Device** > **Connection Settings** menu option. You may connect using either USB or Ethernet.
4. Select a COMM port from the drop-down list and click **Connect**.
5. Click on the **Register View** tab on the left part of the page.
6. Change the **Source Register** selection to **I/O Board Registers**.
7. In the **Write Registers** area, write Modbus register 4908 to 1 to enable counting on the rising edge of the input signal.
8. Read Modbus registers 4910 and 4911 to get the 32-bit value of the count.

Example: Change Universal Input 2 to a 0 to 10 V dc Input

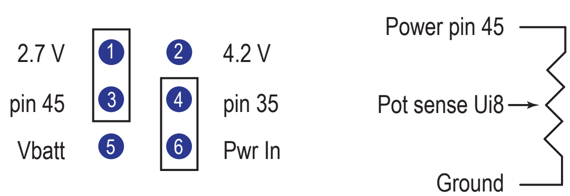
1. Connect the DXM to the PC.
2. Launch the DXM Configuration Software software.
3. Connect to the DXM by selecting the **Device** > **Connection Settings** menu option. You may connect using either USB or Ethernet.
4. Select a COMM port from the drop-down list and click **Connect**.
5. Click on the **Register View** tab on the left part of the page.
6. Change the **Source Register** selection to **I/O Board Registers**.
7. Write a 3 to Modbus register 3326 on Modbus Slave ID 11 (I/O board).
8. Cycle power to the device.
9. Using the **Register View** tab, read register 3326 to verify it is set to 3.

Example: Change Analog Output 1 to a 0 to 10 V dc Output

1. Connect the DXM to the PC.
2. Launch the DXM Configuration Software software.
3. Connect to the DXM by selecting the **Device** > **Connection Settings** menu option. You may connect using either USB or Ethernet.
4. Select a COMM port from the drop-down list and click **Connect**.
5. Click on the **Register View** tab on the left part of the page.
6. Change the **Source Register** selection to **I/O Board Registers**.
7. Set jumper 1 on the I/O base board to the 0 to 10 V position. Refer to the base board image for the analog output jumper position.
8. Write a 3 to Modbus register 4008 on Modbus Slave ID 11 (I/O board).
9. Cycle power to the device.
10. Using the **Register View** tab, read register 4008 to verify it is set to 3.

Example: Change Universal Input 8 to Read a Potentiometer Input

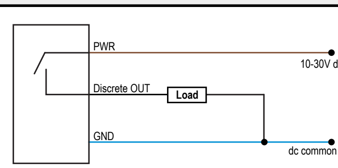
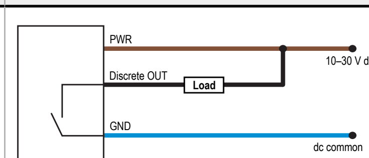
Figure 5. Default jumper position



1. Launch the DXM Configuration Software tool.
2. Click on the **Register View** tab on the left part of the page.
3. In the upper right part of the window select **Modbus Registers using Modbus Slave ID** radio button and enter Modbus Slave ID 11.
4. To set universal input 8 as the sense, write Modbus register 3446 with 5 (Potentiometer Sense).
5. Verify the jumpers are still set to their default position. One jumper should be on pins 1 and 3 to get a 2.7 V source voltage out pin 45. The default position of the other jumper is on pins 4 and 6.
6. Connect one potentiometer side to power output (pin 45), connect the tap point of the pot to universal input 8 (pin 37), and connect the other end of the pot to ground (pin 36).

3.10.3 PNP and NPN Outputs for the B2 and S2 Models

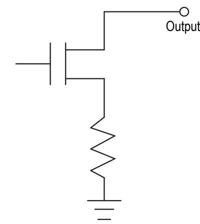
Table 5: Pins for the PNP/NPN outputs for the DXM150-B2, DXM1500-B2, and DXM150-S2 models

Pin	Output	Modbus Register	Description	PNP OUT Wiring	NPN OUT Wiring
19	1	501	PNP/NPN Output 1		
20	2	502	PNP/NPN Output 2		
21	3	503	PNP/NPN Output 3		
22	4	504	PNP/NPN Output 4		
30	5	505	PNP/NPN Output 5		
29	6	506	PNP/NPN Output 6		
28	7	507	PNP/NPN Output 7		
27	8	508	PNP/NPN Output 8		

The DXM150-B1, DXM1500-B1, and DXM150-S1 models do not have PNP/NPN outputs.

3.10.4 NMOS Outputs

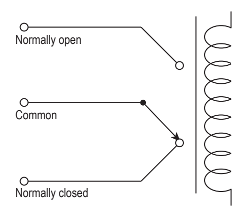
Table 6: Pins for the NMOS outputs for the DXM150-B1, DXM1500-B1, and DXM150-S1 models

Pin	Modbus Registers	Output	Description	Wiring
Pin 25	505	NMOS Discrete Outputs	Less than 1 A maximum current at 30 V DC ON-State Saturation: Less than 0.7 V at 20 mA ON Condition: Less than 0.7 V OFF Condition: Open	
Pin 27	506			
Pin 28	507			
Pin 30	508			

The DXM150-B2, DXM1500-B2, and DXM150-S2 models do not have NMOS outputs.

3.10.5 Relay Outputs for the DXM150-B1, 1500-B1, and 150-S1

Table 7: Relay output pins

Pin	Output	Description	Wiring
Pin 19	Output 1: Normally Open	SPDT (Form C) relay, 250 V AC, 16 A	
Pin 20	Output 1: Common		
Pin 21	Output 1: Normally Closed		
Pin 22	Output 3: Normally Open		
Pin 23	Output 3: Common		
Pin 24	Output 3: Normally Closed		

3.10.6 Analog Outputs (DAC)

The following characteristics are configurable for each of the analog outputs.

Table 8: Pins for the analog (DAC) outputs

Pin	Output	Description
Pin 33	Analog Output 1	0 to 20 mA or 0 to 10 V DC output (selectable using the Analog Output Characteristics Jumpers) Accuracy: 0.1% of full scale +0.01% per °C Resolution: 12-bit
Pin 32	Analog Output 2	

4 Additional Information

4.1 Setting the Modbus Slave ID on the I/O Base Board

Only DXM150-Sx and SxR2 Modbus Slave models require that the Modbus Slave ID to be adjusted on the I/O base board. The DXMs use DIP switch J and rotary dial K to set the Modbus slave ID. The device can use a Modbus register 6804 in the I/O board to access the full range of Modbus Slave IDs.

DIP Switch location J defines the course group of Modbus Slave IDs. DIP Switch 4 must be set to ON for DXM1*xx*-Sx and DXM1*xx*-SxR2 models. Use rotary dial K to select the lower digit of the Modbus Slave ID.

Table 9: Location J DIP Switches

Settings	Location J DIP Switches			
	1	2	3	4
Modbus Slave ID set to 11 through 19	OFF	OFF		
Modbus Slave ID set to 20 through 29	ON	OFF		
Modbus Slave ID set to 30 through 39	OFF	ON		
Modbus Slave ID set to 40 through 49	ON	ON		
Not Used			-	
Modbus Slave Configuration (S1 model only) [1]				ON
I2C Processor Communication				OFF

Use rotary dial location K and DIP switch location J to set the Modbus Slave IDs.

Table 10: Location K Rotary Dials — Position 0 through 9

DIP Switches J		Location K Rotary Dials — Position 0 through 9									
1	2	0	1	2	3	4	5	6	7	8	9
OFF	OFF	x [2]	11	12	13	14	15	16	17	18	19
ON	OFF	20	21	22	23	24	25	26	27	28	29
OFF	ON	30	31	32	33	34	35	36	37	38	39
ON	ON	40	41	42	43	44	45	46	47	48	49

Example to Set the DXM Modbus Slave ID using DIP Switches

To set the DXM to a Modbus Slave ID of 25, set the following:

Location J DIP switches set to: 1= ON, 2=OFF
Rotary dial set to 5

The DIP switch sets the upper digit of the slave ID to 2 while the rotary dial sets the lower digit to 5.

Example to Set the DXM I/O Board Modbus Slave ID using Modbus Registers

Write to the I/O board's Modbus register 6804 to set the Modbus Slave ID to any valid Modbus Slave ID (1 through 245).

- Rotary dial K should be in the zero position to use the Modbus register slave ID.

4.2 Modbus Register Summary

4.2.1 Modbus Registers

The DXM150-S1 and S2 devices can have two Modbus IDs: one for the MultiHop ISM radio (by default, set to 1) and one for the I/O base (by default, set to 11).

All Modbus registers are defined as 16-bit Modbus Holding Registers. When connecting additional Modbus slave devices, only use Modbus IDs 11 through 60. The master device can be expanded to use Modbus IDs 2 through 198 with modifications to the Master radio settings.

1 Must be in the ON position for the -S1 model)
2 Uses value in Modbus register 6804.

4.2.2 Modbus Registers for the -B1 and -S1 Model I/O Board

By default, the I/O board Modbus ID is 11.

Table 11: Base board input connection

Modbus Register	Description
1	Isolated discrete input 1 (1A and 1B)
2	Isolated discrete input 2 (2A and 2B)
3	Universal input 1
4	Universal input 2
5	Universal input 3
6	Universal input 4
7	Universal input 5
8	Universal input 6
9	Universal input 7
10	Universal input 8

Table 12: Base board output connection

Modbus Register	Description
501	Relay 1
502	Not used
503	Relay 2
504	Not used
505	NMOS Output 5
506	NMOS Output 6
507	NMOS Output 7
508	NMOS Output 8
509	DAC Output 1
510	DAC Output 2

4.2.3 Modbus Registers for the -B2 and -S2 I/O Board

By default, the I/O board Modbus ID is 11.

Table 13: Base board input connection

Modbus Register	Description
1	Optically isolated input 1
2	Optically isolated input 2
3	Universal input 1
4	Universal input 2
5	Universal input 3
6	Universal input 4
7	Universal input 5
8	Universal input 6
9	Universal input 7
10	Universal input 8

Table 14: Base board output connection

Modbus Register	Description
501	PNP/NPN Output 1
502	PNP/NPN Output 2
503	PNP/NPN Output 3
504	PNP/NPN Output 4
505	PNP/NPN Output 5
506	PNP/NPN Output 6
507	PNP/NPN Output 7
508	PNP/NPN Output 8
509	DAC Output 1
510	DAC Output 2

Table 15: Board output settings

Register	Description	Values	Register	Description
3704	Enable Discrete Output 1	0 = NPN; 1 = PNP	3705	Invert Output
3724	Enable Discrete Output 2	0 = NPN; 1 = PNP	3725	Invert Output
3744	Enable Discrete Output 3	0 = NPN; 1 = PNP	3745	Invert Output
3764	Enable Discrete Output 4	0 = NPN; 1 = PNP	3765	Invert Output
3784	Enable Discrete Output 5	0 = NPN; 1 = PNP	3785	Invert Output
3804	Enable Discrete Output 6	0 = NPN; 1 = PNP	3805	Invert Output
3824	Enable Discrete Output 7	0 = NPN; 1 = PNP	3825	Invert Output
3844	Enable Discrete Output 8	0 = NPN; 1 = PNP	3845	Invert Output

For example, to change between PNP/NPN outputs, set parameter register 3704 to 0 for NPN and 1 for PNP.

