Sure Cross® DXM100-Bx and DXM1000-Bx Wireless Controllers

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1 System Overview

1.1 System Overview for the B1 Models

Banner’s DXM Logic Controller integrates Banner’s wireless radio, cellular connectivity, and local I/O to provide a platform for the Industrial Internet of Things (IIoT).

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

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

Connectivity—The DXM’s wired and wireless connectivity options make it easy to share data between local and remote equipment. The cellular modem option eliminates the need for IT infrastructures to connect remote equipment for sensing and control. The integrated Sure Cross® wireless radio enables Modbus connectivity to remote sensors, indicators, and control equipment.

Wired Connectivity
- Ethernet: Modbus TCP or Ethernet/IP
- Field Bus: Modbus RS-485 Master/Slave or Controller Area Network (CAN)

Wireless Connectivity
- Sure Cross Wireless Radio: DX80 900 MHz, DX80 2.4 GHz, MultiHop 900 MHz, or MultiHop 2.4 GHz
- Cellular modem: LTE (United States) or GSM (outside the United States)

Logic Controller—Program the DXM’s logic controller using action rules and/or ScriptBasic language, which can execute concurrently. The control functions allow freedom when creating custom sensing and control sequences. The logic controller supports the Modbus protocol standards for data management, ensuring seamless integration with existing automation systems.

Action Rules
- Supports simple logic, arithmetic and thresholding
- Use for low complexity solutions
- SMS text message Notifications
- E-mail Notifications
- Push data on conditions

Text Programming Language
- ScriptBasic
- Use when Action Rules can’t supply a solution

Scheduler
- Time/calendar-based events
- Astronomical clock

Data Logging
- Cyclic Data/Event logging
- E-mail log files

SMS Commanding
- Read/Write Local Registers
- Upload data to the cloud-based data service
- Reboot controller

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**User Interface**—A simple user interface consists of an LCD screen and four LED indicators. Use the LCD to access system status and setup, view user selectable events or data, and to bind and perform site surveys for Sure Cross radios. Configure the user programmable LEDs to indicate the status of the DXM, processes, or equipment.

**User programmable LCD**
- Binding Sure Cross radios
- Conducting a Site Survey
- Viewing sensor information
- Viewing the system’s status

**User Defined LED indicators**

### 1.2 System Overview for the B2 Models

Banner’s DXM Logic Controller integrates Banner’s wireless radio, cellular connectivity, and local I/O to provide a platform for the Industrial Internet of Things (IIoT).

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

- Universal Inputs
- Discrete outputs
- Courtesy power
- Switch power
- Battery backup
- Solar controller
- DC latching outputs
- SDI-12 sensor interface

**Connectivity**—The DXM’s wired and wireless connectivity options make it easy to share data between local and remote equipment. The cellular modem option eliminates the need for IT infrastructures to connect remote equipment for sensing and control. The integrated Sure Cross® wireless radio enables Modbus connectivity to remote sensors, indicators, and control equipment.

**Wired Connectivity**
- Ethernet: Modbus/TCP or Ethernet/IP
- Field Bus: Modbus RS-485 Master/Slave or Controller Area Network (CAN)

**Wireless Connectivity**
- Sure Cross Wireless Radio: DX80 900 MHz, DX80 2.4 GHz, MultiHop 900 MHz, or MultiHop 2.4 GHz
- Cellular modem: LTE (United States) or GSM (outside the United States)

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- Supports simple logic, arithmetic and thresholding
- Use for low complexity solutions
- SMS text message Notifications
- E-mail Notifications
- Push data on conditions

**Text Programming Language**
- ScriptBasic
- Use when Action Rules cannot supply a solution

**Scheduler**
- Time/calendar-based events
- Astronomical clock

**Data Logging**
- Cyclic Data/Event logging
- E-mail log files

**SMS Commanding**
- Read/Write Local Registers
- Upload data to the cloud-based data service
- Reboot controller

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**User programmable LCD**
- Binding Sure Cross radios
- Conducting a Site Survey
- Viewing sensor Information
- Viewing the system’s status

**User Defined LED indicators**

### 1.3 Hardware Overview

The DXM can have several different configurations. The DXM has a model number label on the housing. Use the model number and model table to identify which boards are included in the your controller.

