DXM100-Sx Wireless Modbus Server Product Manual

Original Instructions
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Chapter 1 DXM100-Sx Overview

DXM100-Sx Hardware Configuration Overview

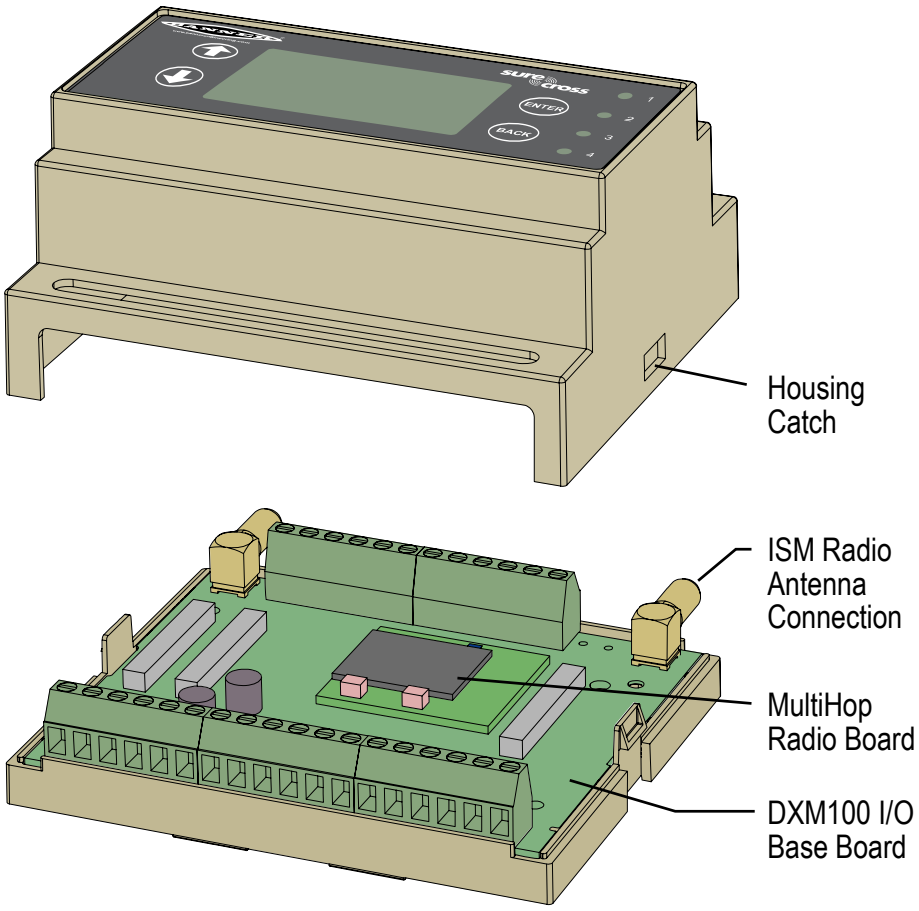
The DXM100 can have multiple configurations. The DXM100 will have a model number label on the housing. Use the model number and model table in the datasheet to identify which boards are included in the controller.

When opening the DXM100, 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.

DXM100-Sx hardware overview



The DXM100 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) or lithium ferrophosphate (LFP) battery. The battery connection can also be used with line power to provide a battery backup in case of line power outages.

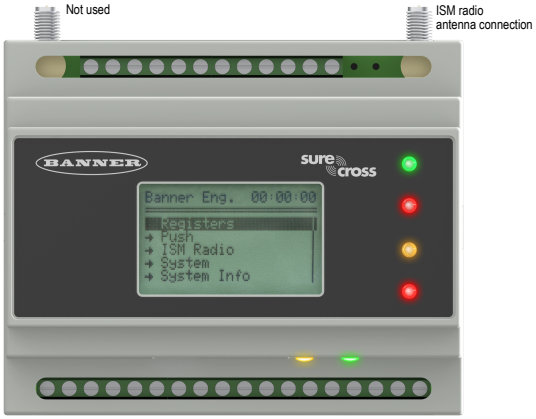
The ISM radio fits on the I/O base board in the parallel sockets. Install the ISM radio so the U.FL antenna connection is to the side with the SMA antenna connectors. Connect the U.FL cable from the ISM radio U.FL to the right-side U.FL connector. The ISM radio boards are available with either a 900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

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DXM100-S1 System Overview

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

Inputs and Outputs	Connectivity	User Interface
Universal Inputs	Sure Cross® Radios	LCD
Discrete Outputs	RS-485	Four Buttons
Courtesy Power		
Switch Power		



Inputs and Outputs

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

Universal inputs, discrete outputs, courtesy power outputs, switch power 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

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

User Interface

LCD and four buttons

Use the LCD to access system status and setup, view user-selectable events or data, and bind Sure Cross radios.

DXM100-S1 Models

Model	Power In	Power Out	Inputs / Outputs	Radio
DXM100-S1	12-30 V DC, Solar, or Battery	Two selectable 5 V or 16 V switched power, one 5 V courtesy power	Inputs: Four universal Outputs: Four NMOS, two 0-10V or 4-20mA analog	None
DXM100-S1R2				900 MHz HE5 MultiHop Data Radio (North America)

The following models are no longer available for order but are still covered by the information in this document.

- DXM100-S1R4 (2.4 GHz HE5 MultiHop Radio)

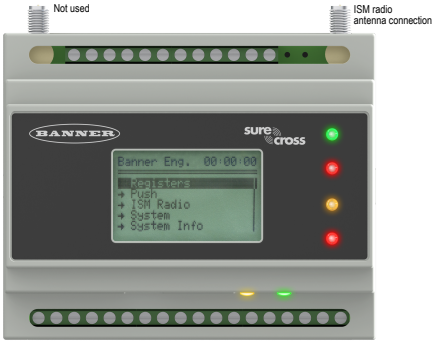
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DXM100-S2 System Overview

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

Inputs and Outputs	Connectivity	User Interface
Universal Inputs	Sure Cross Radios	LCD
DIscrete Outputs	RS-485	Four Buttons
Courtesy Power		
Switch Power		
DC Latching Outputs		
Analog Outputs		
SDI-12 Sensor Interface		

Inputs and Outputs



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

Universal inputs, discrete outputs, courtesy power and switched power outputs, analog outputs

Battery backup, solar controller, DC latching solenoid outputs, SDI-12 sensor interface

Connectivity

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

Wired Connectivity -- Field Bus: Modbus RS-485

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

User Interface

LCD and four buttons

Use the LCD to access system status and setup, view user-selectable events or data, and bind Sure Cross radios.

DXM100-S2 Models

Model	Power In	Power Out	Inputs / Outputs	Radio
DXM100-S2	12-30 V DC, Solar, or Battery	Two adjustable 5-24 V switched power, one SDI switched power, one 5 V courtesy power	Inputs: Four universal Outputs: Four NMOS, two 0-10 V analog, two DC latching	None
DXM100-S2R2				900 MHz HE5 MultiHop Data Radio (North America)

The following models are no longer available for order but are still covered by the information in this document.

- DXM100-S2R4 (2.4 GHz HE5 MultiHop Radio for Worldwide use)

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DXM Configuration Software Overview (Sx Models)

Download the latest version of all configuration software from http://www.bannerengineering.com. For more information on using the DXM Configuration Software, refer to the instruction manual (p/n 209933).

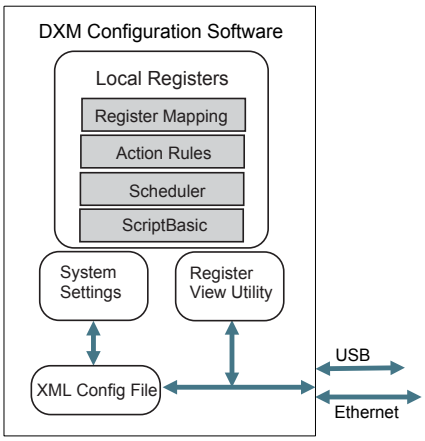
The configuration software configures the DXM client by creating an XML file that is transferred to the DXM client using a USB or Ethernet connection. The DXM client can also receive the XML configuration file from a Web server using a cellular or Ethernet connection.

This configuration file governs all aspects of the DXM client and server operation.

The wireless network devices are a separate configurable system. Use the MultiHop Configuration Software to configure the internal DX80 client radio and the wireless server nodes bound to it.

All configuration software can be connected to the DXM client using a USB cable or an Ethernet connection.

Overview of the configuration software features



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Chapter 2 Configuration Instructions

Quick Start Guide

Follow these steps to set up your DXM100-Sx Wireless Modbus Server.

1. Configure the ISM radio using the LCD Menu system or DIP switches (see "DIP Switch Settings for the MultiHop HE5 Board Module" on page 16).
2. Configure the I/O board using the LCD Menu system or DIP switches (see "DIP Switches for the IO Board" on page 17).
3. Connect the communication pins (see "Connecting the Communication Pins" on page 8).
4. Apply power (see "Applying Power to the DXM100-Sx Controller" on page 8).
5. Bind your DXM100 to its client radio (see "Binding the ISM Radio of a Modbus Server" on page 9).
6. Configure your I/O (see "Inputs and Outputs" on page 9).

Connecting the Communication Pins

The base board communications connection for an 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 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 server 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 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 +	

Applying Power to the DXM100-Sx Controller

Apply power to the DXM100-Sx Wireless Modbus Server using either 12 to 30 V DC or a 12 V DC solar panel with a 12 V sealed lead acid battery or 12 V lithium ferrophosphate battery.

Pin	Description
Pin 1	No connection
Pin 2	12 to 30 V DC input (+) or solar panel connection (+)
Pins 3, 5, 8, 17, 26, 29	Main logic ground for the DXM100-Sx Wireless Modbus Server
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 or lithium ferrophosphate (LFP) battery.

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Connecting a Battery

When attaching a battery to the DXM100 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 only with a sealed lead acid (SLA) or lithium ferrophosphate (LFP) battery..

- 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 backup battery (default configuration), connect the incoming main power pin 2 (+) and to pin 3 (-). Connect the 12 V battery to pin 4 (+) and pin 5 (-). The incoming main power must be 15 to 30 V DC to charge the battery.

Supplying Power from a Solar Panel

To power the DXM100-Sx Wireless Modbus Server from a 12 V DC solar panel, connect the solar panel to power pins 2(+) and 3(-). Connect a 12 V DC SLA or LFP 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 DXM100 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 (ID 11):

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

Binding the ISM Radio of a Modbus Server

A DXM100 (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 DXM100 (as either a repeater or server radio) to its client radio, follow the MultiHop binding instructions. If the binding instructions are not included in the client 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 client radio during binding using the client radio's rotary dials or the DXM Controller's LCD Binding menu. For example, if the client's binding number is 25, the DXM Server ISM radio's Modbus ID is set to 25.

By default, the I/O board's Modbus ID is set to 11.

- For DXM Server models without an LCD, use the I/O board DIP switches to change the Modbus ID.
- For DXM Server models with an LCD, the DIP switches are set by the factory to allow the user to change the Modbus ID of the I/O board and ISM radio using the menu system. For more information, see "LCD and Menu System (DXM100-Sx)" on page 21.

Use the MultiHop Configuration Software to display and configure a MultiHop radio network. With the DXM100, 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.

Inputs and Outputs

The I/O base board is a Modbus server device that communicates using Modbus commands. Refer to the Modbus Registers section for more descriptions of each Modbus register on the DXM100-Sx Wireless Modbus Server.