4.2.4 Modbus Configuration Registers for the Discrete and Universal Inputs

Modbus configuration registers are identified below. The configuration software creates a graphical view of the I/O board parameters. This allows for easy and quick configuration of the I/O board parameters.

For the DXM150-Bx models, use the DXM Configuration Software to configure the registers using the **Local Registers** > **Local Registers in Use** > **Edit Registers** screen.

For the DXM150-Sx models, a DXM Master radio is required to access the remote modbus slave device and configure the Discrete and Universal Inputs. Manually write to these modbus registers to set parameters or configure the input parameters using the **Configuration** > **Configure Device** > **Inputs** screen of the Multihop Configuration Software..

Table 16: Registers for isolated discrete input 1

Register	Isolated Discrete Input 1
3013	Enable rising edge counter
3014	Enable falling edge counter
3015	High register for counter
3016	Low register for counter

Table 17: Registers for isolated discrete input 2

Register	Isolated Discrete Input 2
3033	Enable rising edge counter
3034	Enable falling edge counter
3035	High register for counter
3036	Low register for counter

Table 18: Universal input parameter Modbus registers

Universal Inputs	1	2	3	4	5	6	7	8
Enable Full Scale	3303	3323	3343	3363	3383	3403	3423	3443
Temperature °C/°F	3304	3324	3344	3364	3384	3404	3424	3444
Input Type	3306	3326	3346	3366	3386	3406	3426	3446
Threshold	3308	3328	3348	3368	3388	3408	3428	3448
Hysteresis	3309	3329	3349	3369	3389	3409	3429	3449
Enable Rising	4908	4928	4948	4968	4988	5008	5028	5048
Enable Falling	4909	4929	4949	4969	4989	5009	5029	5049
High Register for Counter	4910	4930	4950	4970	4990	5010	5030	5050
Low Register for Counter	4911	4931	4951	4971	4991	5011	5031	5051

Table 19: Universal input register ranges

Register Types	Unit	Minimum Value	Maximum Value
Discrete input/output		0	1
Universal input 0 to 10 V	mV	0	10000 *
Universal input 0 to 20 mA	µA	0	20000 *
Universal input temperature (–40 °C to +85 °C)	C or F, signed, in tenths of a degree	–400	850
Universal potentiometer	unsigned	0	65535

* Setting Enable Full Scale to 1 sets the ranges to a linear scale of 0 to 65535.

4.2.5 Modbus Configuration Registers for the I/O (Definitions)

Enable Full Scale

Set to 1 to enable a linear range from 0 to 65535 for specified input range. For a 4 to 20 mA input, a value of 0 represents 4 mA and 65535 represents 20 mA. Set this parameter to 0 to store input readings in unit-specific data. For example, the register data representing a 15.53 mA reading is 15530. For units of current (0 to 20 mA inputs), values are stored as µA (micro Amps) and voltage values are stored as mV (millivolts).

Enable Rising/Falling

Use these registers to enable the universal input logic to count on a rising transition or a falling transition. Write a one (1) to enable; write a zero (0) to disable.

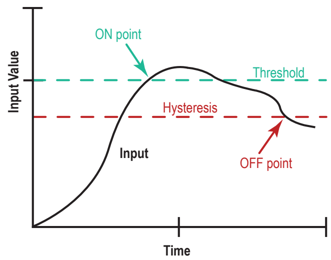
High/Low Register for Counter

The low and high registers for the counter hold the 32-bit counter value. To erase the counter, write zeroes to both registers. To preset a counter value, write that value to the appropriate register.

Hysteresis and Threshold

Threshold and hysteresis work together to establish the ON and OFF points of an analog input. The threshold defines a trigger point or reporting threshold (ON point) for a sensor input. When the input value is higher than the threshold, the input is ON. Hysteresis defines how far below the threshold the analog input is required to be before the input is considered OFF. A typical hysteresis value is 10% to 20% of the unit's range.

In the example shown, the input is considered on at 15 mA. To consider the input off at 13 mA, set the hysteresis to 2 mA. The input will be considered off when the value is 2 mA less than the threshold.



Input Type

Program the universal inputs to accept input types NPN, PNP, 10k thermistor, 0 to 10 V, 0 to 20 mA, or potentiometer. The default setting is 8: NPN raw fast. To set the input type, write the following values to the Input Type Modbus registers.

0 = NPN
1 = PNP
2 = 0 to 20 mA
3 = 0 to 10 V DC
4 = 10k Thermistor
5 = Potentiometer Sense (DXM150 only)
6 = Not used
7 = Bridge
8 = NPN Raw Fast (default)

Temperature °C/°F

Set to 1 to represent temperature units in degrees Fahrenheit, and set to 0 (default) to represent temperature units in degrees Celsius.

4.2.6 Modbus Configuration Registers for Power

To monitor the input power characteristics of the DXM, read the following power Modbus registers. The on-board thermistor is not calibrated, but can be used as a non-precision temperature input.

Table 20: Configuration registers for power

Modbus Register	Description
6071	Battery backup charging algorithm. 0 = Battery is recharged from a solar panel 1 = Battery is recharged from 12 to 30 V DC (default)
6081	Battery voltage (mV). If no battery is present, the value in this register is less than 5 V. If the value in this register is greater than the incoming voltage register, the battery is powering the system.
6082	Battery charging current (mA). The charging configuration charges the battery when the incoming voltage register value is greater than the battery voltage register value. This registers shows the charging current in milliamps.
6083	Incoming supply voltage (mV) (solar or power supply). The incoming power can be from a solar panel or from a power supply. The battery is charging when the incoming voltage register value is greater than the battery voltage register value. The battery is powering the system when the incoming voltage register value is less than the battery voltage register value.
6084	On-board thermistor temperature (ºC). A thermistor measures the temperature of the solar controller board and its surrounding area and uses the temperature as part of the battery charge calculations. This register stores the thermistor reading in tenths of degrees C. This is not a calibrated input: divide by 10 to calculate the temperature in degrees C. For calibrated temperature inputs, define one of the universal inputs as a temperature input.

4.3 Working with Solar Power

A reliable solar system requires careful planning and monitoring to size the components correctly. The recommendations provided are for the DXM system as an autonomous system.

Adding extra components increases the power requirements and likely requires increasing the solar system components. Depending upon the geographical location, the size of the solar panel and battery may vary.

4.3.1 Setting the DXM for Solar Power

By default, the DXM is set from the factory to charge a backup battery from a line power source.

For DXM models with an LCD, use the buttons and menu system to change the charging algorithm to solar power. Go to **System Config** > **I/O Board** > **Charger**. Use the up/down arrows to select **Solar**.

For DXM models without an LCD, use the configuration software to adjust the I/O board Modbus register 6071. Set the register to 0 to select battery charging from a solar panel, and set to 1 to select battery charging from incoming 12 to 30 V DC supply.

To minimize the power consumption (may not apply to all models):

- If Ethernet is not being used, save up to 25% of the consumed power by disabling Ethernet. Set DIP switch 1 to the ON position on the processor board then reboot.
- Instead of powering external devices all the time, take advantage of the switched power mechanisms to turn off devices when possible.
- Minimize the number of cellular transactions and the amount of data pushed across the cellular modem.

4.3.2 Solar Components

The components of a solar system include the battery and the solar panel.

Battery

The DXM solar controller is designed to use a 12 V sealed lead acid (SLA) battery. The characteristics of a solar system require the battery to be of a certain type. There are two types of lead acid batteries:

- SLI batteries (Starting Lights Ignition) designed for quick bursts of energy, like starting engines
- Deep Cycle batteries - greater long-term energy delivery. This is the best choice for a solar battery.

Since a solar system charges and discharges daily, a deep cycle battery is the best choice. There are different versions of a lead acid battery: wet cell (flooded), gel cell, and an absorbed glass mat (AGM).

Wet cell batteries are the original type of rechargeable battery and come in two styles, serviceable and maintenance free. Wet cell batteries typically require special attention to ventilation as well as periodic maintenance but are the lowest cost. The gel cell and AGM battery are sealed batteries that cost more but store very well and do not tend to sulfate or degrade as easily as a wet cell. Gel or AGM batteries are the safest lead acid batteries you can use.

Battery capacity is a function of the ambient temperature and the rate of discharge. Depending upon the specific battery, a battery operating at –30 °C can have as much as 40 percent less capacity than a battery operating at 20 °C. Choose enough battery capacity based on your geographical location.

Table 21: Average voltage readings relative to battery charge

State of Charge (%)	Open Circuit Voltage
100	13.0 or higher
75	12.6
50	12.1
25	11.66
0	11.4 or less

A larger capacity battery typically lasts longer for a given solar application because lead-acid batteries do not like deep cycling (discharging a large percentage of its capacity). Depending upon the battery, a battery discharging only 30 percent of its capacity before recharging will have approximately 1100 charge/discharge cycles. The same battery discharging 50 percent of its capacity will have approximately 500 charge/discharge cycles. Discharging 100 percent leaves the battery with only 200 charge/discharge cycles.

Use this information as a guide to the approximate state of charge and in determining when to apply conservation measures. Batteries degrade over time based on discharge/charge cycles and environmental conditions. Always monitor the battery system to obtain the best performance of the solar powered system.

Solar Panel

Banner solar panels come in two common sizes for the DXM: 5 Watt and 20 Watt. Both panels are designed to work with the DXM but provide different charging characteristics. Use the 5 watt panel for light duty operation and use the 20 watt panel when you require greater charging capabilities.

Solar Panel	Voltage	Current	Typical DXM Configurations
5 Watt	17 V	0.29 A	DXM Controller configured as a slave, ISM radio, I/O base board
20 Watt	21 V	1 A	DXM Controller with ISM radio and Cellular modem

Photovoltaic panels are very sensitive to shading. Unlike solar thermal panels, PV solar panels cannot tolerate shading from a branch of a leafless tree or small amounts of snow in the corners of the panel. Because all cells are connected in a series string, the weakest cell will bring down the other cells' power level.