**Base**

**DXM100-Bx**

- **B1 =** Modbus controller for data aggregation of sensors and wireless networks
- **Power:** 12–30 V dc/ Solar/ Battery
- **Comms:** RS-485, CAN, RS-232 w/flow or secondary RS-485
- **Inputs:** (4) universal IN
- **Outputs:** (4) NMOS OUT, (2) analog OUT (0–10 V or 4–20 mA)
- **Power Out:** (2) Selected 5 V or 16 V switched power; (1) 5 V courtesy power

**Radio Configuration**

- **R1 =** 900 MHz, 1 W PE5 Performance Radio (North America)
- **R2 =** 900 MHz, 1 W HE5 MultiHop Data Radio (North America)
- **R3 =** 2.4 GHz, 65 mw PE5 Performance Radio (Worldwide)
- **R4 =** 2.4 GHz, 65 mw HE5 MultiHop Data Radio (Worldwide)
- **R5 =** 900 MHz, 65 mw HESL MultiHop Data Radio (Used for M-GAGE networks)
- **R6 =** 900 MHz, Performance Radios approved for Australia/New Zealand
- **R9 =** 900 MHz, MultiHop Radio approved for Australia/New Zealand

**DXM1000-Bx**

- **B1 =** Modbus controller for data aggregation of sensors and wireless networks
- **Power:** 12–30 V dc/ Solar/ Battery
- **Comms:** RS-485, CAN, RS-232 w/flow or secondary RS-485
- **Inputs:** (4) universal IN
- **Outputs:** (4) NMOS OUT, (2) analog OUT (0–10 V or 4–20 mA)
- **Power Out:** (2) Selected 5 V or 16 V switched power; (1) 5 V courtesy power

**Radio Configuration**

- **R1 =** 900 MHz, 1 W PE5 Performance Radio (North America)
- **R2 =** 900 MHz, 1 W HE5 MultiHop Data Radio (North America)
- **R3 =** 2.4 GHz, 65 mw PE5 Performance Radio (Worldwide)
- **R4 =** 2.4 GHz, 65 mw HE5 MultiHop Data Radio (Worldwide)
- **R5 =** 900 MHz, 65 mw HESL MultiHop Data Radio (Used for M-GAGE networks)
- **R8 =** 900 MHz, Performance Radios approved for Australia/New Zealand
- **R9 =** 900 MHz, MultiHop Radio approved for Australia/New Zealand
Sure Cross® DXM100-Bx and DXM1000-Bx Wireless Controllers

Not all combinations of base boards and radios are supported.

**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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**DXM100-B2**

Base

B2 = Smart valve control, SDI-12 data collection

Comms: RS-485, (1) SDI-12 sensor interface

Inputs: (4) universal IN

Outputs: (4) NMOS OUT, (2) 0-10 V analog, (2) DC Latching

Power Out: (2) Adjustable 5 V to 24 V switched power,
(1) SDI switched power, and (1) 5 V courtesy power

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**Radio Configuration**

R1

Blank = None

R1 = 900 MHz, 1 W PE5 Performance Radio (North America)
R2 = 900 MHz, 1 W HE5 MultiHop Data Radio (North America)
R3 = 2.4 GHz, 65 mW PE5 Performance Radio (Worldwide)
R4 = 2.4 GHz, 65 mW HE5 MultiHop Data Radio (Worldwide)
R5 = 900 MHz, 65 mW HE5L MultiHop Data Radio (Used for M-GAGE networks)
R8 = 900 MHz, Performance Radios approved for Australia/New Zealand
R9 = 900 MHz, MultiHop Radio approved for Australia/New Zealand