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Universal Inputs

The universal inputs on the DXM100-Sx Wireless Modbus Server can be programmed to accept several different types of inputs:

- Discrete NPN/PNP
- 0 to 20 mA analog
- 0 to 10 V analog
- 10k temperature thermistor
- Potentiometer sense
- Bridge
- NPN raw fast

Any input can be used as a synchronous counter by configuring the input as a discrete NPN/PNP input.

To configure the input type, use the DXM Configuration Software or the LCD menu system (see "LCD and Menu System (DXM100-Sx)" on page 21) to write to the appropriate Modbus registers in the I/O board.

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. Refer to the DXM100 Controller Instruction Manual (p/n 190037) 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 IO Registers for the DXM100-S1x IO Base Board" on page 27 for universal input register definitions.

Pin	Universal Input	Modbus Register	Description
27	4	4	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 defined in "Modbus IO Registers for the DXM100-S1x IO Base Board" on page 27. 0 = NPN 1 = PNP 2 = 0 to 20 mA 3 = 0 to 10 V DC 4 = 10k Thermistor 5 = Not used 6 = Not used 7 = Bridge 8 = NPN Raw Fast (default)
28	3	3	
31	2	2	
32	1	1	

Thermistor Input

A thermistor input must use a 10k temperature 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 Modbus registers defined in "Modbus IO Registers for the DXM100-S1x IO Base Board" on page 27.

Potentiometer Input

A potentiometer input is created from three inputs: a voltage source (pin 30) that supplies 5 V to the potentiometer and two inputs set to voltage inputs to read the voltage across the potentiometer. See the DXM tech note for setting up a potentiometer.

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.

Synchronous Counters

When an input is configured as a counter (inputs set to NPN/PNP), the input counts the input signal transitions. The count 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 10.

Synchronous counter sample the inputs every 10 ms. The input logic does not detect rising or falling edges, but instead 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.

Example: Configure Input 1 as a Synchronous Counter

1. Change the **Source Register** selection to **I/O Board Registers**.
2. In the **Write Registers** area, write Modbus register 4908 to 1 to enable counting on the rising edge of the input signal.
3. Read Modbus registers 4910 and 4911 to get the 32-bit value of the count.

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Example: Change Universal Input 2 to a 0–10 V DC Input

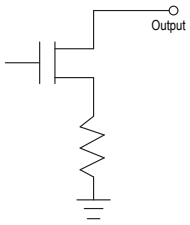
1. Write a 3 to Modbus register 3326 on Modbus ID 11 (I/O board).
2. Cycle power to the device.
3. Using the **Register View** tab, read register 3326 to verify it is set to 3.

Example: Change Analog Output 1 to a 0–10 V DC Output

1. Change the **Source Register** selection to **I/O Board Registers**.
2. 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.
3. Write a 3 to Modbus register 4008 on Modbus ID 11 (I/O board).
4. Cycle power to the device.
5. Using the **Register View** tab, read register 4008 to verify it is set to 3.

NMOS Outputs for the DXM100

NMOS output pins for the DXM100 models

Pin	NMOS Discrete Outputs	Modbus Register	Description	Wiring
22	4	504	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	
23	3	503		
24	2	502		
35	1	501		

Analog (DAC) Outputs for the B1 and S1 Models

The B1 and S1 analog outputs may be configured as either 0 to 20 mA outputs (default) or 0 to 10 V outputs.

To change the analog (DAC) output type:

1. Remove power to the device.
2. Remove the DXM cover.
3. Change the hardware jumper position (see the table for the pin number and "DXM100-S1 I/O Base Board Connections" on page 18 for the pin locations).
4. Replace the DXM cover.
5. Restore power to the DXM.
6. Set the Output Type Select Modbus register (on the I/O board, ID 200) to a value of 2 (default) to select 0 to 20 mA or a value of 3 to select 0 to 10 V. For analog output 1 write to Modbus register 4008, for analog output 2 write to Modbus register 4028 (see the table for the values).

DXM100/1000-B1 and S1 Models			
Pin	**Analog Output**	**Modbus Register**	**Description**
20	1	507	0 to 20 mA or 0 to 10 V DC output (I/O board jumper selectable) Accuracy: 0.1% of full scale +0.01% per °C Resolution: 12-bit
19	2	508	

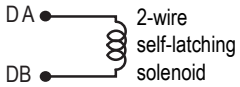
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Analog (DAC) Outputs for the B2 and S2 Models

The B2 and S2 analog outputs are 0 to 10 V dc outputs and cannot be changed.

DXM100/1000-B2 and S2 Models			
Pin	**Analog Output**	**Modbus Register**	**Description**
20	1	509	0 to 10 V DC output Accuracy: 0.1% of full scale +0.01% per °C Resolution: 12-bit
19	2	510	

DC Latching Outputs for the B2 and S2 Models

Pin	DC Latching Outputs	Modbus Register	Description	Wiring
9	D1A	507	Write a 1 to the output register to activate the DC Latching output from A to B. Write a 0 to the output register to deactivate the DC Latching output from B to A.	
10	D1B			
11	D2A	508		
12	D2B			

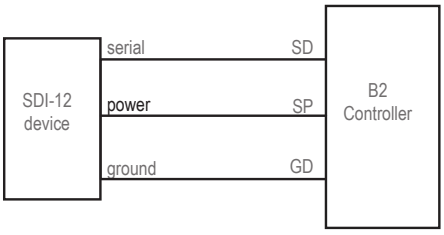
The DXM Configuration Software allows the user to adjust parameters that govern the operation of the DC latch outputs. Most applications will not require any changes for correct operation. Software parameters include:

- **Enable H-Bridge**—Enable or disable the H-bridge output. Default Enabled.
- **Voltage**—The voltage applied to the output when the output is activated. Default 13 V DC.
- **Cap Warmup Time**—The amount of time given to charge the output capacitor. The more time given to charge the output capacitor the more energy will be available to turn on the output. Default 80 ms
- **Switch Time**—The amount of time the output is turned on to be able to change the solenoid output. Default 40 ms

SDI-12 Interface for the B2 and S2 Models

The SDI-12 interface on the B2 Wireless Controllers can support up to five devices with twelve 32-bit register values each. The SDI-12 interface can be configured to increase the number of registers per device address for devices with large register sets. The factory default enables one SDI-12 device using device address 1 with up to nine registers with a SDI-12 command of "M!".

Use the configuration software or the LCD menu system to adjust the SDI-12 parameters.



Basic SDI-12 Interface Parameters

Up to five devices/commands can be accessed using the SDI-12 interface. There are three parameters for each device/command: Enable, Device Address, Device Command. For more information, refer to the SDI-12 Technical Notes.

enable. Instructs the DXM100 device to activate or deactivate the SDI-12 device. Write a 1 to enable, and write a 0 to disable. The factory default for device 1 is enabled; devices 2 through 5 are disabled.

device address. Each SDI-12 device must have a unique device address. This parameter is the ASCII code for the device address. Valid device addresses are `0–9` and `a–z` that map to ASCII codes `48–57` and `97–122`, respectively. The factory default addresses are:

- SDI-12 Device 0 uses ASCII code 48
- SDI-12 Device 1 uses ASCII code 49
- SDI-12 Device 2 uses ASCII code 50
- SDI-12 Device 3 uses ASCII code 51
- SDI-12 Device 4 uses ASCII code 52

device command The SDI-12 interface supports "M!" or "C!" commands. Use the Device Command parameter to define which command to use for this device. The factory default is "M!" commands for all devices (value of 10 in the Modbus register).

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Supported M! commands

SDI-12 Command	Register Value	SDI-12 Command	Register Value
xM!	0 or 10	xM5!	15
xM1!	11	xM6!	16
xM2!	12	xM7!	17
xM3!	13	xM8!	18
xM4!	14	xM9!	19

Supported C! commands

SDI-12 Command	Register Value	SDI-12 Command	Register Value
xC!	1 or 20	xC5!	25
xC1!	21	xC6!	26
xC2!	22	xC7!	27
xC3!	23	xC8!	28
xC4!	24	xC9!	29

The Modbus configuration registers are listed. All registers are defined as Modbus holding registers. The factory default values are shown in parentheses. All values are in decimal unless noted otherwise.

Device/CMD Configuration	Registers (Default Value)		
	Enable	Device Address	Device Command
SDI-12 Device/CMD 1	1751 (1)	11001 (48) [1]	11002 (10)
SDI-12 Device/CMD 2	1701 (0)	11201 (49)	11202 (10)
SDI-12 Device/CMD 3	1651 (0)	11401 (50)	11402 (10)
SDI-12 Device/CMD 4	1601 (0)	11601 (51)	11602 (10)
SDI-12 Device/CMD 5	1551 (0)	11801 (52)	11802 (10)

SDI-12 Device Result Registers

The result registers store all information received from the SDI-12 devices.

The registers are 16-bit registers and require two registers to store a 32-bit value. The factory default configuration defines the result registers as 32-bit registers, floating point format, and the first nine result registers are enabled for use. A host system reads the SDI-12 device data from these registers.

Result Registers	Register 1	Register 2	Register 3	Register 4	Register 5	Register 6
SDI-12 Device/CMD 1 Result Upper	11101	11103	11105	11107	11109	11111
SDI-12 Device/CMD 1 Result Lower	11102	11104	11106	11108	11110	11112
SDI-12 Device/CMD 2 Result Upper	11301	11303	11305	11307	11309	11311
SDI-12 Device/CMD 2 Result Lower	11302	11304	11306	11308	11310	11312
SDI-12 Device/CMD 3 Result Upper	11501	11503	11505	11507	11509	11511
SDI-12 Device/CMD 3 Result Lower	11502	11504	11506	11508	11510	11512
SDI-12 Device/CMD 4 Result Upper	11701	11703	11705	11707	11709	11711
SDI-12 Device/CMD 4 Result Lower	11702	11704	11706	11708	11710	11712
SDI-12 Device/CMD 5 Result Upper	11901	11903	11905	11907	11909	11911
SDI-12 Device/CMD 5 Result Lower	11902	11904	11906	11908	11910	11912

[1] The default device addresses 48 through 52 are in ASCII.

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Result Registers	Register 7	Register 8	Register 9	Register 10	Register 11	Register 12
SDI-12 Device/CMD 1 Result Upper	11113	11115	11117	11119	11121	11123
SDI-12 Device/CMD 1 Result Lower	11114	11116	11118	11120	11122	11124
SDI-12 Device/CMD 2 Result Upper	11313	11315	11317	11319	11321	11323
SDI-12 Device/CMD 2 Result Lower	11314	11316	11318	11320	11322	11324
SDI-12 Device/CMD 3 Result Upper	11513	11515	11517	11519	11521	11523
SDI-12 Device/CMD 3 Result Lower	11514	11516	11518	11520	11522	11524
SDI-12 Device/CMD 4 Result Upper	11713	11715	11717	11719	11721	11723
SDI-12 Device/CMD 4 Result Lower	11714	11716	11718	11720	11722	11724
SDI-12 Device/CMD 5 Result Upper	11913	11915	11917	11919	11921	11923
SDI-12 Device/CMD 5 Result Lower	11914	11916	11918	11920	11922	11924

SDI-12 Device Settings

The following are generic sampling, power, and warmup parameters that should work for all SDI-12 devices. See the tested device table below. In most cases, parameters will not need to be adjusted but if needed there are three common SDI-12 device parameters that control the communications and power of the SDI-12 device. Contact Banner Engineering Corp support for more guidance.

sample rate

Formed using two 16-bit parameters, a HI word and a LOW word. The sample rate is how often the SDI-12 device is powered up, then interrogated for data. The value in the registers is the number of 0.010 second counts. For example, the default values are HI word (1) and LOW word (24,464), which after combining the words in hexadecimal will calculate to 90,000 × 0.010 seconds. Adjusting this value affects the battery life.

warmup time

Amount of time to wait, in 0.010 second increments, from powering on the device to the time to send communications to the device. The default value is 200, or 200 × 0.010 seconds. Adjusting this value affects the battery life.

voltage

The default voltage setting is approximately 6.7 volts or a register value of 148. Adjusting this value affects the battery life.