Good quality solar panels will not degrade much from year to year, typically less than 1 percent .

To capture the maximum amount of solar radiation throughout the year, mount a fixed solar panel to optimize the sun's energy. For the northern hemisphere, face the panel true south. For the southern hemisphere, face the panel true north. If you are using a compass to orientate the panels, compensate for the difference between true north and magnetic north. Magnetic declination varies across the globe.

A solar panel's average tilt from horizontal is at an angle equal to the latitude of the site location. For optimum performance, adjust the tilt by plus 15 degrees in the winter or minus 15 degrees in the summer. For a fixed panel with a consistent power requirement throughout the year, adjust the tilt angle to optimize for the winter months: latitude plus 15 degrees. Although in the summer months the angle may not be the most efficient, there are more hours of solar energy available.

For sites with snow in the winter months, the increased angle helps to shed snow. A solar panel covered in snow produces little or no power.

4.3.3 Recommended Solar Configurations

These solar panel and battery combinations assume direct sunlight for at least two to three hours a day. Solar insolation maps provide approximate sun energy for various locations. The depth of battery discharge is assumed to be 50 percent.

Table 22: Solar panel and battery combinations for a DXM system

Solar Panel Output (W)	Battery Capacity (Ahr)	Days of Autonomy	DXM Current (mA)	DXM Model
5	10	10	25	DXM-Sx models with an ISM radio and I/O base board
20	14	10	30	DXM-Bx models with an ISM radio and no cellular modem
20	20	10	35	DXM-Bx models with an ISM radio and cellular modem

Battery capacity (amp hour) is a standard amp rating taken for 20 hours. Battery capacity should be monitored for reliable system power and may need to be increased for cold weather locations.

4.3.4 Monitoring Solar Operation

The DXM solar controller provides Modbus registers that allow the user to monitor the state of the solar panel input voltage, the battery voltage, the charging current, and the temperature in °C. The DXM can be configured to monitor the health of the charging system as well as send an alert message when the battery is too low.

The charts show a typical charging cycle, with each vertical grid representing about eight hours. The chart shows three days of charging.

Figure 6. Solar Panel Voltage (mV) -- Cloudy First Day

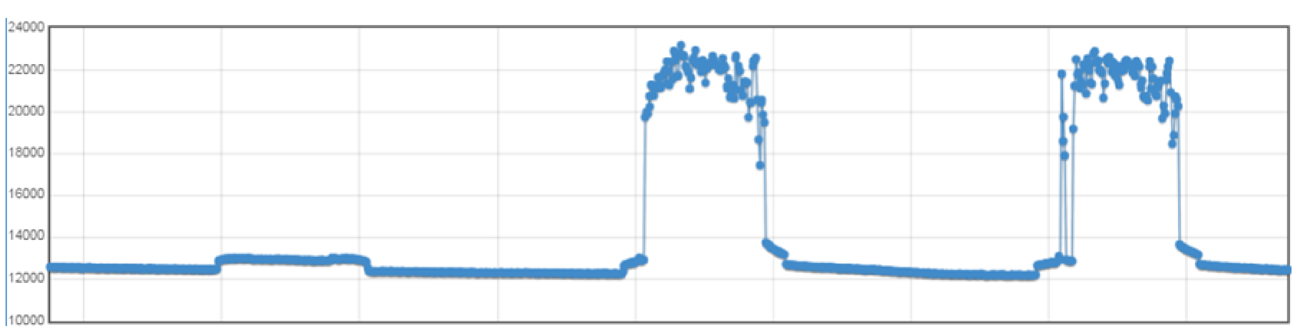
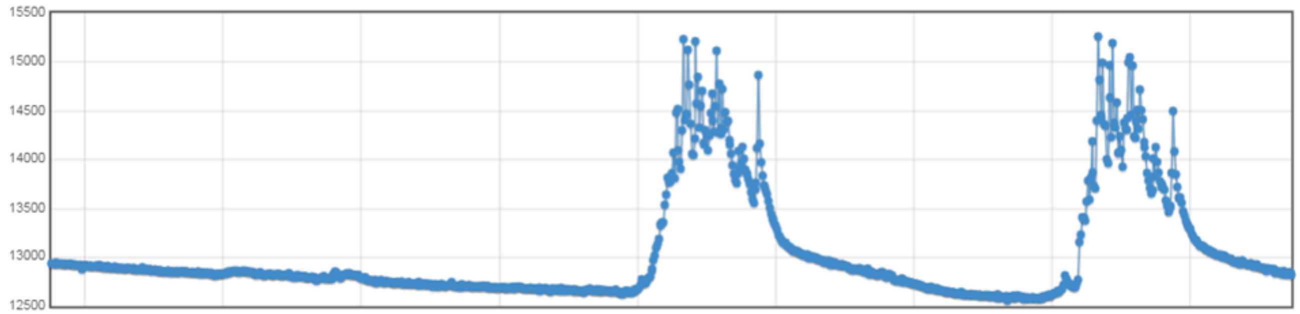


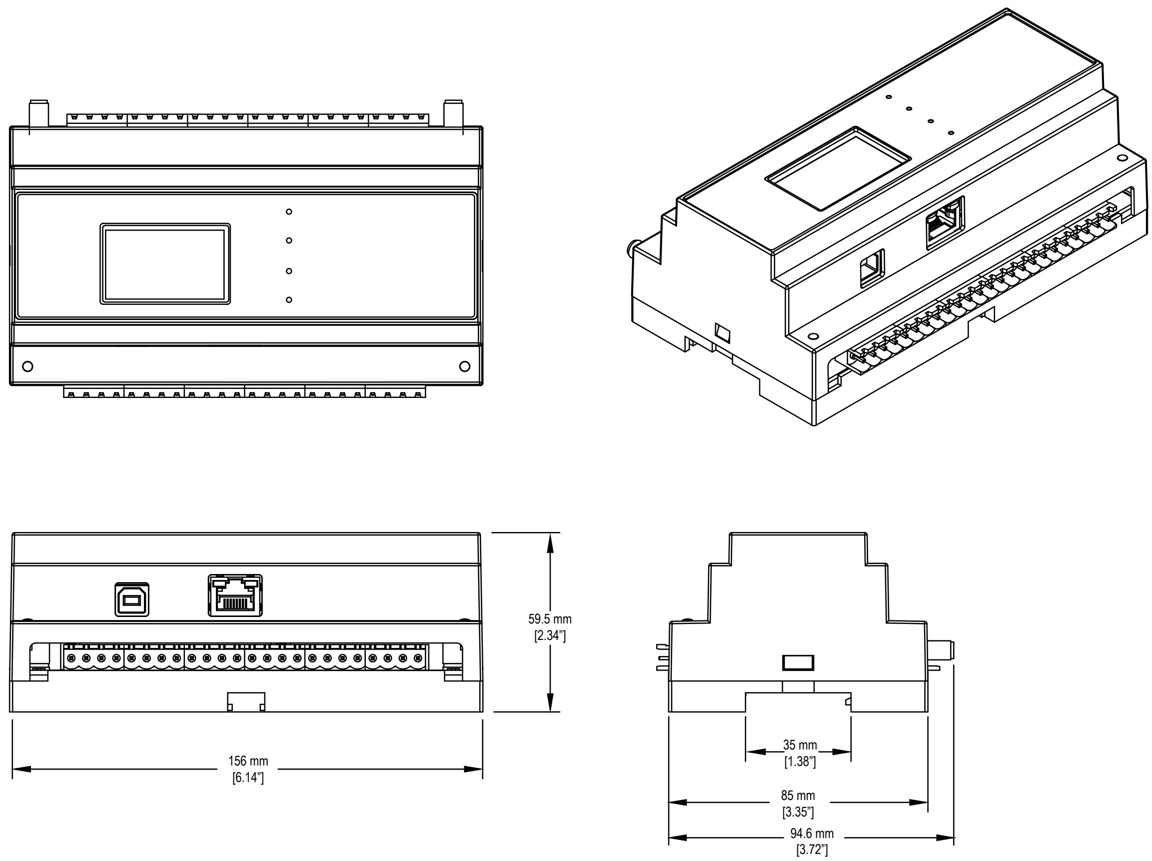
Figure 7. Battery Voltage (mV) - Cloudy First Day



5 DXM150 and DXM1500 Dimensions

All measurements are listed in millimeters [inches], unless noted otherwise.

Figure 8. Dimensions for the DXM150 and DXM1500 models



6 Troubleshooting

6.1 Restoring Factory Default Settings for the I/O Base Board

To reset the I/O base board to factory defaults, write to two Modbus registers in the base board. The default slave ID for the base board is 11.

To reset the DXM I/O base board parameters back to factory defaults:

1. Write a 1 to Modbus register 4152
2. Write a 10 to Modbus register 4151

To reboot (cycle power) the DXM I/O base board:

1. Write a 0 to Modbus register 4152
2. Write a 10 to Modbus register 4151

Table 23: Restoring Factory Defaults for the I/O Base Board

Register	Values	Description
4151	0–255	Reset/restore trigger. This timer is based in 100 millisecond units. Once written, the timer starts to count down to zero. After the timer expires, the restore factory defaults are applied if register 4152 = 1. If register 4152 is zero, the I/O board is reset. Default value: 0 1 = 100 milliseconds, 10 = 1 second.
4152	0–1	0 = Reboots (cycles power) to the I/O base board 1 = Restores factory defaults for I/O parameters

7 Accessories

For a complete list of all the accessories for the Sure Cross wireless product line, please download the Accessories List (p/n b_3147091).

Cordsets

MQDC1-506—5-pin M12/Euro-style, straight, single ended, 6 ft
MQDC1-530—5-pin M12/Euro-style, straight, single ended, 30 ft
MQDC1-506RA—5-pin M12/Euro-style, right-angle, single ended, 6 ft
MQDC1-530RA—5-pin M12/Euro-style, right-angle, single ended, 30 ft

Static and Surge Suppressor

BWC-LFNBMN-DC—Surge Suppressor, bulkhead, N-Type, dc Blocking, N-Type Female, N-Type Male

Short-Range Omni Antennas

BWA-2O2-D—Antenna, Dome, 2.4 GHz, 2 dBi, RP-SMA Box Mount
BWA-9O2-D—Antenna, Dome, 900 MHz, 2 dBi, RP-SMA Box Mount
BWA-9O2-RA—Antenna, Rubber Fixed Right Angle, 900 MHz, 2 dBi, RP-SMA Male Connector

Medium-Range Omni Antennas

BWA-9O5-C—Antenna, Rubber Swivel, 900 MHz 5 dBi, RP-SMA Male Connector
BWA-2O5-C—Antenna, Rubber Swivel, 2.4 GHz 5 dBi, RP-SMA Male Connector

Enclosures and DIN Rail Kits

BWA-AH864—Enclosure, Polycarbonate, with Opaque Cover, 8 × 6 × 4
BWA-AH1084—Enclosure, Polycarbonate, with Opaque Cover, 10 × 8 × 4
BWA-AH12106—Enclosure, Polycarbonate, with Opaque Cover, 12 × 10 × 6
BWA-AH8DR—DIN Rail Kit, 8", 2 trilobular/self-threading screws
BWA-AH10DR—DIN Rail Kit, 10", 2 trilobular/self-threading screws
BWA-AH12DR—DIN Rail Kit, 12", 2 trilobular/self-threading screws

Misc Accessories

BWA-CG.5-3X5.6-10—Cable Gland Pack: 1/2-inch NPT, Cordgrip for 3 holes of 2.8 to 5.6 mm diam, 10 pack
BWA-HW-052— Cable Gland and Vent Plug Pack: includes 1/2-inch NPT gland, 1/2-inch NPT multi-cable gland, and 1/2-inch NPT vent plug, one each

Antenna Cables

BWC-1MRSMN05—LMR200 RP-SMA to N-Type Male, 0.5 m
BWC-2MRSFRS6—LMR200, RP-SMA Male to RP-SMA Female Bulkhead, 6 m
BWC-4MNFN6—LMR400 N-Type Male to N-Type Female, 6 m

Long-Range Omni Antennas

BWA-9O8-AS—Antenna, Fiberglass, 3/4 Wave, 900 MHz, 8 dBi, N-Type Female Connector
BWA-2O8-A—Antenna, Fiberglass, 2.4 GHz, 8 dBi, N-Type Female Connector

Long-Range Yagi Antennas

BWA-9Y10-A—Antenna, 900 MHz, 10 dBd, N-Type Female Connector

Cellular Antenna

BWA-CELLA-002—Cellular multiband, 2 dBi, RP-SMA male connection, 6.3 inch blade style. Datasheet: b_4475176

Power Supplies

PSD-24-4—DC Power Supply, Desktop style, 3.9 A, 24 V dc, Class 2, 4-pin M12/Euro-style quick disconnect (QD)
PSDINP-24-13 —DC power supply, 1.3 Amps, 24 V DC, with DIN Rail Mount, Class I Division 2 (Groups A, B, C, D) Rated
PSDINP-24-25 — DC power supply, 2.5 Amps, 24 V DC, with DIN Rail Mount, Class I Division 2 (Groups A, B, C, D) Rated
BWA-SOLAR PANEL 20W—Solar Panel, 12 V, 20 W, Multicrystalline, 573 × 357 × 30, "L" style mounting bracket included (does not include controller)

8 Product Support and Maintenance

8.1 DXM150 Documentation

- DXM Wireless Controller Sell Sheet, p/n 194063
- DXM150-B1 Wireless Controller Datasheet, p/n 178136
- DXM150-B2 Wireless Controller Datasheet, p/n 195952
- DXM150-Bx Wireless Controller Instruction Manual, p/n 190038
- DXM150-S1 Modbus Slave Datasheet, p/n 160171
- DXM150-S2 Modbus Slave Datasheet, p/n 200634
- DXM150-Sx Modbus Slave Instruction Manual, p/n 195455
- DXM ScriptBasic Instruction Manual, p/n 191745
- DXM Controller API Protocol, p/n 186221
- DXM Controller Configuration Quick Start, p/n 191247
- DXM Configuration Software v4 (p/n b_4496867)
- DXM Configuration Software v4 Instruction Manual, p/n 209933
- DXM EDS Configuration file for Allen-Bradley PLCs (p/n b_4205242)
- EIP Configuration File for DXM 1xx-BxR1 and R3 models (p/n 194730)
- Activating a Cellular Modem (p/n b_4419353)
- Additional technical notes and videos

For more information about the DXM150 family of products, including technical notes, configuration examples, and ScriptBasic programs, please visit www.bannerengineering.com/wireless.

8.2 Contact Us

Banner Engineering Corp. headquarters is located at:

9714 Tenth Avenue North
Minneapolis, MN 55441, USA
Phone: + 1 888 373 6767

For worldwide locations and local representatives, visit www.bannerengineering.com.

8.3 FCC and ISED Certification, 900 MHz, 1 Watt Radios

This equipment contains transmitter module RM1809.

FCC ID: UE3RM1809
IC: 7044A-RM1809
HVIN: RM1809

This device complies with Part 15 of the FCC Rules. Operation is subject to the following two conditions: (1) this device may not cause harmful interference, and (2) this device must accept any interference received, including interference that may cause undesired operation.

This device contains licence-exempt transmitters(s)/receiver(s) that comply with Innovation, Science and Economic Development Canada’s licence-exempt RSS(s). Operation is subject to the following two conditions: (1) This device may not cause interference, and (2) This device must accept any interference, including interference that may cause undesired operation of the device.

Cet appareil contient des émetteurs/récepteurs exemptés de licence conformes à la norme Innovation, Sciences, et Développement économique Canada. L’exploitation est autorisée aux deux conditions suivantes: (1) L’appareil ne doit pas produire de brouillage, and (2) L’utilisateur de l’appareil doit accepter tout brouillage radioélectrique subi, même si le brouillage est susceptible d’en compromettre le fonctionnement.

FCC Notices

IMPORTANT: The transmitter modules RM1809 have been certified by the FCC / ISED for use with other products without any further certification (as per FCC section 2.1091). Changes or modifications not expressly approved by the manufacturer could void the user’s authority to operate the equipment.

IMPORTANT: The transmitter modules RM1809 have been certified for fixed base station and mobile applications. If modules will be used for portable applications, the device must undergo SAR testing.

IMPORTANT: If integrated into another product, the FCC ID label must be visible through a window on the final device or it must be visible when an access panel, door, or cover is easily removed. If not, a second label must be placed on the outside of the final device that contains the following text:

Contains Transmitter Module RM1809
FCC ID: UE3RM1809
IC: 7044A-RM1809
HVIN: RM1809
This device complies with Part 15 of the FCC Rules. Operation is subject to the following two conditions: (1) this device may not cause harmful interference, and (2) this device must accept any interference received, including interference that may cause undesired operation.

Note

This equipment has been tested and found to comply with the limits for a Class A digital device, pursuant to Part 15 of the FCC Rules. These limits are designed to provide reasonable protection against harmful interference in a residential installation. This equipment generates, uses, and can radiate radio frequency energy and, if not installed and used in accordance with the instructions, may cause harmful interference to radio communications. However, there is no guarantee that interference will not occur in a particular installation. If this equipment does cause harmful interference to radio or television reception, which can be determined by turning the equipment off and on, the user is encouraged to try to correct the interference by one or more of the following measures:

- Reorient or relocate the receiving antenna,
- Increase the separation between the equipment and receiving module,
- Connect the equipment into an outlet on a circuit different from that to which the receiving module is connected, and/or
- Consult the dealer or an experienced radio/TV technician for help.

Antenna WARNING: This device has been tested with Reverse Polarity SMA connectors with the antennas listed in Table 24 on page 27. When integrated into OEM products, fixed antennas require installation preventing end-users from replacing them with non-approved antennas. Antennas not listed in the tables must be tested to comply with FCC Section 15.203 (unique antenna connectors), FCC Section 15.247 (emissions), and ISED RSS-Gen Section 6.8.

FCC and ISED Approved Antennas

WARNING: This equipment is approved only for mobile and base station transmitting devices. Antenna(s) used for this transmitter must be installed to provide a separation distance of at least 20 cm from all persons and must not be collocated or operating in conjunction with any other antenna or transmitter.

This radio transmitter module RM1809 have been approved by FCC and ISED Canada to operate with the antenna types listed below, with the maximum permissible gain indicated. Antenna types not included in this list that have a gain greater than the maximum gain indicated for any type listed are strictly prohibited for use with this device.

Table 24: Certified Antennas for 900 MHz 1 Watt

Model Number	Antenna Type	Maximum Gain	Impedance	Minimum Required Cable/ Connector Loss
-	Integral Antenna	Unity gain		0
BWA-9O1-x	Omni, 1/4 wave dipole	≤2 dBi	50 Ω	0
BWA-9O2-C	Omni, 1/2 wave dipole, Swivel	≤2 dBi	50 Ω	0
BWA-9O6-A	Omni Wideband, Fiberglass Radome	≤8.2 dBi	50 Ω	2.2 dB
BWA-9O5-B	Omni Base Whip	≤7.2 dBi	50 Ω	1.2 dB
BWA-9Y10-A	Yagi	≤10 dBi	50 Ω	4 dB

8.4 FCC and ISED Certification, 2.4GHz

This equipment contains transmitter module DX80-2400 or SX243.

FCC ID: UE300DX80-2400
IC: 7044A-DX8024
FCC ID: UE3SX243
IC: 7044A-SX243
HVIN: DX80G2 / DX80N2 / SX243

This device complies with Part 15 of the FCC Rules. Operation is subject to the following two conditions: (1) this device may not cause harmful interference, and (2) this device must accept any interference received, including interference that may cause undesired operation.

This device contains licence-exempt transmitters(s)/receiver(s) that comply with Innovation, Science and Economic Development Canada’s licence-exempt RSS(s). Operation is subject to the following two conditions: (1) This device may not cause interference, and (2) This device must accept any interference, including interference that may cause undesired operation of the device.

Cet appareil contient des émetteurs/récepteurs exemptés de licence conformes à la norme Innovation, Sciences, et Développement économique Canada. L’exploitation est autorisée aux deux conditions suivantes: (1) L’appareil ne doit pas produire de brouillage, and (2) L’utilisateur de l’appareil doit accepter tout brouillage radioélectrique subi, même si le brouillage est susceptible d’en compromettre le fonctionnement.

FCC Notices

IMPORTANT: The transmitter modules DX80-2400 and SX243 have been certified by the FCC / ISED for use with other products without any further certification (as per FCC section 2.1091). Changes or modifications not expressly approved by the manufacturer could void the user’s authority to operate the equipment.