	Registers (Default Value)							
Device / Cmd Configuration	Enable	Device Address	Switch Power Enable	Device Command	Sample Hi	Sample Low	Warmup Time	Voltage
SDI-12 Device/CMD 1	1751 (1)	11001 (48) (2)	1754 (4)	11002 (10)	1752 (1)	1753 (24464)	1755 (200)	1756 (148)
SDI-12 Device/CMD 2	1701 (0)	11201 (49)	1704 (4)	11202 (10)	1702 (1)	1703 (24464)	1705 (200)	1706 (148)
SDI-12 Device/CMD 3	1651 (0)	11401 (50)	1654 (4)	11402 (10)	1652 (1)	1653 (24464)	1655 (200)	1656 (148)
SDI-12 Device/CMD 4	1601 (0)	11601 (51)	1604 (4)	11602 (10)	1602 (1)	1603 (24464)	1605 (200)	1606 (148)
SDI-12 Device/CMD 5	1551 (0)	11801 (52)	1554 (4)	11802 (10)	1552 (1)	1553 (24464)	1555 (200)	1556 (148)

These SDI-12 probes have been tested and are functional with the factory default settings.

MFG	Models	Technical Note
Acclima	SEN-SDI (TDT SDI-12 Soil Moisture Sensor)	SDI-12 and the Acclima TDT SDI-12 Soil Moisture Probe (p/n b_4182040)
Adcon Telemetry	HydraProbeII	

Continued on page 15

(2) The default device addresses 48 through 52 are in ASCII.

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Continued from page 14

MFG	Models	Technical Note
AquaCheck	Sub-surface Probe	SDI-12 and the AquaCheck Sub-Surface Soil Moisture Probe (p/n b_4182041)
Decagon	MPS-2, MPS-6, 5TE, TS1, T8	SDI-12 and the Decagon 5TE Soil Moisture Probe (p/n b_4182042) SDI-12 and the Decagon GS3 Soil Moisture Probe (p/n b_4182043) SDI-12 and the Decagon MPS-2 Soil Moisture Probe (p/n b_4182044)
HSTI	HydraScout	SDI-12 and the HydraScout HSTI Probe (p/n b_4182045)
Sentek	EnviroSCAN	SDI-12 and the Sentek EnviroScan Soil Moisture Probe (p/n b_4182046)

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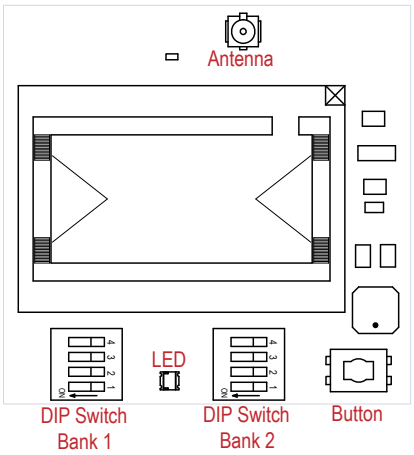
Chapter 3 Internal Board Modules

ISM Radio Board (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 DXM models with a display, set the radio options using the LCD menu.

ISM radio board



Button Operation

For DXM models without an LCD, use the button to bind the ISM radio. For models with an LCD, 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.

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				
Disable serial (low power mode) and enable the receiver slots select for switches 1-2			ON	ON				
Transmit power 900 MHz radios: 500 mW (27 dBm) 2.4 GHz radios: 65 mW (18 dBm) and 60 ms frame					OFF*			
Transmit power 900 MHz radios: 250 mW (24 dBm) 2.4 GHz radios: 65 mW (18 dBm) and 40 ms frame					ON			
Application mode: Modbus						OFF*		
Application mode: Transparent						ON		
MultiHop radio setting: Repeater							OFF	OFF
MultiHop radio setting: Client							OFF	ON
MultiHop radio setting: Server							ON	OFF
MultiHop radio setting: DXM LCD Menu Control							ON*	ON*

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* Default configuration

Application Mode

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

Modbus mode uses the Modbus protocol for routing packets. In Modbus mode, a routing table is stored in each parent device to optimize the radio traffic. This allows for point-to-point communication in a multiple data radio network and acknowledgment/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 acknowledgment of the data packets to provide better throughput. In transparent mode, there is no access to the radio's I/O.

Baud Rate and Parity

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

Disable Serial

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.

Transmit Power Levels/Frame Size

The 900 MHz data radios can be operated at 500 mW (27 dBm) or 250 mW (24 dBm). For most models, the default transmit power is 500 mW.

For 2.4 GHz radios, the transmit power is fixed at 65 mW (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.

DIP Switches for the IO Board

The DXM100-Sx Wireless Modbus Server I/O board DIP switches are set from the factory to Modbus ID 11.

Set the Modbus ID on the IO Base Board (for Models without LCDs)

For DXM Server models without an LCD menu system, use DIP switches J and K to set the Modbus ID.

This device can use Modbus register 6804 in the I/O board to access the full range of Modbus IDs.

DIP Switch location J defines the course group of Modbus IDs. DIP Switch 4 must be set to ON for DXM100-S1, DXM100-S2, DXM100-S1R2, and DXM100-S2R2 models.

Settings	Location J DIP Switches			
	1	2	3	4
Modbus ID set to 11 through 19	OFF	OFF		
Modbus ID set to 20 through 29	ON	OFF		
Modbus ID set to 30 through 39	OFF	ON		
Modbus ID set to 40 through 49	ON	ON		
Not Used			-	
Modbus Server Configuration (DX100-S1 and -S1R2 models only) [3]				ON
Standard Communication Mode				OFF

The DIP switches at location K define the lower digit of the Modbus ID.

[3] Must be in the ON position for the -S1 and -S1R2 model)

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DIP Switches J		DIP Switch K, Switches 1, 2, 3, 4 (0 is OFF, 1 is ON)									
1	2	0,0,0,0	1,0,0,0	0,1,0,0	1,1,0,0	0,0,1,0	1,0,1,0	0,1,1,0	1,1,1,0	0,0,0,1	1,0,0,1
OFF	OFF	x [4]	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

DXM100-Sx Wireless Modbus Server Example—To set the DXM100-Sx Wireless Modbus Server to a Modbus ID of 34, set the following:

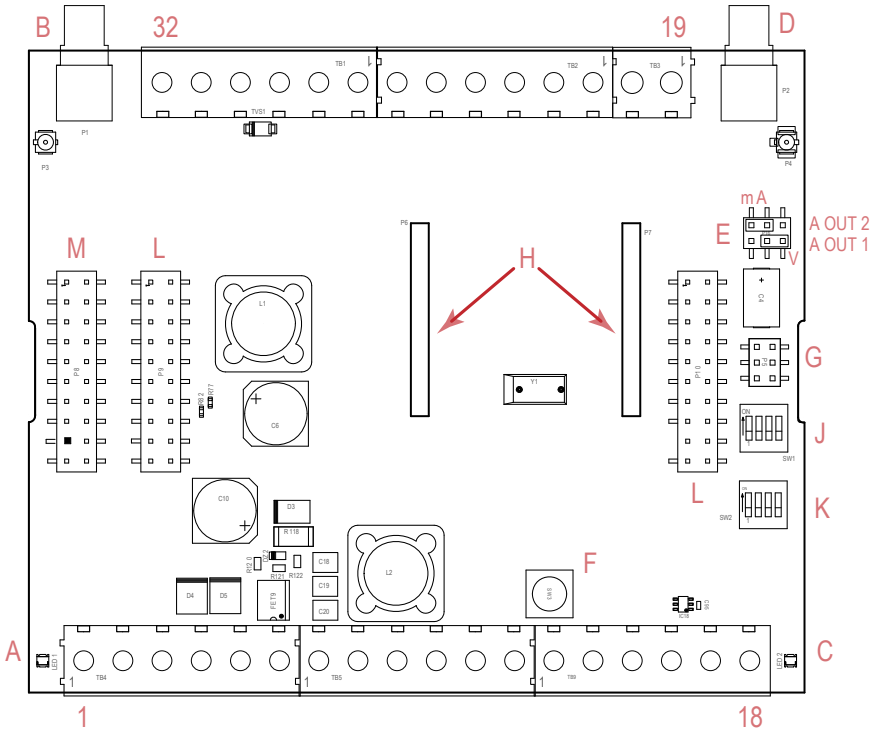
Location J DIP switches set to 1=OFF, 2=ON
Location K DIP switches set to 1=OFF, 2=OFF, 3=ON, 4=OFF

The location J DIP switches set the upper Modbus ID digit to 3 while the location K DIP switches set the lower digit to 4.

Setting the DXM I/O Board Modbus ID using Modbus Registers—Write to the I/O board's Modbus register 6804 to set the Modbus ID to any valid Modbus ID (1 through 245).

- For the DXM100-Sx Wireless Modbus Server model, all switches on DIP switch K should be in the OFF position to use the Modbus register server ID.

DXM100-S1 I/O Base Board Connections



1	No connection	12	Not used	23	N3. NMOS OUT 3
2	PW. 12 to 30 V DC or solar power in (+)	13	Not used	24	N2. NMOS OUT 2
3	GD. Ground	14	Not used	25	N1. NMOS OUT 1
4	B+. Battery in (< 15 V DC)	15	CL. CANL	26	GD. Ground
5	GD. Ground	16	CH. CANH	27	U4. Universal Input 4

Continued on page 19

[4] Uses value in Modbus register 6804.