IMPORTANT: The transmitter modules DX80-2400 and SX243 have been certified for fixed base station and mobile applications. If modules will be used for portable applications, the device must undergo SAR testing.

IMPORTANT: If integrated into another product, the FCC ID/IC label must be visible through a window on the final device or it must be visible when an access panel, door, or cover is easily removed. If not, a second label must be placed on the outside of the final device that contains the following text:

Contains Transmitter Module [DX80-2400 or SX243]

FCC ID: [UE300DX80-2400 or UE3SX243]

IC: [7044A-DX8024 or 7044A-SX243]

HVIN: [DX80G2, DX80N2 or SX243]

This device complies with Part 15 of the FCC Rules. Operation is subject to the following two conditions: (1) this device may not cause harmful interference, and (2) this device must accept any interference received, including interference that may cause undesired operation.

Note

This equipment has been tested and found to comply with the limits for a Class A digital device, pursuant to Part 15 of the FCC Rules. These limits are designed to provide reasonable protection against harmful interference in a residential installation. This equipment generates, uses, and can radiate radio frequency energy and, if not installed and used in accordance with the instructions, may cause harmful interference to radio communications. However, there is no guarantee that interference will not occur in a particular installation. If this equipment does cause harmful interference to radio or television reception, which can be determined by turning the equipment off and on, the user is encouraged to try to correct the interference by one or more of the following measures:

- Reorient or relocate the receiving antenna,
- Increase the separation between the equipment and receiving module,
- Connect the equipment into an outlet on a circuit different from that to which the receiving module is connected, and/or
- Consult the dealer or an experienced radio/TV technician for help.

Antenna Warning: This device has been tested with Reverse Polarity SMA connectors with the antennas listed in Table 25 on page 29. When integrated into OEM products, fixed antennas require installation preventing end-users from replacing them with non-approved antennas. Antennas not listed in the tables must be tested to comply with FCC Section 15.203 (unique antenna connectors), FCC Section 15.247 (emissions), and ISED RSS-Gen Section 6.8.

FCC and ISED Approved Antennas

WARNING: This equipment is approved only for mobile and base station transmitting devices. Antenna(s) used for this transmitter must be installed to provide a separation distance of at least 20 cm from all persons and must not be collocated or operating in conjunction with any other antenna or transmitter.

The radio transmitter modules DX80-2400 and SX243 have been approved by FCC and ISED Canada to operate with the antenna types listed below, with the maximum permissible gain indicated. Antenna types not included in this list that have a gain greater than the maximum gain indicated for any type listed are strictly prohibited for use with this device.

Table 25: Certified Antennas for 2.4 GHz

Model	Antenna Type	2.4 GHz Radio Module	Maximum Gain	Impedance
	Integral antenna	DX80-2400	Unity gain	
BWA-2O2-C	Omni, 1/2 wave dipole, Swivel	DX80-2400 or SX243	≤ 2 dBi	50 Ω
BWA-2O2-D	Omni, Dome, Box Mount	DX80-2400	≤ 2 dBi	50 Ω
BWA-2O2-E	Omni, 1/4 wave dipole, Swivel	DX80-2400	≤ 2 dBi	50 Ω
BWA-2O5-C	Omni, Collinear, Swivel	DX80-2400	≤ 5 dBi	50 Ω
BWA-2O5-MA	Omni, full-wave dipole, NMO	DX80-2400	≤ 4.5 dBi	50 Ω
BWA-2O6-A	Omni, Dome, Box Mount	DX80-2400	≤ 6 dBi	50 Ω
BWA-2O7-C	Omni, Coaxial Sleeve, Swivel	DX80-2400	≤ 7 dBi	50 Ω

8.5 Notas Adicionales

Información México: La operación de este equipo está sujeta a las siguientes dos condiciones: 1) es posible que este equipo o dispositivo no cause interferencia perjudicial y 2) este equipo debe aceptar cualquier interferencia, incluyendo la que pueda causar su operación no deseada.

Banner es una marca registrada de Banner Engineering Corp. y podrán ser utilizadas de manera indistinta para referirse al fabricante. "Este equipo ha sido diseñado para operar con las antenas tipo Omnidireccional para una ganancia máxima de antena de 6 dBd y Yagi para una ganancia máxima de antena 10 dBd que en seguida se enlistan. También se incluyen aquellas con aprobación ATEX tipo Omnidireccional siempre que no excedan una ganancia máxima de antena de 6dBd. El uso con este equipo de antenas no incluidas en esta lista o que tengan una ganancia mayor que 6 dBd en tipo omnidireccional y 10 dBd en tipo Yagi, quedan prohibidas. La impedancia requerida de la antena es de 50 ohms."

Antenas SMA	Modelo
Antena, Omni 902-928 MHz, 2 dBd, junta de caucho, RP-SMA Macho	**BWA-9O2-C**
Antena, Omni 902-928 MHz, 5 dBd, junta de caucho, RP-SMA Macho	**BWA-9O5-C**

Antenas Tipo-N	Modelo
Antena, Omni 902-928 MHz, 6 dBd, fibra de vidrio, 1800mm, N Hembra	**BWA-9O6-A**
Antena, Yagi, 900 MHz, 10 dBd, N Hembra	**BWA-9Y10-A**

8.6 Mexican Importer

Banner Engineering de Mèxico, S. de R.L. de C.V.
David Alfaro Siqueiros 103 Piso 2 Valle oriente
San Pedro Garza Garcia Nuevo Leòn, C. P. 66269

81 8363.2714

8.7 ANATEL

Modelo (Model): DX80-2400—Este equipamento não tem direito à proteção contra interferência prejudicial e não pode causar interferência em sistemas devidamente autorizados. Para maiores informações, consulte o site da ANATEL www.gov.br/anatel/pt-br/

ANATEL
Agência Nacional de Telecomunicações

ANATEL: 15966-21-04042

8.8 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.** 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. This device has been designed to operate with the antennas listed on Banner Engineering's website and having a maximum gain of 9 dBm. Antennas not included in this list or having a gain greater that 9 dBm are strictly prohibited for use with this device. The required antenna impedance is 50 ohms. To reduce potential radio interference to other users, the antenna type and its gain should be so chosen such that the equivalent isotropically radiated power (EIRP) is not more than that permitted for successful communication. Consult with Banner Engineering Corp. if the destination country is not on this list.

Important: Please download the complete DXM150-Sx Wireless Modbus Slave technical documentation, available in multiple languages, from www.bannerengineering.com for details on the proper use, applications, Warnings, and installation instructions of this device.

Important: Por favor descargue desde www.bannerengineering.com toda la documentación técnica de los DXM150-Sx Wireless Modbus Slave, disponibles en múltiples idiomas, para detalles del uso adecuado, aplicaciones, advertencias, y las instrucciones de instalación de estos dispositivos.

Important: Veuillez télécharger la documentation technique complète des DXM150-Sx Wireless Modbus Slave sur notre site www.bannerengineering.com pour les détails sur leur utilisation correcte, les applications, les notes de sécurité et les instructions de montage.

WARNING:
- **Do not use this device for personnel protection**
- Using this device for personnel protection could result in serious injury or death.
- This device does not include the self-checking redundant circuitry necessary to allow its use in personnel safety applications. A device failure or malfunction can cause either an energized (on) or de-energized (off) output condition.

Important:
- **Never operate a 1 Watt radio without connecting an antenna**
- Operating 1 Watt radios without an antenna connected will damage the radio circuitry.
- To avoid damaging the radio circuitry, never apply power to a Sure Cross® Performance or Sure Cross MultiHop (1 Watt) radio without an antenna connected.

Important:
- **Electrostatic discharge (ESD) sensitive device**
- ESD can damage the device. Damage from inappropriate handling is not covered by warranty.
- Use proper handling procedures to prevent ESD damage. Proper handling procedures include leaving devices in their anti-static packaging until ready for use; wearing anti-static wrist straps; and assembling units on a grounded, static-dissipative surface.

8.9 Banner Engineering Corp Limited Warranty

Banner Engineering Corp. warrants its products to be free from defects in material and workmanship for one year following the date of shipment. Banner Engineering Corp. will repair or replace, free of charge, any product of its manufacture which, at the time it is returned to the factory, is found to have been defective during the warranty period. This warranty does not cover damage or liability for misuse, abuse, or the improper application or installation of the Banner product.

THIS LIMITED WARRANTY IS EXCLUSIVE AND IN LIEU OF ALL OTHER WARRANTIES WHETHER EXPRESS OR IMPLIED (INCLUDING, WITHOUT LIMITATION, ANY WARRANTY OF MERCHANTABILITY OR FITNESS FOR A PARTICULAR PURPOSE), AND WHETHER ARISING UNDER COURSE OF PERFORMANCE, COURSE OF DEALING OR TRADE USAGE.

This Warranty is exclusive and limited to repair or, at the discretion of Banner Engineering Corp., replacement. **IN NO EVENT SHALL BANNER ENGINEERING CORP. BE LIABLE TO BUYER OR ANY OTHER PERSON OR ENTITY FOR ANY EXTRA COSTS, EXPENSES, LOSSES, LOSS OF PROFITS, OR ANY INCIDENTAL, CONSEQUENTIAL OR SPECIAL DAMAGES RESULTING FROM ANY PRODUCT DEFECT OR FROM THE USE OR INABILITY TO USE THE PRODUCT, WHETHER ARISING IN CONTRACT OR WARRANTY, STATUTE, TORT, STRICT LIABILITY, NEGLIGENCE, OR OTHERWISE.**

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. Any misuse, abuse, or improper application or installation of this product or use of the product for personal protection applications when the product is identified as not intended for such purposes will void the product warranty. Any modifications to this product without prior express approval by Banner Engineering Corp will void the product warranties. All specifications published in this document are subject to change; Banner reserves the right to modify product specifications or update documentation at any time.

8.10 Glossary of Wireless Terminology

This definitions list contains a library of common definitions and glossary terms specific to the Wireless products.

EtherNet/IP™ is a trademark of ODVA, Inc.

Microsoft and Windows are registered trademarks of Microsoft Corporation in the United States and/or other countries.

Modbus® is a registered trademark of Schneider Electric USA, Inc.

PROFINET® is a registered trademark of PROFIBUS Nutzerorganisation e.V.

active threshold An active threshold is a trigger point or reporting threshold for an analog input.

a/d converter An analog to digital converter converts varying sinusoidal signals from instruments into binary code for a computer.

address mode The Sure Cross® wireless devices may use one of two types of addressing modes: rotary dial addressing or extended addressing. In **rotary dial** address mode, the left rotary dial establishes the network ID (NID) and the right rotary dial sets the device address. **Extended** address mode uses a security code to "bind" Nodes to a specific Gateway. Bound Nodes can only send and receive information from the Gateway they are bound to.

antenna Antennas transmit radio signals by converting radio frequency electrical currents into electromagnetic waves. Antennas receive the signals by converting the electromagnetic waves back into radio frequency electrical currents.

attenuation Attenuation is the radio signal loss occurring as signals travel through the medium. Radio signal attenuation may also be referred to as free space loss. The higher the frequency, the faster the signal strength decreases. For example, 2.4 GHz signals attenuate faster than 900 MHz signals.

baseline filter (M-GAGE) Under normal conditions, the ambient magnetic field fluctuates. When the magnetic field readings drift below a threshold setting, the baseline or drift filter uses an algorithm to slowly match the radio device's baseline to the ambient magnetic field.

binding (DX80 star networks) Binding Nodes to a Gateway ensures the Nodes only exchange data with the Gateway they are bound to. After a Gateway enters binding mode, the Gateway automatically generates and transmits a unique extended addressing (XADR), or binding, code to all Nodes within range that are also in binding mode. The extended addressing (binding) code defines the network, and all radios within a network must use the same code.

After binding your Nodes to the Gateway, make note of the binding code displayed under the ***DVCFG** > **XADR** menu on the Gateway's LCD. Knowing the binding code prevents having to re-bind all Nodes if the Gateway is ever replaced.

binding (MultiHop networks) Binding MultiHop radios ensures all MultiHop radios within a network communicate only with other radios within the same network. The MultiHop radio master automatically generates a unique binding code when the radio master enters binding mode. This code is then transmitted to all radios within range that are also in binding mode. After a repeater/slave is bound, the repeater/slave radio accepts data only from the master to which it is bound. The binding code defines the network, and all radios within a network must use the same binding code.

After binding your MultiHop radios to the master radio, make note of the binding code displayed under the ***DVCFG** > **-BIND** menu on the LCD. Knowing the binding code prevents having to re-bind all radios if the master is ever replaced.

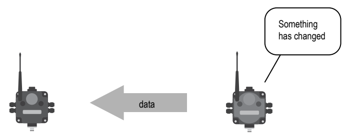
binding (serial data radio networks) Binding the serial data radios ensures all radios within a network communicate only with the other radios within the same network. The serial data radio master automatically generates a unique binding code when the radio master enters binding mode. This code is transmitted to all radios within range that are also in binding mode. After a repeater/slave is bound, the repeater/slave radio accepts data only from the master to which it is bound. The binding code defines the network, and all radios within a network must use the same binding code.

bit packing i/o Bit packing uses a single register, or range of contiguous registers, to represent I/O values. This allows you to read or write multiple I/O values with a single Modbus message.

booster (boost voltage) A booster is an electronic circuit that increases a battery-level voltage input (3.6V) to a sensor operating voltage output (5 to 20 V).

CE The CE mark on a product or machine establishes its compliance with all relevant European Union (EU) Directives and the associated safety standards.

change of state Change of state reporting is a report initiated by the Node when a change to the sensor's input state is detected. If the input does not change, nothing is reported to the Gateway.



channel A channel may be either a path for communications or a range of radio frequencies used by a transceiver during communication.

collision A collision is a situation in which two or more transmissions are competing to communicate on a system that can only handle one transmission at a time. This may also be referred to as a data collision.

collocated networks To prevent interference between collocated wireless networks, assign each wireless network a different Network ID. The Network ID is a unique identifier assigned to each wireless network using the rotary dials on the Gateway.

contention architecture Contention architecture is a wireless communication architecture that allows all network devices access to the communications channel at the same time. This may lead to transmission collisions.

counter - event The event counter counts the total number of times an input signal changes to the high/ON/1 state. The counter increments on the falling edge of an input signal when the signal level crosses the threshold.

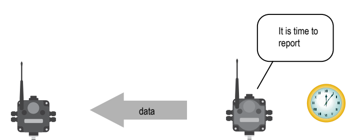
Event counters can be used to measure the total operational cycles of a spinning shaft or the total number of items traveling down a conveyor.

counter - frequency The frequency counter calculates the frequency of the input signal, in Hz.

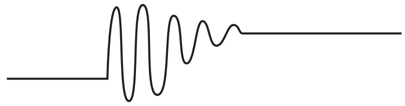
Frequency counters can be used to measure flow rates, such as measuring the flow rate of items on a conveyor or the speed at which a windmill spins.

courtesy power outputs Courtesy power outputs provide continuous power and cannot be turned on or off.

cyclic reporting Cyclic reporting is when the Gateway polls the Node at user-defined intervals.

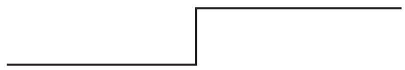


debounce When a signal changes state using a mechanical switch or relay, the signal can oscillate briefly before stabilizing to the new state. The debounce filter examines the signal's transitions to determine the signal's state.



The signal oscillates between states after a mechanical switch or relay activates.

Without a debounce filter, the signal is interpreted to change state multiple times.



With a debounce filter, the signal is interpreted to change state only once.

The factory default setting is to activate the input filtering to compensate for unclean state transitions.

decibel

A decibel is a logarithmic ratio between a specific value and a base value of the same unit of measure. With respect to radio power, dBm is a ratio of power relative to 1 milliWatt. According to the following equation, 1 mW corresponds to 0 dBm.

Equation: PmW = $10^{x/10}$ where x is the transmitted power in dBm, or dBm = 10 log(PmW)

Another decibel rating, dBi, is defined as an antenna's forward gain compared to an idealized isotropic antenna. Typically, dBm = dBi = dBd + 2.15 where dBi refers to an isotropic decibel, dBd is a dipole decibel, and dBm is relative to milliwatts.

deep sleep mode

Potted Puck models, potted M-GAGE models: Some battery-powered M-GAGE radios ship in a "deep sleep" mode to conserve battery power. While in "deep sleep" mode, the M-GAGE does not attempt to transmit to a parent radio and remains in "deep sleep" until an LED light at the receiving window wakes it up. M-GAGEs that ship in "deep sleep" mode are typically the potted M-GAGEs that require an LED Optical Commissioning Device to configure the M-GAGE.

Wireless Q45 Sensors: If the Wireless Q45 Sensor fails to communicate with the Gateway for more than 5 minutes, it enters **sleep mode**. The radio continues to search for the Gateway at a slower rate and the LEDs do not blink. To wake up the sensor, press any button. After the Q45 wakes up, it will do a fast rate search for the Gateway for five more minutes.

default output triggers

Default output triggers are the conditions that drive outputs to defined states. Example default output conditions include when radios are out of sync, when a device cycles power, or during a host communication timeout.

Device Power Up—Outputs are set to user-defined states every time the device is powered up.

Out of Sync—Outputs are set to user-defined states when the radio is out of sync with its parent radio.

Host Link Failure—Host link failure is when the defined timeout period has elapsed with no communications between the host system (or Modbus master device) and the DX80 Gateway, typically about four seconds. Outputs are set to user-defined states when a host link failure has been detected.

Node Link Failure—Node link failures are determined by the polling interval or the out-of-sync timing. When a Node detects a communications failure with the Gateway and the Node Link Failure flag is set, the output points are set to the user-defined states and the inputs are frozen.

Gateway Link Failure—Gateway link failures are determined by three global parameters: Polling Interval, Maximum Missed Message Count and Re-link Count. When the Node's Gateway Link Failure flag is set and the Gateway determines a timeout condition exists for a Node, any outputs linked from the failing Node are set to the user-defined default state.

default output value

Default output values are specific values written to output registers. For discrete outputs, this is a 1 (on) or 0 (off) value. For analog outputs the value can be any valid register value. When a default condition occurs, these default output values are written to the output register.

delta

The delta parameter defines the change required between sample points of an analog input before the analog input reports a new value. To turn off this option, set the Delta value to 0.

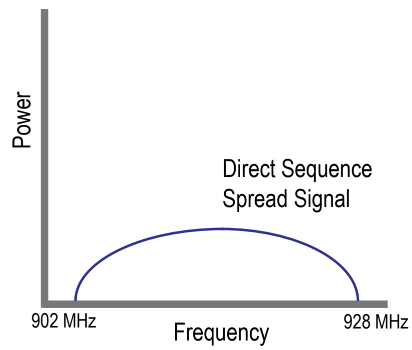
determinism

A deterministic system defines how network endpoints behave during the loss of communications. The network identifies when the communications link is lost and sets relevant outputs to user-defined conditions. Once the radio signal is re-established, the network returns to normal operation.

device, node, or radio address/ID (DX80 Networks) The Node address is a unique identifier for each wireless device on a network and is set using the rotary dials. For the DX80 networks, Gateways are identified as device 0. Nodes are assigned addresses (NADR) from 01 to 47 using the rotary dials.

directional antenna A direction antenna, or Yagi, is an antenna that focuses the majority of the signal energy in one specific direction.

Direct Sequence Spread Spectrum (DSSS) Direct Sequence Spread Spectrum is a method for generating spread spectrum transmissions where the transmitted signal is sent at a much higher frequency than the original signal, spreading the energy over a much wider band. The receiver is able to de-spread the transmission and filter the original message. DSSS is useful for sending large amounts of data in low to medium interference environments.



DX83 Ethernet Bridge The Ethernet Bridge acts as a communications bridge between the Modbus RTU network (Gateway) and Modbus/TCP or EtherNet/IP host systems and includes the ability to configure the network using a Web browser interface.

effective isotropic radiated power (EIRP) The EIRP is the effective power found in the main lobe of a transmitter antenna, relative to a 0 dB radiator. EIRP is usually equal to the antenna gain (in dBi) plus the power into that antenna (in dBm).

Ethernet Ethernet is an access method for computer network (Local Area Networks) communications, defined by IEEE as the 802 standard.

EtherNet/IP™ EtherNet/IP is Allen-Bradley’s DeviceNet running over Ethernet hardware.

extended address mode Using extended address mode isolates networks from one another by assigning a unique code, the extended address code, to all devices in a particular network. Only devices sharing the extended address code can exchange data. The extended address code is derived from the Gateway's serial number, but the code can be customized using the manual binding procedure.

flash pattern Flash patterns are established by selecting timeslots to turn the output on or off. While originally the flash pattern was designed to turn on and off an indicator light, the flash pattern can be set for any discrete output or switch power output.