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Continued from page 18

6	M-. Primary RS-485 -	17	GD. GND	28	U3. Universal Input 3
7	M+. Primary RS-485 +	18	P3. Courtesy Power 5 V	29	GD. Ground
8	GD. Ground	19	A2. Analog OUT 2	30	P1. Switch Power (5 V or 16 V)
9	Not used	20	A1. Analog OUT 1	31	U2. Universal Input 2
10	Not used	21	P2. Switch Power 2 (5 V or 16 V)	32	U1. Universal Input 1
11	Not used	22	N4. NMOS OUT 4		

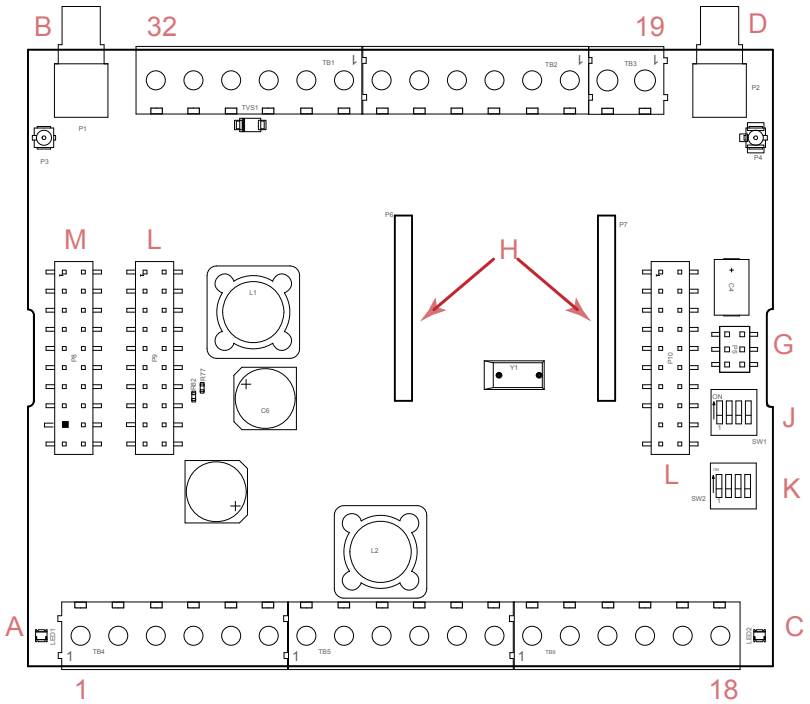
A	Base board LED	E	Jumpers - Configures Analog Out 1 and 2 for mA or V	J	Modbus Server ID DIP Switches
B	A1. Cellular or secondary antenna	F	Radio Binding Button	K	Modbus Server ID DIP Switches
C	Radio LED	G	Programming header	L	Processor Board Connection
D	A2. ISM Antenna	H	ISM Radio Board Connection	M	Display Connection

I/O Board Jumpers for the B1 and S1 Models

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.

Jumper	Function	Positions
E	Analog output characteristics for AO2 (pin 19) and AO1 (pin 20)	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.

DXM100-S2 I/O Base Board Connections



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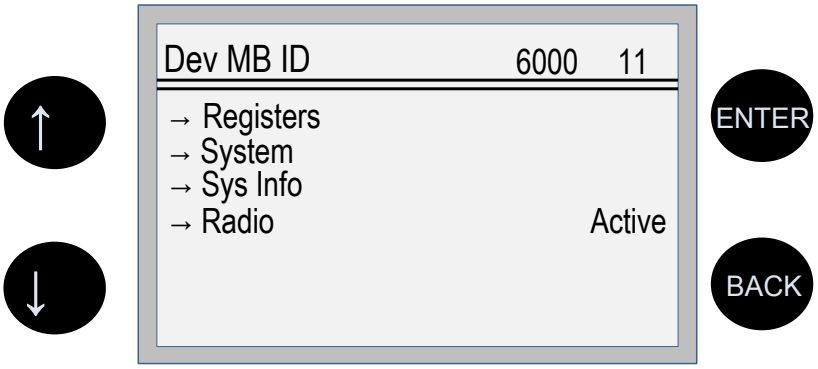
1	No connection	12	2B. DLatch 2B	23	N3. NMOS OUT 3
2	PW. 12–30 V DC or solar power in (+)	13	S-. Secondary RS-485 – (not used for the S2)	24	N2. NMOS OUT 2
3	GD. Ground	14	S+. Secondary RS-485 + (not used for the S2)	25	N1. NMOS OUT 1
4	B+. Battery in (< 15 V DC)	15	SP. SDI-12 Courtesy Power	26	GD. Ground
5	GD. Ground	16	SD. SDI-12 Data	27	U4. Universal Input 4
6	M-. Primary RS-485 –	17	GD. GND	28	U3. Universal Input 3
7	M+. Primary RS-485 +	18	P3. Courtesy Power 5 V	29	GD. Ground
8	GD. Ground	19	A2. Analog OUT 2 (0–10 V)	30	P1. Adjustable Courtesy Power (5–24 V)
9	1A. DLatch 1A	20	A1. Analog OUT 1 (0–10 V)	31	U2. Universal Input 2
10	1B. DLatch 1B	21	P2. Adjustable Courtesy Power (5–24 V)	32	U1. Universal Input 1
11	2A. DLatch 2A	22	N4. NMOS OUT 4		

A	Base board LED			J	Modbus Server ID DIP Switches
B	A1. Cellular or secondary antenna			K	Modbus Server ID DIP Switches
C	Radio LED	G	Programming header	L	Processor Board Connection
D	A2. ISM Antenna	H	ISM Radio Board Connection	M	Display Connection

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Chapter 4 LCD and Menu System

The LCD has four control buttons and a menu screen. The four buttons control the navigation of the menu system on the LCD.



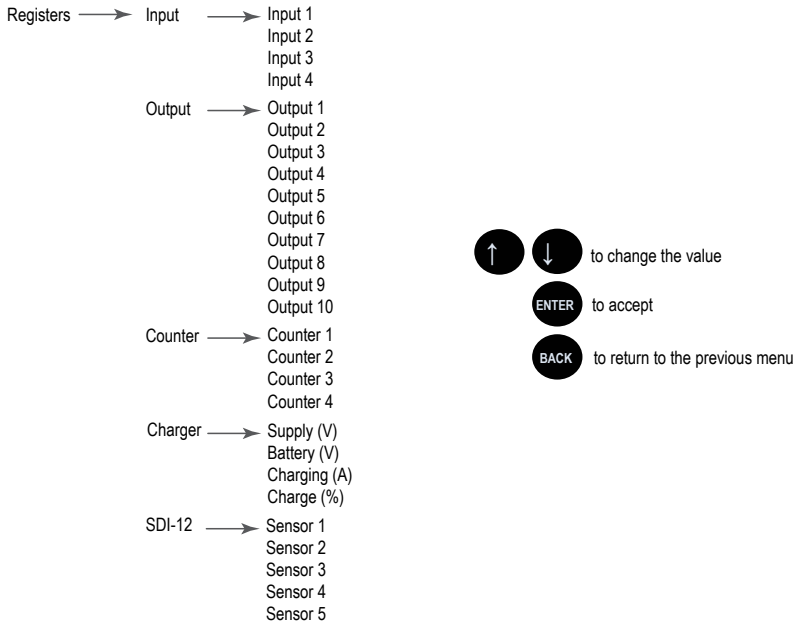
The top-level menu always displays the DXM server ID followed by the Modbus ID of the I/O board.

- The up and down arrows scroll through display items.
- The **ENTER** button selects the highlighted items on the display
- The **BACK** button returns to a previous menu option

The left display column shows an arrow at the beginning of the line if the menu has submenus. The right column shows a vertical line with an arrow at the bottom if the user can scroll down to see more menu items.

Registers

Use the **Registers** submenus to view input values, output values, input counter values, SDI-12 input values, and the charger status of the DXM server device. To change the configuration parameters, use the **System** menu.



The **Registers** menu includes the following submenus.

Charger

The on-board solar/battery charger of the DXM server device stores information about the charging circuit in Modbus registers. Use the LCD menu to view information about the incoming voltage, charging current, battery voltage, and battery charge percentage.

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Counters

Counters on the DXM server device base board are associated to inputs, but the count value is stored in a different register. Adjust or view the count register using the LCD menu.

Inputs

Lists the inputs. Depending upon the input type, the value and unit's information will also be displayed.

Outputs

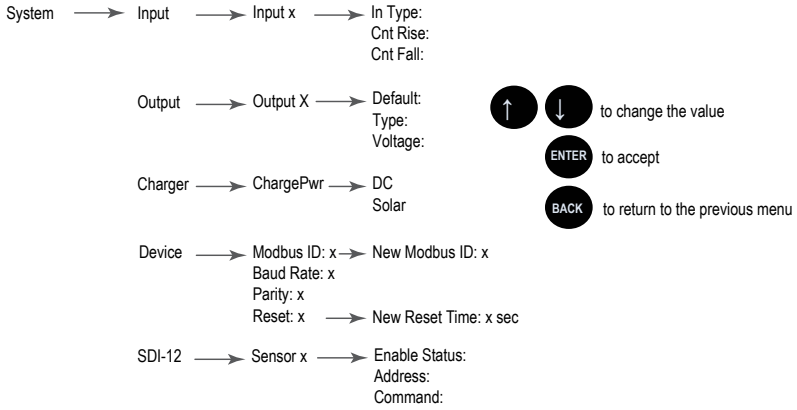
The DXM server device base configuration can include discrete, current, or voltage outputs. The output values will be displayed based on their configuration settings.

SDI-12

The SDI-12 interface can support up to five devices with twelve 32-bit register values each. The factory default enables one SDI-12 device using device address 1 with up to nine registers with the SDI-12 command of "M!".

System Config

Use the **System** submenus to change the configuration parameters for the inputs, outputs, charger, DXM server, and SDI-12 devices.



Inputs

Use the **Input** menu to change the input type. The universal inputs on the DXM are factory default as sinking inputs.

To change the input type:

1. Go to **System › Input menu**.
2. Select the input to change.
3. Select the input type. The available parameters include the **Input Type**, **Counter Rise**, and **Counter Fall Detect**.

Any input can be used as a synchronous counter by configuring the input as a discrete NPN/PNP input. For example, **Input 1** is mapped to **Counter 1** when it has been configured as NPN/PNP input with **Cnt Rise** or **Cnt Fall** enabled. All other inputs are mapped to their respective counters when configured in this manner.

DXM Display Input parameters

Input Type	Description	Input Range
Sinking	Discrete input, low active	0 or 1
Sourcing	Discrete input, high active	0 or 1
Current	Analog input, µA	0 to 20000
Voltage	Analog input, mV	0 to 10000
Thermistor 1	Thermistor input, 10k – G (r-t curve), beta(K) 3575	-400 to 850
Thermistor 2	Thermistor input, 10k – J (r-t curve), beta(K) 3890	-400 to 850

Outputs

Use the **Output** menu to change the default condition, output type, and switched power voltage.

1. Go to **System › Output** menu.
2. Select the output to change.

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3. Set the appropriate parameters. Available parameters may include **Default**, **Voltage**, and **Output Type**.

Output parameters

Output	Description	Settings
1	NMOS Sink, N1	Default: 0 or 1
2	NMOS Sink, N2	Default: 0 or 1
3	NMOS Sink, N3	Default: 0 or 1
4	NMOS Sink, N4	Default: 0 or 1
5	Switch Pwr, P1	Default: 0 or 1 Voltage: 5 V or 16V (S1); 5-24V (S2)
6	Switch Pwr, P2	Default: 0 or 1 Voltage: 5 V or 16V (S1); 5-24V (S2)
7	DC Latch, S2 Model Only	Default: 0 or 1
8	DC Latch, S2 Model Only	Default: 0 or 1
9	Analog I/V, A1	Default: 0-10V or 0-20mA Out Type: Voltage or Current (S1); Voltage (S2)
10	Analog I/V, A2	Default: 0-10V or 0-20mA Out Type: Voltage or Current (S1); Voltage (S2)

Charger

Use the **Charger** menu to change the charging algorithm for the battery.

This parameter can also be set by writing to Modbus register 6071 of the DXM server. See "Supplying Power from a Solar Panel" on page 9.

1. Go to **System › Output** menu.
2. Select the charging algorithm the DXM will use. The available parameters are **DC** and **Solar**.

Charger Parameters	Description
DC	Used when 12-24 V DC power supplies connected to the DXM power pins and the attached batteries are used as backup batteries. This limits the current during the battery charging process. (factory default setting)
Solar	Select Solar when a solar panel is connected to the power pins of the DXM. Solar panels are current-limited by their design and can charge the battery without managing the input power.