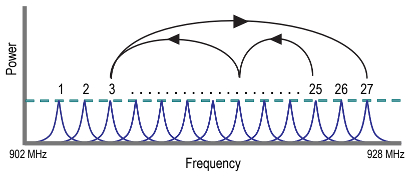
***Flex*Power** Banner’s *Flex*Power® technology allows for a true wireless solution by allowing the device to operate using either 10 to 30 V DC, 3.6 V lithium D cell batteries, or solar power. This unique power management system can operate a *Flex*Power Node and an optimized sensing device for up to 5 years on a single lithium D cell.

free space loss (FSL) The radio signal loss occurring as the signal radiates through free space. Free Space Loss = 20 Log (4(3.1416)d/λ) where d is in meters. Remembering that $\lambda f = c = 300 \times 10^6$ m/s, the equations reduce down to:

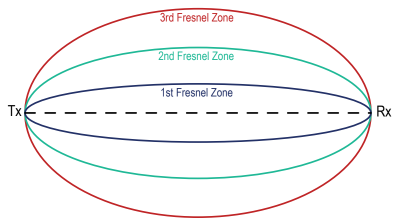
For the 900 MHz radio band: FSL = 31.5 + 20 Log d (where d is in meters).

For the 2.4 GHz radio band: FSL = 40 + 20 Log d (where d is in meters.)

Frequency Hopping Spread Spectrum (FHSS)
Frequency Hopping Spread Spectrum (FHSS) is a method for generating spread spectrum transmissions where the signal is switched between different frequency channels in a pseudo-random sequence known by both the transmitter and the receiver. FHSS is useful for sending small packets of data in a high interference environment.



Fresnel zone
Fresnel zones are the three-dimensional elliptical zones of radio signals between the transmitter and receiver. Because the signal strength is strongest in the first zone and decreases in each successive zone, obstacles within the first Fresnel zone cause the greatest amount of destructive interference.



gain
Gain represents how well the antenna focuses the signal power. A 3 dB gain increase doubles the effective transmitting power while every 6 dB increase doubles the distance the signal travels. Increasing the gain sacrifices the vertical height of the signal for horizontal distance increases. The signal is 'squashed' down to concentrate the signal strength along the horizontal plane.

gateway
A gateway is a general network device that connects two different networks.

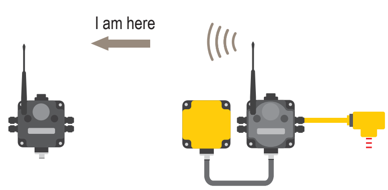
Gateway
A Sure Cross® Gateway is the wireless sensor network master device used to control network timing and schedule communication traffic. Similar to how a gateway device on a wired network acts as a "portal" between networks, the Sure Cross Gateway acts as the portal between the wireless network and the central control process. Every wireless I/O sensor network requires one Gateway device. Every Sure Cross device is a transceiver, meaning it can transmit and receive data.

GatewayPro
The GatewayPro combines the standard Gateway and the DX83 Ethernet Bridge into one device.

ground loop
Ground loops are grounds within a system that are not at the same potential. Ground loops can damage electrical systems.

ground plane
A ground plane is an electrically conductive plate that acts as a 'mirror' for the antenna, effectively doubling the length of the antenna. When using a 1/4 wave antenna, the ground plane acts to 'double' the antenna length to a 1/2 wave antenna.

heartbeat mode
In heartbeat mode, the Nodes send "heartbeat" messages to the Gateway at specific intervals to indicate the radio link is active. The heartbeat is always initiated by the Node and is used only to verify radio communications. Using the Nodes to notify the Gateway that the radio link is active instead of having the Gateway "poll" the Nodes saves energy and increases battery life.



hibernation/ storage mode
While in **storage mode**, the radio does not operate. To put any integrated battery Sure Cross® radio into storage mode, press and hold button 1 for five seconds. To wake the device, press and hold button 1 for five seconds. The radio is in storage mode when the LEDs stop blinking, but in some models, the LCD

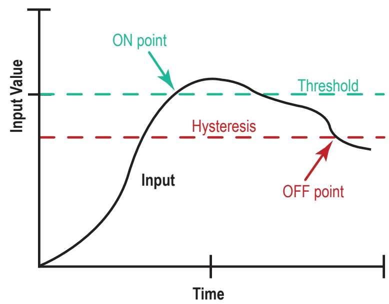
remains on for an additional minute after the radio enters storage mode. After a device has entered storage mode, you must wait one minute before waking it.

For the Wireless Q45 and Q120 Sensors: While in **storage mode**, the device's radio does not operate, to conserve the battery. To put any device into storage mode, press and hold the binding button for five seconds. The device is in storage mode when the LEDs stop blinking. To wake the device, press and hold the binding button (inside the housing on the radio board) for five seconds.

hop
As a verb, hopping is the act of changing from one frequency to another. As a noun, a hop is the device to device transmission link, such as from the Master device to the Slave device.

hop table
A hop table is a precalculated, pseudo-random list of frequencies used by both the transmitter and receiver of a radio to create a hopping sequence.

hysteresis
Hysteresis defines how far below the active threshold (ON point) an analog input is required to be before the input is considered OFF. A typical hysteresis value is 10% to 20% of the unit's range. For more specific details, see *Threshold*.



Industrial, Scientific, and Medical Band (ISM)
The ISM, or Industrial, Scientific, and Medical band, is the part of the radio spectrum that does not require a license for use. The Sure Cross radios operate in the ISM band.

latency
A network's latency is the maximum delay between transmission and reception of a data signal.

lightning arrestor
Also called a lightning suppressor, surge suppressor, or coaxial surge protection, lightning arrestors are used in remote antenna installations to protect the radio equipment from damage resulting from a lightning strike. Lightning arrestors are typically mounted close to the ground to minimize the grounding distance.

line of sight
Line of sight is the unobstructed path between radio antennas.

link failures
A **Host Link Failure** occurs when the defined timeout period, typically about four seconds, elapses with no communication between the host system (or Modbus master device) and the DX80 Gateway.

A **Gateway Link Failure** refers to the radio link between a Node and the Gateway and is determined by three global parameters: Polling Interval, Maximum Missed Message Count, and Re-link Count. When the Node's Gateway Link Failure flag is set and the Gateway determines a timeout condition exists for a Node, any outputs linked from the failing Node are set to the user-defined default state.

A **Node Link Failure** is determined by the polling interval or the out-of-sync timing. When a Node detects a communications failure with the Gateway and the Node Link Failure flag is selected, the output points are set to the user-defined states and the inputs are frozen.

local and non-local registers Local registers are registers specific to the device in question. When discussing a Gateway, the Gateway's local registers include the registers specific to the Gateway in addition to all the Nodes' registers that are stored in the Gateway. Non-local, or remote, registers refer to registers on other Modbus slave devices, such as other MultiHop slave radios or third-party Modbus devices.

master/slave relationship The master/slave relationships is the model for a communication protocol between devices or processes in which one device initiates commands (master) and other devices respond (slave). The Sure Cross network is a master/slave network with the Gateway acting as the master device to the Nodes, which are the slave devices. A PC can also be a master device to a wireless sensor network. See *star networks*.

maximum bad count The maximum bad count refers to a user-established maximum count of consecutive failed polling attempts before the Gateway considers the radio (RF) link to have failed.

maximum misses The maximum misses is the number of consecutive polling messages the Node fails to respond to. For more information, see Polling Rate and Maximum Misses.

median filter When the median filter is turned on, three samples are taken for each analog sensor reading. The high and low values are discarded and the middle value is used as the analog value. Set to zero (0) to turn off the median filter. Set to one (1) to turn on the median filter.

Modbus Modbus is a master-slave communications protocol typically used for industrial applications.

Modbus/TCP Modbus/TCP is an open standard protocol very similar to Modbus RTU except that it uses standard Internet communication protocols.

MultiHop 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. A MultiHop Radio is either a master radio, a repeater radio, or a slave 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. Repeater radios extend the range of the wireless network and slave radios are the end point of the wireless network.

For more information, refer to the Sure Cross MultiHop Radios Instruction Manual (p/n 151317).

multipath fade Obstructions in the radio path reflect or scatter the transmitted signal, causing multiple copies of a signal to reach the receiver through different paths. Multipath fade is the signal degradation caused by these obstructions.

network ID The Network ID (NID) is a unique identifier you assign to each wireless network to minimizes the chances of two collocated networks interfering with each other. Assigning different NIDs to different networks improves collocation performance in dense installations.

node A node is any communications point within a network.

Node Nodes are remote I/O slave devices within Banner's wireless sensor networks. Sensors and other devices connect to the Node's inputs or outputs, allowing the Node to collect sensor data and wirelessly transmit it to the Gateway. Every Sure Cross device is a transceiver, meaning it can transmit and receive data.

noise Noise is any unwanted electromagnetic disturbances from within the RF equipment, especially the receiver. Noise is more of a concern when signal levels are low.

omni-directional antenna Omni-directional antennas transmit and receive radio signals equally in all directions.

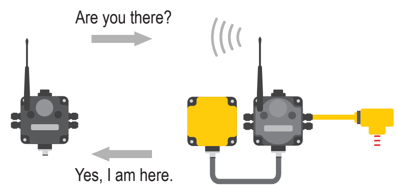
out of sync/link loss (loss of radio signal) The Sure Cross wireless devices use a deterministic link time-out method to address RF link interruption or failure. When a radio link fails, all pertinent wired outputs are sent to the selected default value/state until the link is recovered, ensuring that disruptions in the communications link result in predictable system behavior. Following a time-out, all outputs linked to the Node in question are set to 0, 1, or hold the last stable state depending on the value selected.

path loss Path loss describes attenuation as a function of the wavelength of the operating frequency and the distance between the transmitter and receiver.

path loss (or link loss) calculations Link loss calculations determine the capabilities of a radio system by calculating the total gain or loss for a system. If the total gain/loss is within a specific range, the radio signal will be received by the radio. **Total Gain = Effective output + Free space loss + Total received power** . Because the transmitter and receiver gains are positive numbers and the free space loss is a larger negative number, the total gain of a system should be negative. A link loss calculation may also be called a link budget calculation.

peer to peer network
Peer-to-peer is a model for a communication protocol in which any device in the network can send or receive data. Any device can act as a Master to initiate communication.

polling interval/ rate
The Gateway communicates with, or polls, each Node to determine if the radio link is active. The polling rate defines how often the Gateway communicates with each Node. Polling is always initiated by the Gateway and only verifies radio signal communications.



polling interval/ rate and maximum misses
The Gateway communicates with, or polls, each Node to determine if the radio link is active. The polling rate, or interval, defines how often the Gateway communicates with each Node. Polling is always initiated by the Gateway and only verifies radio signal communications. Nodes that fail to respond are counted against the 'Maximum Misses' for that Node. If the 'Maximum Misses' is exceeded for any Node, the Gateway generates an RF timeout error in the Modbus I/O register 8 of the appropriate Node. The 'Maximum Misses' is defined as the number of consecutive polling messages that the Node fails to respond to.