Device

Use the **Device** menu to change the Modbus ID and **Reset** parameters for the DXM server device.

1. Go to the **System › Device** menu.
2. Select **Modbus ID** to adjust and update the I/O board's ID within the Modbus network.
3. Change the **Baud Rate** and **Parity** settings using the DXM Configuration Software. These settings cannot be configured using the LCD menu system.
4. Reset the DXM Server.
    a. Select **Reset** and click **ENTER**.
    b. Use the up and down arrow buttons to enter a time delay value.
    c. Press **ENTER** to execute the function.

SDI-12

Use the **SDI-12** menu to adjust the parameters for SDI-12 sensors.

Up to five device/commands can be accessed using the SDI-12 interface. There are three parameters to configure for each device/command: **Enabled/Disabled**, **Device Address**, and **Device Command**. See "SDI-12 Interface for the B2 and S2 Models" on page 12.

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1. Go to the **System › SDI-12** menu.
2. Select the **Sensor** to configure.
3. Change the **Enabled/Disabled**, **Device Address** (0-9), and **M!** or **C!** command parameters as needed.

Supported M! commands

SDI-12 Command	Register Value	SDI-12 Command	Register Value
xM!	0 or 10	xM5!	15
xM1!	11	xM6!	16
xM2!	12	xM7!	17
xM3!	13	xM8!	18
xM4!	14	xM9!	19

Supported C! commands

SDI-12 Command	Register Value	SDI-12 Command	Register Value
xC!	1 or 20	xC5!	25
xC1!	21	xC6!	26
xC2!	22	xC7!	27
xC3!	23	xC8!	28
xC4!	24	xC9!	29

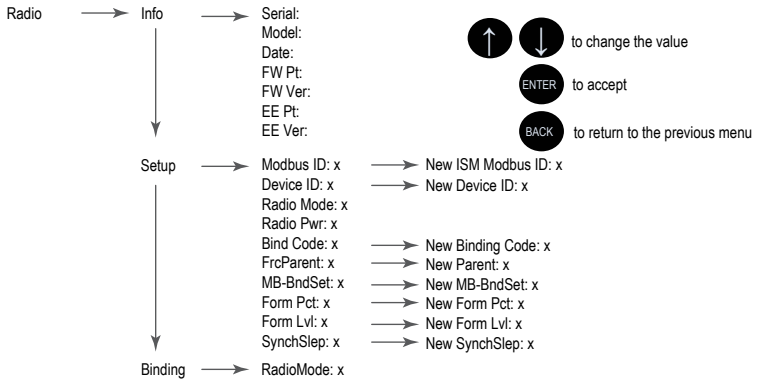
The SDI-12 Device Result Registers store all information received from the SDI-12 devices. These registers are found by navigating to **Registers › SDI-12 › Sensor x** menu.

System Info

Information about the DXM server device is shown on this screen. The serial number, model, date, firmware part numbers, and EEPROM version numbers for the I/O board are available. These parameters can be helpful for debugging. The System Information menu is read-only.

Radio

The **Radio** menu allows the user to view the Modbus ID of the internal ISM radio, enter binding mode, and view detailed information about the radio module within the DXM server device.



Info

Displays the radio serial number, model, date, firmware part numbers, and EEPROM version numbers.

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Setup

Modbus ID

The ISM radio is set at the factory to use Modbus device address 1 (Modbus ID 1). For most applications, you need to change the Modbus ID or allow the client radio to assign the new ID during the binding process. Adjust the Modbus device address using the LCD menu system. Any other method may cause the DXM to not know which Modbus device address is assigned to the radio, which causes issues running Binding or Site Surveys.

Set the radio Modbus ID to a valid number not being used by the DXM system for MultiHop radio networks (11 through 110 is typical). By default, the I/O board is set to ID 11.

When setting the new ISM Modbus ID, the system changes the Modbus ID on the internal radio and changes the reference to it on the DXM client. The reference Modbus ID is what the DXM server uses to access the internal radio when running Binding or Site Survey.

Device ID

A reference ID

Radio Mode

The user can configure the device as either a **Server** or **Repeater**.

A radio in **Server** mode operates as a traditional Modbus server by supplying information per request from the Modbus client.

A radio in **Repeater** mode operates simultaneously as a Modbus server and also forwards data from its subordinate servers to the Modbus client. A radio in Repeater mode has a higher power consumption as it must transmit more frequently. This additional power consumption must be considered when operating these devices in a solar/battery application (size of solar panel and battery).

Radio Power

The 900 MHz radios can transmit at a high or a low output option. The low output option reduces the radio's range but improves the battery life in short-range remote applications. For 2.4 GHz models, the transmit power is fixed. All radios within the same network must have identical radio output settings.

Binding Code

Setting the binding code allows the user to define the binding code with the ISM radio. Binding servers to a client radio ensures that the server radios only exchange data with the client they are bound to. After a client radio enters binding mode, the client automatically generates and transmits a unique binding code to all servers within range that are also in binding mode. Typically, you will not have to adjust this number unless you are replacing an existing server or client radio.

FrcParent

Force Parent Address

This is used to force the routing tree in the radio network. Leave the value as a zero (0) to allow automatic generation of the routing table for the MultiHop network in most applications.

MB-BndSet

Set Mobus Override from Binding

This is to set the Modbus address from the binding process or set it manually. Leave the value as one (1) to allow the system to create this automatically for most applications.

Form Pct

Synch Up Percent Limit

This is the synch-up percentage that the radio needs to see to enter the network during out-of-synch. Leave the value as 70% for most applications.

Form Lvl

Statistics Count Level

This limits the Synch Up Percent Limit (Form Pct) to only look at "green" packets. Leave the value as zero (0) for most applications.

SynchSlep

Disable Passive Scan

This disables the slow scan mode if the device is found for 15 minutes. Leave the value as one (1) for most applications.

Binding

Pressing **ENTER** on this option is equivalent to triple-clicking the binding button on the internal ISM radio.

The DXM server contains two boards: a MultiHop ISM radio and an I/O base board. Each board is a separate Mobus device and requires a unique Modbus ID.

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- 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 by the client radio during the binding process.
- The I/O board must have a unique Modbus ID of 11-247 to access the I/O register data. The default is set to ID 11.

Bind a DXM Server to a DXM Client using the Server LCD

Follow these steps to bind a DXM server to a DXM client radio. To bind your DXM server to a non-DXM client, refer to their respective datasheets or manuals for binding instructions.

1. Apply power to all MultiHop radios and place the MultiHop radios configured as servers or repeaters at least two meters apart from the client radio.
2. Enter binding mode on the DXM Client radio.
    a. Use the arrow keys to select the **ISM Radio** menu on the LCD and press **ENTER**.
    b. Highlight the **Binding** menu and press **ENTER**.
    c. Use the arrow keys to change the **Bind to >** number by selecting the unique Modbus ID of the DXM server/repeater's ISM radio. Banner recommends using Modbus ID 1 and then incrementing this ID for each subsequent server/repeater radio.

    The screen indicates the DXM client is in binding mode.
3. Enter binding mode on the DXM Server/Repeater radio.
    a. Use the arrow keys to select the **ISM Radio** menu on the LCD and press **ENTER**.
    b. Highlight the **Binding** option and press **ENTER**. Pressing **ENTER** on this option is equivalent to triple-clicking the binding button on other MulitHop devices.
    c. The screen indicates the server/repeater radio has **Bound** to the client radio. Press the **BACK** button until you reach the main menu of the server/repeater radio.
4. Repeat Steps 2 and 3 for as many server/repeater radios as are needed for your network.
5. When all server/repeater radios are bound to the client, exit binding mode on the client radio by pressing the **BACK** button until you reach the main menu.

All radio devices begin to form the network after the client radio exits binding mode.

Server/Repeater Radios Synchronize to the Client Radios -- The synchronization process enables a Sure Cross® radio to join a wireless network formed by a client radio. After power-up, synchronization may take a few minutes to complete. First, all radios within range of the client data radio wirelessly synchronize to the client radio. These radios may be server radios or repeater radios. After repeater radios are synchronized to the client radio, any radios that are not in sync with the client but can "hear" the repeater radio will synchronize to the repeater radios. Each repeater “family” that forms a wireless network path creates another layer of synchronization process. The table below details the process of synchronization with a parent. When testing the devices before installation, verify the radio devices are at least two meters apart or the communications may fail.

Server and Repeater LED Behavior

All bound radios set to server or repeater modes follow this LED behavior after powering up. The LEDs are located on the DXM's internal ISM radio,

Process Steps	Response	LED
1	Power is supplied to the radio.	Solid amber
2	The server/repeater searches for a parent device.	Flashes red (1 per 3 sec)
3	A parent device is detected. The server/repeater searches for other parent radios within range.	Solid red
4	The server/repeater selects a suitable parent.	Solid amber
5	The server/repeater attempts to synchronize to the selected parent.	Solid red
6	The server/repeater is synchronized to the parent.	Flashes green
7	The server/repeater enters RUN mode.	Solid green, then flashes green
	Serial data packets begin transmitting between the server/repeater and its parent radio.	Flashes amber

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Chapter 5 Additional Information

Adjusting the Receive Slots and Retry Count Parameters

The number of receive slots governs how often a MultiHop device can communicate on the wireless network.

Battery-powered devices typically have DIP switches that allow the user to set the number of receive slots, which directly affects the battery life of the radio. Adjusting the receive slots changes how often a message can be received. By default, the receive slots are set to 4 (every 1.3 seconds). When the receive slots are set to 32, the radio listens for an incoming message every 0.16 seconds.

Users may also leave the retry mechanism to the application that is accessing the wireless network, in this case the DXM100. Adjust the number of retries in the MultiHop devices by writing the number of retries desired to Modbus register 6012. The factory default setting is 8.

Modbus Register Summary

Modbus IO Registers for the DXM100-S1x IO Base Board

The I/O base board stores the input and output values in Modbus holding registers. Since the I/O base board is defined as a separate device, configure the DXM100 to read or write the values on the I/O base board.

Base Board Input Connection		
Modbus Register	**Range**	**Description**
1	0–65535	Universal input 1
2	0–65535	Universal input 2
3	0–65535	Universal input 3
4	0–65535	Universal input 4

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.

Base Board Output Connection		
Modbus Register	**Range**	**Description**
501	0–1	NMOS Output 1
502	0–1	NMOS Output 2
503	0–1	NMOS Output 3
504	0–1	NMOS Output 4
505	0–1	Switched Power 1 (5 V or 16 V)
506	0–1	Switched Power 2 (5 V or 16 V)
507	0–20000	Analog Output 1 default (0-20.000 mA)
	0–10000	Analog Output 1 (0-10.000 V)

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Base Board Output Connection		
Modbus Register	**Range**	**Description**
508	0–20000	Analog Output 2 default (0-20.000 mA)
	0–10000	Analog Output 2 (0-10.000 V)

Modbus IO Registers for the DXM100-S2x IO Base Board

The I/O base board stores the input and output values in Modbus holding registers. Since the I/O base board is defined as a separate device, configure the DXM100 to read or write the values on the I/O base board.

Base Board Input Connection		
Modbus Register	**Range**	**Description**
1	0–65535	Universal input 1
2	0–65535	Universal input 2
3	0–65535	Universal input 3
4	0–65535	Universal input 4

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.