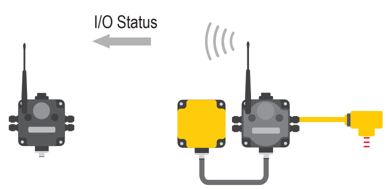
radiation pattern
An antenna's radiation pattern is the area over which the antenna broadcasts an easily received signal. The radiation pattern/shape changes based on the antenna type and gain.

re-link count
The re-link count is the number of completed polling messages the Gateway receives from a Node before a lost RF link is considered re-established and normal operation resumes.

remote antenna
A remote antenna installation is any antenna not mounted directly to the Sure Cross wireless device, especially when coaxial cable is used. Always properly install and ground surge suppressors in remote antenna systems.

repeater radio
A repeater radio extends the transmission range of a wireless network. Repeaters are typically used in long-distance transmission.

report interval/ rate
The report rate defines how often the Node communicates the I/O status to the Gateway. For battery-powered applications, setting the report rate to a slower rate extends the battery life.



Change of state reporting sets the system to report only when the value crosses the threshold setting.

rotary dial address mode
See: *address mode*

Received Signal Strength Indicator (RSSI)
An RSSI is the measurement of the strength of received signals in a wireless environment. See *Site Survey*.

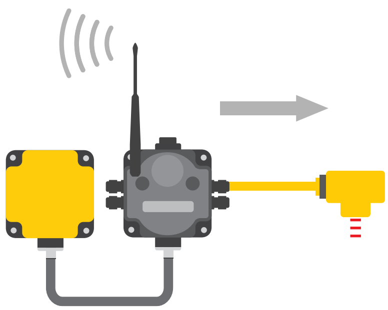
resistance temperature detector (RTD)
An RTD is a temperature measurement device that measures the electrical resistance across a pure metal. The most commonly used metal is platinum because of its temperature range, accuracy, and stability.

RTDs are used for higher precision applications or for longer wire runs because RTDs can compensate for wire length. In industrial applications, RTDs are not generally used at temperatures above 660º C. Though RTDs are more accurate, they are slower to respond and have a smaller temperature range than thermocouples.

sample high/ sample low (analog I/O)
For analog inputs, the sample high parameter defines the number of consecutive samples the input signal must be above the threshold before a signal is considered active. Sample low defines the number of consecutive samples the input signal must be below the threshold minus hysteresis before a signal is considered deactivated. The sample high and sample low parameters are used to avoid unwanted input transitions.

sample high/ sample low (discrete I/O)
For discrete inputs, the sample high parameter defines the number of consecutive samples the input signal must be high before a signal is considered active. Sample low defines the number of consecutive samples the input signal must be low before a signal is considered low. The sample high and sample low parameters are used to create a filter to avoid unwanted input transitions. The default value is 0, which disables this feature. The value range is 1 through 255.

sample interval/ rate
The sample interval, or rate, defines how often the Sure Cross device samples the input. For battery-powered applications, setting a slower rate extends the battery life.



sample on demand
Sample on demand allows a host system to send a Modbus command to a register and require the inputs to immediately sample the sensor and report readings back to the host system and/or Gateway. Sampling on demand can be used between the normal periodic reporting.

The sample on demand feature requires using a host-controlled system capable of sending Modbus commands to the master radio.

signal-to-noise ratio (SNR)
The signal-to-noise ratio is the ratio of the signal to any background noise or noise generated by the medium. In radio terms, it a ratio of the transmitted radio signal to the noise generated by any electromagnetic equipment, in particular the radio receiver. The weaker the radio signal, the more of an influence noise has on radio performance. Like gain, the signal-to-noise ratio is measured in decibels.

The equations for calculating SNR are:

SNR = 20 × log (Vs/Vn) where Vs is the signal voltage and Vn is the noise voltage;
SNR = 20 × log (As/An) where As is the signal amplitude and An is the noise amplitude; or
SNR = 10 × log (Ps/Pn) where Ps is the signal power and Pn is the noise power.

single-point ground
All grounds within a system are made to a single ground to avoid creating ground loops.

site survey
Conducting a site survey, also known as a radio signal strength indication (RSSI), analyzes the radio communications link between the Gateway (or master radio) and any Node (or slave radio) within the network by analyzing the radio signal strength of received data packets and reporting the number of missed packets that required a retry.

slave ID
The slave ID is an identifying number used for devices within a Modbus system. When using more than one Modbus slave, assign each slave a unique ID number.

By default, Gateways are set to Modbus Slave ID 1.

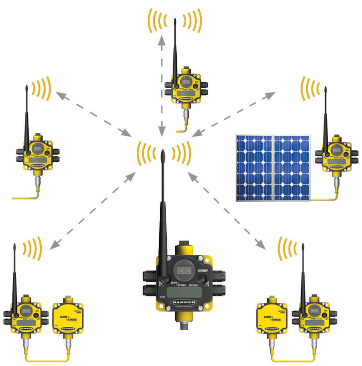
sleep mode
During normal operation, the Sure Cross radio devices enter **sleep mode** after 15 minutes of operation. The radio continues to function, but the LCD goes blank. To wake the device, press any button.

slow scan mode
(All internal battery models)In slow scan mode, the device enters a deeper sleep mode to conserve battery power after the device loses its communication link with its parent or master radio. The device wakes up periodically to search for its parent radio. If a parent or master radio is not found, the device goes back to sleep for another sleep cycle. If the parent or master radio is detected, the device exits slow scan mode. To manually exit slow scan mode, press the binding button.

SMA connector An SMA connector (SubMiniature version A) is a 50 ohm impedance connector used for coaxial RF connections and developed in the 1960s. An SMA connector is typically used between the radio and the antenna.

spread spectrum Spread spectrum is a technique in which the transmitter sends (or spreads) a signal over a wide range of frequencies. The receiver then concentrates the frequencies to recover the information. The Sure Cross radio devices use a version of spread spectrum technology called Frequency Hop Spread Spectrum.

star networks A star topology network is a point to multipoint network that places the network master radio in a center or hub position. Slave radios only transmit messages to the master radio, not to each other. These network layouts can be very flexible and typically operate relatively quickly. Slave radios acknowledge receipt of messages transmitted from the master radio.



For more information on Banner's star network products, refer to the Sure Cross Performance DX80 Wireless I/O Network Instruction Manual (p/n 132607)

switch power Efficient power management technology enables some *Flex*Power devices to include an internal power output supply, called switch power (SP), that briefly steps up to power sensors (ideally, 4 to 20 mA loop-powered sensors). The warmup time denotes how long the sensor must be powered before a reliable reading can be taken. After the warmup time has passed, the input reads the sensor, then the switched power shuts off to prolong battery life.

system operating margin (fade margin) The system operating margin, or fade margin, is the difference between the received signal level (in dBm) and the receiver sensitivity (also in dBm) required for reliable reception. It is recommended that the receiver sensitivity be more than 10 dBm less than the received signal level. For example, if the signal is about –65 dB after traveling through the air and the radio receiver is rated for -85 dB, the operating margin is 20 dB — an excellent margin.

tau filter Set to zero (0) to turn off the tau filter. Set to 1 (weakest filter) through 6 (strongest filter) to turn on the tau filter. (In the DX80 products, the Low Pass Filter is a combination of the median filter and the tau filter.)

TCP/IP TCP/IP stands for Transfer Control Protocol / Internet Protocol and describe several layers in the OSI model that control the transfer and addressing of information.

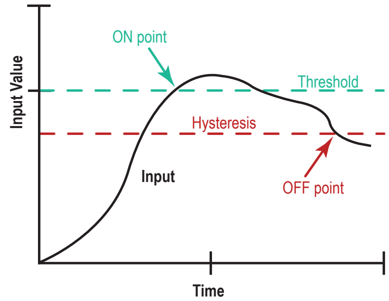
time-division multiple access (TDMA) TDMA is a wireless network communication architecture that provides a given slot of time for each device on the network, providing a guaranteed opportunity for each device to transmit to the wireless network master device.

thermistor A thermistor is a temperature-sensitive resistor that changes resistance based on temperature fluctuation.

thermocouple A thermocouple is a temperature measuring device consisting of two dissimilar metals joined together so that the difference in voltage can be measured. Voltage changes in proportion to temperature, therefore the voltage difference indicates a temperature difference.

The different “types” of thermocouples use different metal pairs for accuracy over different temperature ranges. Thermocouples are inexpensive, relatively interchangeable, have standard connectors, and have a wide temperature range of operation. They can be susceptible to noise, with the wire length affecting accuracy. Thermocouples are best suited for applications with large temperature ranges, not for measuring small temperature changes over small ranges.

threshold and hysteresis Threshold and hysteresis work together to establish the ON and OFF points of an analog input. The threshold defines a trigger point or reporting threshold (ON point) for a sensor input. When the input value is higher than the threshold, the input is ON. Hysteresis defines how far below the threshold the analog input is required to be before the input is considered OFF. A typical hysteresis value is 10% to 20% of the unit's range.



In the example shown, the input is considered on at 15 mA. To consider the input off at 13 mA, set the hysteresis to 2 mA. The input will be considered off when the value is 2 mA less than the threshold.

Setting threshold and hysteresis points prevents inputs from oscillating between 'on' and 'off' when the input remains close to the threshold point.

timeout interval The Timeout Interval is the total elapsed time before the system flags an error condition. This is a calculated value from Polling Interval (sec) × Maximum Misses.

topology Topology is the pattern of interconnection between devices in a communication network. Some examples include point to point, bus, ring, tree, mesh, and star configurations.

transceiver A transceiver includes both a transmitter and receiver in one housing and shares circuitry; abbreviated as RxTx.

wireless sensor network (WSN) A wireless sensor network is a network of low-power electronic devices that combine sensing and processing ability. The devices use radio waves to communicate to a gateway device, connecting remote areas to the central control process.

Yagi Yagi is the name commonly given to directional antennas. The full name of the antenna is a Yagi-Uda antenna, named for the developers Shintaro Uda and Hidetsugu Yagi, both of Tohoku Imperial University in Sendai, Japan. Yagi antennas may also be called beam antennas or directional antennas.