Base Board Output Connection		
Modbus Register	**Range**	**Description**
501	0–1	NMOS Output 1
502	0–1	NMOS Output 2
503	0–1	NMOS Output 3
504	0–1	NMOS Output 4
505	0–1	Switched Power 1 (5 V or 16 V)
506	0–1	Switched Power 2 (5 V or 16 V)
507	0–20000	Analog Output 1 default (0-20.000 mA)
	0–10000	Analog Output 1 (0-10.000 V)
508	0–20000	Analog Output 2 default (0-20.000 mA)
	0–10000	Analog Output 2 (0-10.000 V)

Modbus Configuration Registers for the Universal Inputs

Each input or output on the I/O base board has associated Modbus registers that configure its operation.

Universal Input Parameters Registers				
Universal Inputs	**1**	**2**	**3**	**4**
Enable Full-Scale Registers	3303	3323	3343	3363
Temperature °C/°F Registers	3304	3324	3344	3364

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Universal Input Parameters Registers				
Universal Inputs	**1**	**2**	**3**	**4**
Input Type Registers	3306	3326	3346	3366
Threshold Registers	3308	3328	3348	3368
Hysteresis Registers	3309	3329	3349	3369
Enable Rising Registers	4908	4928	4948	4968
Enable Falling Registers	4909	4929	4949	4969
High Register for Counter Registers	4910	4930	4950	4970
Low Register for Counter Registers	4911	4931	4951	4971

Modbus Configuration Registers for the Analog Output

The I/O base board has two analog outputs that are selectable as 0 to 20 mA (factory default) or 0 to 10 V. To change the analog output characteristic, physical jumpers on the I/O board and a Modbus register parameter must both be changed.

For step-by-step instructions on changing the output characteristics see .

Parameters for Analog Output 1 start at 4001 through 4008. Parameters for Analog Output 2 start at 4021 through 4028.

Registers for analog output (4xxxx) parameters

Analog output 1	Analog output 2	Description	Values
4001	4021	Maximum Analog Value	
4002	4022	Minimum Analog Value	
4003	4023	Enable Register Full-Scale	0 = Store readings in unit-specific data 1 = Linear rate from 0 to 65535
4004	4024	Hold Last State Enable	0 = Disables Hold Last State and uses the Default Output State setting during an error condition 1 = Sets the output to its last known value
4005	4025	Default Output State	
4008	4028	Analog Output Type	0 to 20 mA or 0 to 10 V DC output (I/O board jumper selectable) Accuracy: 0.1% of full scale +0.01% per °C Resolution: 12-bit After changing the jumper position, write the appropriate value to the Modbus registers to define your analog output to match the setting selected by the jumper. 2 = 0 to 20 mA output (default) 3 = 0 to 10 V output
2952		Enable Default Communication Timeout	0 = Disable 1 = Enable
2953		Communication Default I/O Timeout (100 ms/Count)	Number of 100 ms periods
2954		Enable Default on Power Up	0 = Disable 1 = Sends device outputs to their default condition

Analog Output Type—The analog outputs may be configured as either 0 to 20 mA outputs (default) or 0 to 10 V outputs. To change the analog output type change the hardware jumper position and write to the Modbus register that defines the analog output type. For analog output 1, write to Modbus register 4008, for analog output 2 write to Modbus register 4028. Write a value of 2 (default) to select 0 to 20 mA; write a value of 3 to select 0 to 10 V.

Default Output Conditions—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.

- **2952 Enable Default Communication Timeout**— A “communication timeout" refers to the communication between any Modbus client host and the DXM baseboard. Set this register to 1 to enable the default condition when the host has not communicated with the DXM baseboard for the period of time defined by the Communication Default IO Timeout.

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- **2953 Communication Default I/O Timeout (100 ms/Count)**—This parameter defines the host timeout period in 100-millisecond increments. If a host does not communicate within this timeout period, the device outputs are set to the default values.
- **2954 Enable Default on Power Up**—Setting this parameter to 1 sends the device outputs to their default condition when the DXM baseboard is powered up. Set to 0 to disable this feature.

Default Output State—The Default Output State parameter represents the default condition of the analog output. When an error condition exists, the outputs are set to this 16-bit user-defined output state. To define the error conditions for device outputs, refer to the MultiHop default output parameters 2950–2954.

Enable Register Full-Scale—Set to 1 to enable a linear range from 0 to 65535 for the specified input range. For a 4 to 20 mA output, a value of 0 represents 4 mA and 65535 represents 20 mA. Set this parameter to 0 to store 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 outputs), values are stored as µA (micro Amps), and voltage values are stored as mV (millivolts).

Hold Last State Enable—Set the Hold Last State to 1 to set the output to its last known value before the error occurred. Set this parameter to 0 to disable the Hold Last State and use the Default Output State setting during an error condition.

Maximum Analog Value—The Maximum Analog Value register stores the maximum allowed analog value. The specific units of measure apply to the register value. For example, the register may contain 20000, for 20 mA, or for a voltage output the register may contain 8000, for 8 volts.

Minimum Analog Value—The Minimum Analog Value register stores the minimum allowed analog value. The specific units of measure apply to register value. For example, the register may contain 4000, for 4 mA, or for a voltage output the register may contain 2000, for 2 volts.

Modbus Configuration Registers for the IO (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 0 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.

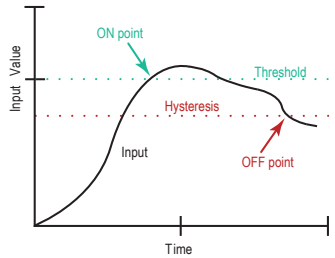
High/Low Register for Counter

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

A system's 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 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.

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Modbus Configuration Registers for Power

To monitor the input power characteristics of the DXM100, read the following power Modbus registers. The on-board thermistor is not calibrated but can be used as a non-precision temperature input.

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 register 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.

Using Courtesy Power or Switch Power

Pin 18 of the DXM100-Sx Wireless Modbus Server is a constant power source that supplies 5 V up to 500 mA.

Pins 21 (switch power 2) and 30 (switch power 1) are switched power outputs. Configure the switched power outputs using Modbus registers or by using the DXM Configuration Software's **Settings › I/O Board** screen. The output voltage can be selected and is controlled using a Modbus register on the I/O board (Modbus ID 200). The voltage options are:

- 5 V or 16 V for DXM100-B1 models; or
- 5 to 24 V DC for DXM100-B2 models.

Turn the switched power on or off using the output register 505 for switch power 1 or 506 for switch power 2. For continuous power, set the Default Output register to 1, then cycle the power.

Switch Power	Enable Register	Enable Register Value	Voltage Register	Voltage Register Value	Default Output Register	Output Register
1 (pin 30)	2201	Write a 0 to turn OFF Write a 1 to turn ON (default)	3601	Write a 0 to select 5 V (default) Write a 1 to select 16 V Write a 2 to select 24 V (DXM100-B2 model only)	3602	505
2 (pin 21)	2251		3621		3622	506

Enable Register

Configuration registers that turn on the ability to use the switched power output.

Default setting = ON

Voltage Register

Configuration registers that define the output voltage to the switched power output.

Default setting = 5 V

Default Output Register

Configuration registers that turn on the switched power outputs for continuous power out.

Set register to 1 for continuous power. Cycle power if this register is changed.

Default setting = 0

Modbus Output Register

Turn on or turn off the voltage output. If both outputs 505 and 506 are turned on at the same time but are set to different voltages, the output voltage is 5 V for DXM100-B1 models and set to the lower voltage setting for DXM100-B2 models.

Associating a Switched Power Output to an Input

Use the DXM Configuration Software to associate a switched power output to a universal input.

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Switched power 1 and 2 (pins 30 and 21) can be associated to any Universal input to apply power to a sensor, take a reading, and then remove power from the sensor. This conserves power in battery-operated systems. The switched power supply can be used in one of two different ways: supplying courtesy power to an output pin or associated to an input. (Only one method can be active at a time.)

To manually configure the switched power output using I/O board Modbus registers, write the specified value to the listed register.

Courtesy Power Output Configuration Parameters [5]	Modbus Registers to Write To	
	Switched Power 1	Switched Power 2
Switched Power Enable	2201	2251
Voltage	3601	3621
Default Output	3602	3622
Output Register	505	506

Default Output

Set the register value to 1 for continuous power. The default setting is 0.

Cycle power if this register value is changed.

Output Register

Write to the Output register to turn on or turn off the voltage output.

If both Output Registers 505 and 506 are turned on at the same time, but are set to different voltages, the output voltage is 5 V for DXM100-B1 models and set to the lower voltage setting for DXM100-B2 models.

Switched Power Enable

Enables the switched power supply. Set to 1 to enable; set to 0 to disable.

This does not enable the supply output to the actual output pin. To enable the supply output to the output pin, set Modbus register 505 or 506 to 1. Set to 0 when associating the switched power supply to an input.

Voltage

For the B1 and S1 models, set the Modbus register value to 0 for a switched power supply at 5 volts. Set the Modbus register value to 1 for a switched power supply at 16 volts.

For the B2 and S2 models, set one of the following register values to select your switched power output voltage.

For 5 V, set the Modbus register to 204
For 7 V, set the Modbus register to 125
For 10 V, set the Modbus register to 69
For 15 V, set the Modbus register to 32
For 20 V, set the Modbus register to 12
For 24 V, set the Modbus register to 3

When associating a switched power supply to an input, set the **Switch Power Output Enable** register to off (0). Set Modbus register 2201 for switched power 1 and Modbus register 2251 for switched power 2. This allows the input sampling mechanism to control the output.

Use the following configuration parameters to define the switch power associated with an input.

Input Parameter	Universal Input Configuration Parameter Modbus Registers to Write To			
	Universal Input 1	Universal Input 2	Universal Input 3	Universal Input 4
Input Enable	1001	1051	1101	1151
Sample Interval (high)	1002	1052	1102	1152
Sample Interval (low)	1003	1053	1103	1153
Switched Power Enable Mask	1004	1054	1104	1154
Switched Power Warmup	1005	1055	1105	1155
Switched Power Voltage	1006	1056	1106	1156
Extended Input Read	1007	1057	1107	1157
Input Out-of-Sync Enable	1008	1058	1108	1158

Extended Input Read

The Extended Input Read is a bit field parameter that allows multiple inputs to be sampled with the same switch power parameters.

If the bit field is set to 0x000F, the first four inputs are sampled after the switch power parameters are satisfied.

[5] Only used when supplying courtesy power to the output pin, not when associating switched power to an input.

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If the Extended Input Read parameter is set in the Universal input 1 configuration registers, set Universal inputs 2 through 4 **Extended Input Read** and **Sample Interval** parameters to zero.

Input Enable

Set to 1 to enable the input. Set to 0 to disable the input.

Out-of-Sync Enable

To enable the input to continue operating when the device is out of sync with the client radio, set to 1.

To disable the input when the device is not synchronized to the client radio, set to 0.

Sample Interval (high), Sample Interval (low)

The sample interval (rate) is a 32-bit value (requires two Modbus registers) that represents how often the I/O board samples the input.

The register value is the number of time units. One time unit is equal to 0.01 seconds.

For example, a Modbus register value of 1000 represents a sample interval of 10 seconds (1000 × 0.010 seconds = 10 seconds).

Switch Power Enable Mask

The Switch Power Enable Mask works with the warm-up and voltage parameters to define the switch power output. The bit mask can select any number of switch powers.

0x0 - No switch power enabled
0x1 - Enable Switch Power 1
0x2 - Enable Switch Power 2
0x3 - Enable Switch Power 1 and Switch Power 2

Switch Power Voltage

The Switch Power Voltage parameter defines the output voltage of the switch power output.

This parameter applies only to inputs using switched power. If switch power is not used with an input, use the Courtesty Power Voltage parameter to control the voltage.

See *Voltage* entry for Modbus register values used to select the output voltage.

Switch Power Warm-up

When an input controls power to external sensors, the Switch Power Warm-up parameter defines how long power is applied to the external sensor before the input point is examined for changes.

The register value is the number of time units, and a time unit is 0.01 seconds. For a warm-up time of 1 second, this parameter value is 100 (0.01 seconds × 100 = 1 second).

To associate universal input 1 with switched power 1, follow these instructions. Set Input 1 to sample every 60 seconds, with a warmup time of 10 seconds.

1. Verify Switched Power 1 Output Enable is off (0). Set Modbus Register 2201 = 0
2. Set the **Sample Interval** to 1 minute. Modbus Registers 1002 = 0, 1003= 6000 (0.01 seconds × 6000 = 60 seconds).
3. Set the **Switched Power Enable Mask** to use Switch Power 1. Modbus Register 1004 = 1
4. Set the **Switched Power Warm-up** time to 10 seconds. Modbus Register 1005 = 1000 (0.01 seconds × 1000 = 10 seconds).
5. Set the **Switched Power Voltage** to 16 volts. Modbus Register 1006 = 1.

Working with Solar Power

A reliable solar system requires careful planning and monitoring to size the components correctly. The recommendations provided are for the DXM100 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.

Setting the DXM100 for Solar Power

By default, the DXM100 is set from the factory to charge a backup battery from a line power source.

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) are 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.

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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.

Average voltage readings relative to battery charge

State of Battery 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 server, 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, this 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.

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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.

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

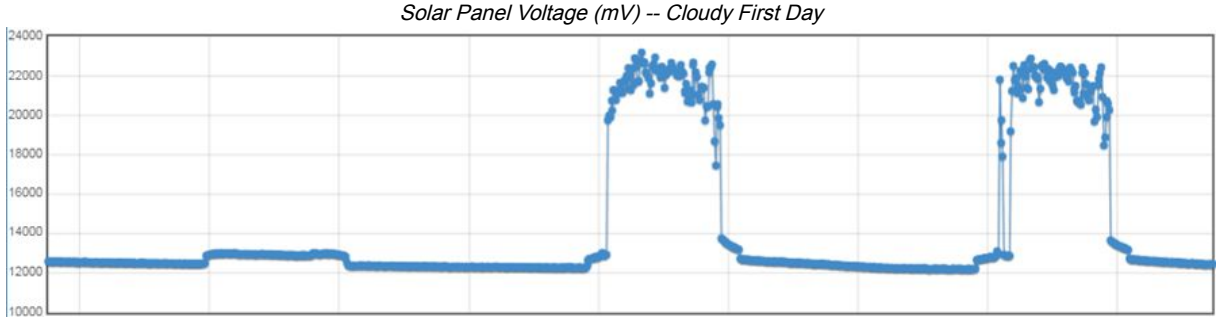
Battery capacity (Ahr) is a standard amp rating taken over 20 hours. Battery capacity should be monitored for reliable system power and may need to be increased for cold weather locations.

Monitoring Solar Operation

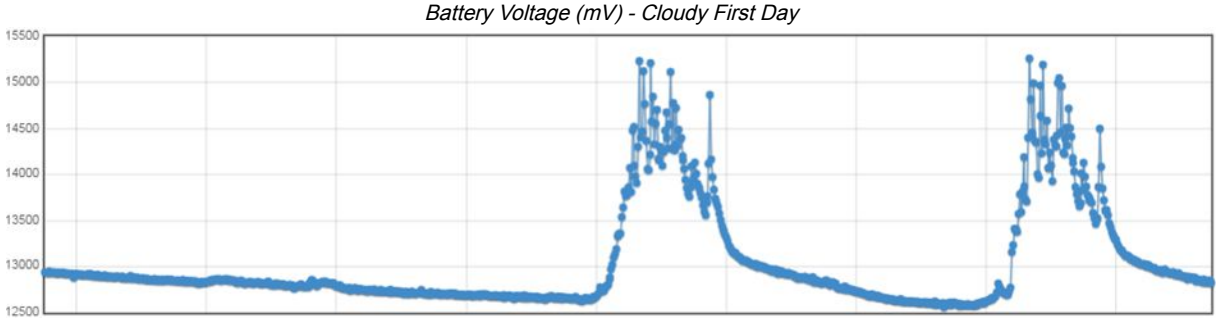
The DXM solar controller uses Modbus registers to allow the user to monitor the state of the solar panel input voltage, the battery voltage, the charging current, and the temperature in °C. The DXM100 can be configured to monitor the health of the charging system as well as send an alert message when 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.

Solar Panel Voltage (mV) -- Cloudy First Day



Battery Voltage (mV) - Cloudy First Day



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Chapter 6 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

BC-M12F5-22-2—5-pin M12, straight, single-ended, 2 m
BC-M12F5-22-10—5-pin M12, straight, single-ended, 10 m
BC-M12F5A-22-2—5-pin M12, right-angle, single-ended, 2 m
BC-M12F5A-22-10—5-pin M12, right-angle, single-ended, 10 m

Static and Surge Suppressor

BWC-PRC827-DC—Surge Suppressor, bulkhead, 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

Power Supplies

PSD-24-4—DC Power Supply, Desktop style, 3.9 A, 24 V DC, Class 2, 4-pin M12 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)

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Chapter 7 Product Support and Maintenance

Cleaning Instructions for the Product Label

Clean the product label with dry or water-dampened cloth only.

Restoring Factory Default Settings for the IO Base Board

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

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

DXM100 Documentation

- DXM Wireless Controller Sell Sheet, p/n 194063
- DXM100-B1 Wireless Controller Datasheet, p/n 186724
- DXM100-B2 Wireless Controller Datasheet, p/n 195232
- DXM100-Bx Wireless Controller Instruction Manual, p/n 190037
- DXM100-S1 Modbus Server Datasheet, p/n 195454
- DXM100-S2 Modbus Server Datasheet, p/n 195231
- DXM100-Sx Modbus Server Instruction Manual, p/n 188231
- 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
- Banner CDS Web Service Quick Start Guide, p/n 201126
- Banner CDS Web Service Instruction Manual, p/n 178337
- Activating a Cellular Modem, p/n b_4419353
- Additional technical notes and videos

For more information about the DXM100 family of products, including technical notes, configuration examples, and ScriptBasic programs, please visit www.bannerengineering.com.

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DXM Support Policy

The DXM Wireless Controllers are industrial wireless controllers that facilitate Industrial Internet of Things (IIoT) applications. As a communications gateway, it interfaces local serial ports, local I/O ports, and local ISM radio devices to the Internet using either a cellular connection or a wired Ethernet network connection. In a continuing effort to provide the best operation for the DXM, stay connected with Banner Engineering Corp to hear about the latest updates through the Banner website. Create a login today to stay informed of all Banner product releases.

Firmware Updates

The DXM has been designed to be a robust and secure IOT device. To provide the most reliable and secure device possible, periodic firmware updates are released to enhance and expand the capabilities of the DXM. Firmware updates and description details are found on the Banner website. Customers with critical update requirements will get access to pre-released firmware from the factory.

Website Information

The Banner website is the main method of disseminating DXM information to customers. The data found on the website include:

- DXM instruction manuals
- Configuration manuals
- Firmware downloads
- Firmware release notes
- Errata data, any known issues with a release of firmware
- Possible work-around solutions for known issues
- DXM Solutions Guides

Feature Requests

Our customer is our most valuable resource to improve our DXM. If you have suggestions for improvements to the DXM or configuration software, please contact Banner Engineering Corp.

Potential DXM Issues

Potential issues with the DXM are collected from Banner's support engineers to provide solutions. Users can get help from the website documentation or by calling Banner Engineering for support help. Solutions are as simple as configuration adjustments, work-around configuration solutions, or potential new firmware updates.

DXM Security

The DXM was designed to collect local wireless sensor data, local sensor data, provide simple control, and send the data to the cloud.

The DXM does not run a Linux or Windows-based operating system but an embedded real-time operating system (RTOS) environment. As a proprietary operating system, the security aspects are easier to manage and minimize.

Security updates are released through the Banner Engineering Corp website (www.bannerengineering.com) and New Product Release Announcements (NPRA).

Specifications

Radio Specifications for MultiHop

Radio Transmit Power (900 MHz, 500 mW radios)

Conducted: 27 dBm (500 mW)

EIRP with the supplied antenna: < 36 dBm

Radio Transmit Power (2.4 GHz radios)

Conducted: < 18 dBm (65 mW)

EIRP with the supplied antenna: < 20 dBm (100 mW)

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Radio Range

A 2 dB antenna ships with this device.

Transmit power and range are subject to many factors, including antenna gain, installation methods, characteristics of the application, and environmental conditions.

Please refer to the following documents for installation instructions and high-gain antenna options.

Installing Your Sure Cross® Radios (151514)
Conducting a Site Survey (133602)
Sure Cross® Antenna Basics (132113)

Antenna Minimum Separation Distance

900 MHz radios transmitting at ≥ 500 mW: 4.57 m (15 ft) with the supplied antenna

2.4 GHz radios transmitting at 65 mW: 0.3 m (1 ft) with the supplied antenna

Antenna Connection

Ext. Reverse Polarity SMA, 50 Ohms

Max Tightening Torque: 0.45 N·m (4 lbf·in)

Spread Spectrum Technology

FHSS (Frequency Hopping Spread Spectrum)

Radio Packet Size (MultiHop)

900 MHz: 175 bytes (85 Modbus registers)

2.4 GHz: 75 bytes (37 Modbus registers)

900 MHz Compliance (SX7023EXT Radio Module)

Radio module is indicated by the product label marking

Contains FCC ID: UE3SX7023EXT

Contains IC: 7044A-SX7023EXT

2.4 GHz Compliance (SX243 Radio Module)

Radio module is indicated by the product label marking

Contains FCC ID: UE3SX243

Radio Equipment Directive (RED) 2014/53/EU

Contains IC: 7044A-SX243

FCC Part 15 Class A for Intentional Radiators

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 when the equipment is operated in a commercial environment. This equipment generates, uses, and can radiate radio frequency energy and, if not installed and used in accordance with the instruction manual, may cause harmful interference to radio communications. Operation of this equipment in a residential area is likely to cause harmful interference in which case the user will be required to correct the interference at his own expense.

(Part 15.21) Any changes or modifications not expressly approved by the party responsible for compliance could void the user's authority to operate this equipment.

Industry Canada Statement for Intentional Radiators

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.
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.
2. L'utilisateur de l'appareil doit accepter tout brouillage radioélectrique subi, même si le brouillage est susceptible d'en compromettre le fonctionnement.

ANATEL

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/

RS-485 Communication Specifications

Communication Hardware (MultiHop RS-485)

Interface: 2-wire half-duplex RS-485

Baud rates: 9.6k, 19.2k (default), or 38.4k via DIP switches; 1200 and 2400 via the MultiHop Configuration Software

Data format: 8 data bits, no parity, 1 stop bit

DXM100-S1 Power and I/O Specifications

Supply Voltage

12 to 30 V DC (use only with a suitable Class 2 power supply (UL) or a SELV (CE) power supply) or

12 V DC solar panel and 12 V sealed lead acid battery

Power Consumption

20 mA average at 12 Volts (exclusive of load)

Courtesy Power Out

One output at 5 Volts, 500 mA maximum

No short circuit protection

Switched Power Out

Two selectable 5 V or 16 V outputs

5 V: 400 mA maximum

16 V: 125 mA maximum

Solar Power

12 V sealed lead acid battery

2 A maximum charge current

12 V, 20 W maximum solar panel

Solar Power Battery Charging

1 A maximum with 20 Watt solar panel

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Construction
Polycarbonate; DIN rail mount option

Counters, Synchronous
32-bits unsigned
10 ms clock rate minimum

Universal Inputs
Sinking/Sourcing discrete, 4–20 mA analog, 0–10 V analog, counter, and temperature 10 kOhm thermistor

Analog Outputs (DAC)
0 to 20 mA or 0 to 10 V DC output
Accuracy: 0.1% of full scale +0.01% per °C
Resolution: 12-bit

Discrete Output Rating (NMOS)
Less than 1 A max 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

Certifications
CE/UKCA approval only applies to 2.4 GHz models

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Blenheim Court
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GREAT BRITAIN

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ANATEL
Agência Nacional de Telecomunicações
03737-22-04042

Required Overcurrent Protection

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

Overcurrent protection is required to be provided by end product application per the supplied table.
Overcurrent protection may be provided with external fusing or via Current Limiting, Class 2 Power Supply.
Supply wiring leads < 24 AWG shall not be spliced.
For additional product support, go to www.bannerengineering.com.

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

DXM100-S2 Power and IO Specifications

Supply Voltage
12 to 30 V DC (use only with a suitable Class 2 power supply (UL) or a SELV (CE) power supply) or
12 V DC solar panel and 12 V sealed lead acid battery

Switched Power Out
Two adjustable 5 V to 24 V outputs
One SDI-12 adjustable 5 V to 24 V output
5 V: 400 mA maximum
16 V: 125 mA maximum
24 V: 85 mA maximum

Power Consumption
20 mA average at 12 Volts (exclusive of load)

Solar Power
12 V sealed lead acid battery
2 A maximum charge current
12 V, 20 W maximum solar panel

Solar Power Battery Charging
1 A maximum with 20 Watt solar panel

Construction
Polycarbonate; DIN rail mount option

Courtesy Power Out
One output at 5 Volts, 500 mA maximum
No short circuit protection

Counters, Synchronous
32-bits unsigned
10 ms clock rate minimum

Universal Inputs
Sinking/Sourcing discrete, 4–20 mA analog, 0–10 V analog, counter, and temperature 10 kOhm thermistor

Analog Outputs (DAC)
0 to 10 V DC output
Accuracy: 0.1% of full scale +0.01% per °C
Resolution: 12-bit

Discrete Output Rating (NMOS)
Less than 1 A max 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

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Certifications

CE/UKCA approval only applies to 2.4 GHz models

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Required Overcurrent Protection

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

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

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

Supply wiring leads < 24 AWG shall not be spliced.

For additional product support, go to www.bannerengineering.com.

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

Environmental Specifications (DXM)

Operating Conditions

–20 °C to +60 °C (–4 °F to +140 °F)

95% maximum relative humidity (non-condensing)

Radiated Immunity: 10 V/m (EN 61000-4-3)

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

Environmental Rating

IP20

Shock and Vibration

All models meet IEC 60068-2-6 and IEC 60068-2-27 testing criteria

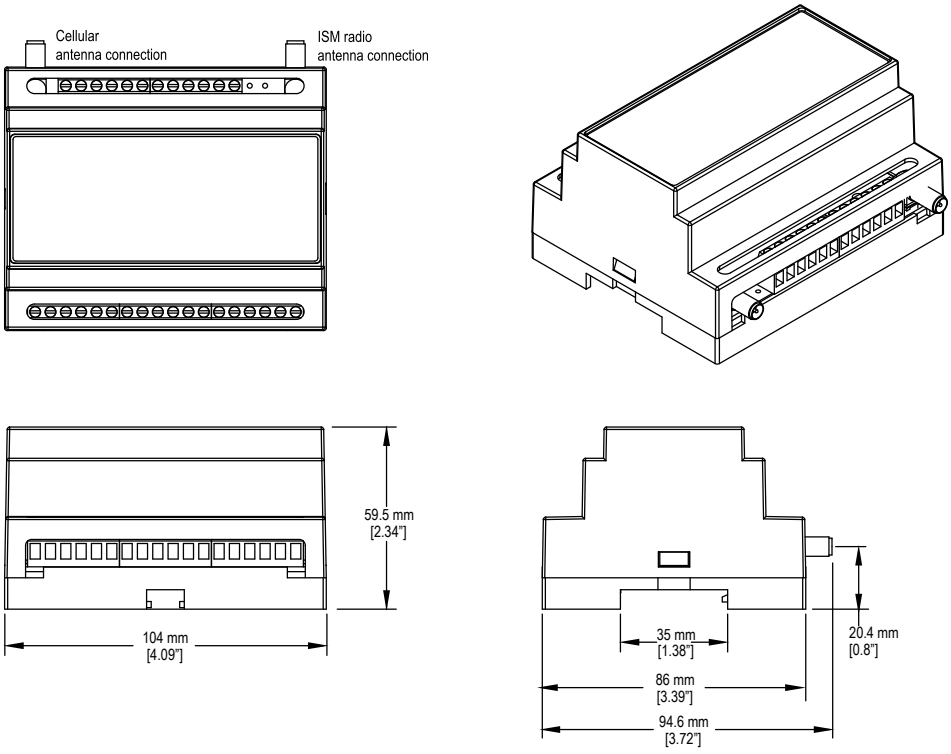
Shock: 15G 11 ms duration, half sine wave per IEC 60068-2-27

Vibration: 10 Hz to 55 Hz, 0.5 mm peak-to-peak amplitude per IEC 60068-2-6

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DXM100 and DXM1000 Dimensions

All measurements are listed in millimeters, unless noted otherwise. The measurements provided are subject to change.



FCC and ISED Certification for 900 MHz

This equipment contains transmitter module RM1809 or SX7023EXT.

Radio Module RM1809	Radio Module SX7023EXT
FCC ID: UE3RM1809	FCC ID: UE3SX7023EXT
IC: 7044A-RM1809	IC: 7044A-SX7023EXT
HVIN: RM1809	HVIN: 223150

FCC Notices

IMPORTANT: The transmitter modules RM1809 and SX7023EXT 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 and SX7023EXT 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:

Transmitter Module [RM1809 or SX7023EXT]
Contains FCC ID: [UE3RM1809 or UE3SX7023EXT]
Contains IC: [7044A-RM1809 or 7044A-SX7023EXT]
HVIN: [RM1809 or 223150]

This device complies with Part 15 of the FCC Rules. This equipment generates, uses, and can radiate radio frequency energy and, if not installed and used in accordance with the instruction manual, may cause harmful interference to radio

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communications. 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.

Antenna WARNING: This device has been tested with Reverse Polarity SMA connectors with the antennas listed in "Certified Antennas for 900 MHz" on page 43. 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: Antenna(s) used for this transmitter must be installed to provide a separation distance of at least 20 cm from all persons.

AVERTISSEMENT : Les antennes utilisées pour cet émetteur doivent être installées de manière à assurer une distance de séparation d'au moins 20 cm de toutes les personnes.

NOTICE: This equipment is approved only for mobile and base station transmitting devices. The antenna(s) used for this transmitter must not transmit simultaneously with any other antenna or transmitter, except in accordance with FCC multi-transmitter product procedures.

The radio transmitter modules RM1809 and SX7023EXT 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.

Certified Antennas for 900 MHz

Model Number	Antenna Type	900 MHz Radio Module	Maximum Gain	Impedance	Minimum Required Cable/Connector Loss
-	Integral Antenna	RM1809	Unity gain		0
BWA-9O1-x	Omni, 1/4 wave dipole	RM1809	≤2 dBi	50 Ω	0
BWA-9O2-C	Omni, 1/2 wave dipole, Swivel	RM1809 or SX7023EXT	≤2 dBi	50 Ω	0
BWA-9O6-A	Omni Wideband, Fiberglass Radome	RM1809	≤8.2 dBi	50 Ω	2.2 dB
BWA-9O5-B	Omni Base Whip	RM1809	≤7.2 dBi	50 Ω	1.2 dB
BWA-9Y10-A	Yagi	RM1809	≤10 dBi	50 Ω	4 dB
BWA-9O5-C	Coaxial sleeve	SX7023EXT	≤5 dBi	50 Ω	0
BWA-9O6-AS	Omni	SX7023EXT	≤6 dBi	50 Ω	0

FCC and ISED Certification for 2.4 GHz

This equipment contains transmitter module DX80-2400 or SX243.

Radio Module DX80-2400	Radio Module SX243
FCC ID: UE300DX80-2400	FCC ID: UE3SX243
IC: 7044A-DX8024	IC: 7044A-SX243
HVIN: DX80G2 / DX80N2	HVIN: SX243

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:

Transmitter Module [DX80-2400 or SX243]

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Contains FCC ID: [UE300DX80-2400 or UE3SX243]
Contains IC: [7044A-DX8024 or 7044A-SX243]
HVIN: [DX80G2, DX80N2 or SX243]

This device complies with Part 15 of the FCC Rules. This equipment generates, uses, and can radiate radio frequency energy and, if not installed and used in accordance with the instruction manual, may cause harmful interference to radio communications. 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.

Antenna Warning: This device has been tested with Reverse Polarity SMA connectors with the antennas listed in "Certified Antennas for 2.4 GHz" on page 44. 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

AVERTISSEMENT : Les antennes utilisées pour cet émetteur doivent être installées de manière à assurer une distance de séparation d'au moins 20 cm de toutes les personnes.

NOTICE: This equipment is approved only for mobile and base station transmitting devices. The antenna(s) used for this transmitter must not transmit simultaneously with any other antenna or transmitter, except in accordance with FCC multi-transmitter product procedures.

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.

Certified Antennas for 2.4 GHz

Model	Antenna Type	2.4 GHz Radio Module	Maximum Gain	Impedance
	Integral antenna	DX80-2400 or SX243	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 or SX243	≤ 2 dBi	50 Ω
BWA-2O2-E	Omni, 1/4 wave dipole, Swivel	DX80-2400 or SX243	≤ 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

Notas Adicionales (con Antena)

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."

Approved Antennas

BWA-9O2-C--Antena, Omni 902-928 MHz, 2 dBd, junta de caucho, RP-SMA Macho
BWA-9O5-C--Antena, Omni 902-928 MHz, 5 dBd, junta de caucho, RP-SMA Macho
BWA-9O6-A--Antena, Omni 902-928 MHz, 6 dBd, fibra de vidrio, 1800mm, N Hembra
BWA-9Y10-A--Antena, Yagi, 900 MHz, 10 dBd, N Hembra

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

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ANATEL

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/

Contact Us

Banner Engineering Corp. | 9714 Tenth Avenue North | Plymouth, MN 55441, USA | Phone: + 1 888 373 6767

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

Warnings

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: Please download the complete DXM100-Sx Wireless Modbus Server 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 DXM100-Sx Wireless Modbus Server, 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 DXM100-Sx Wireless Modbus Server sur notre site www.bannerengineering.com pour les détails sur leur utilisation correcte, les applications, les notes de sécurité et les instructions de montage.

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 than 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:

- **Never operate a radio without connecting an antenna**
- Operating 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 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.

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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.

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