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**DXM1000-B2**

Base

B2 = Smart valve control, SDI-12 data collection

Comms: RS-485, (1) SDI-12 sensor interface

Inputs: (4) universal IN

Outputs: (4) NMOS OUT, (2) 0-10 V analog, (2) DC Latching

Power Out: (2) Adjustable 5 V to 24 V switched power,
(1) SDI switched power, and (1) 5 V courtesy power

---

**Radio Configuration**

R1

Blank = None

R1 = 900 MHz, 1 W PE5 Performance Radio (North America)
R2 = 900 MHz, 1 W HE5 MultiHop Data Radio (North America)
R3 = 2.4 GHz, 65 mW PE5 Performance Radio (Worldwide)
R4 = 2.4 GHz, 65 mW HE5 MultiHop Data Radio (Worldwide)
R5 = 900 MHz, 65 mW HE5L MultiHop Data Radio (Used for M-GAGE networks)
R8 = 900 MHz, Performance Radios approved for Australia/New Zealand
R9 = 900 MHz, MultiHop Radio approved for Australia/New Zealand
The DXM100 I/O Base Board is shown. The DXM1000 I/O Base Board is similar.

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

**ISM Radio**—The ISM radio, either a MultiHop or DX80 Gateway, 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 radio (North America) or a 2.4 GHz radio (world-wide).

**Processor**—The processor board plugs into the base board using the two 20 pin socket connectors. The board sits above the ISM radio socket and held by the base board standoffs. Position the processor board so the USB and RJ45 Ethernet connection is to the front, away from the SMA antenna connections.

**Cellular Modem (Optional)**—The optional cellular modem (purchased separately) board plugs into the processor board with the U.FL antenna connection to the left. Attach the antenna cable from the cellular modem to the left U.FL connection on the base board.

In some DXM models, the cellular modem may be replaced with an ISM radio. In this configuration, position the top ISM radio antenna connection to the left of the SMA antenna connector.

**LCD (Display) Board**—The top housing contains the LCD board. The display board is connected to the base board using a ribbon cable with a 20 pin connector.

### 1.4 DXM Configuration Software

Download the latest version of all configuration software from [http://www.bannerengineering.com](http://www.bannerengineering.com). For more information on using the DXM Configuration Software, refer to the instruction manual (p/n 209933).
The DXM Configuration Software configures the DXM by creating an XML file that is transferred to the DXM using a USB or Ethernet connection. The DXM 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 operation.

The wireless network devices are a separate configurable system. Use the DX80 User Configuration Software to configure the internal DX80 wireless Gateway and the attached wireless Nodes. Use the MultiHop Configuration Software if the internal radio is a MultiHop device.

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

1.5 DXM Automation Protocols

The DXM supports the following automation protocols.

**Modbus RTU**

The DXM manages two separate physical ports running the Modbus RTU protocol. The DXM is the Modbus Master when operating the Modbus master RTU port. The DXM uses the master Modbus RTU bus to communicate with locally connected Modbus devices or uses the Banner wireless radio to communicate with remote Modbus devices.

The other Modbus RTU port is used by a host system to access the DXM as a slave device. The slave Modbus RTU port allows access all the internal registers concurrently with the master RTU port. Set the slave Modbus ID using the LCD menu: SYSTEM CONFIG > DXM Modbus ID.

By default, the Modbus RTU ports are active. Configure the port parameters using the DXM Configuration Software.

**Modbus TCP/IP**

A host system acting as a Modbus master can access the DXM using the Modbus TCP/IP protocol over Ethernet. Standard Modbus port 502 is used by the DXM for all Modbus TCP/IP requests.

All internal registers are available to the host system concurrently with Modbus RTU.

By default, Modbus TCP/IP is active. Configure the DXM using Modbus TCP rules in the DXM Configuration Software.

**EtherNet/IP™**

The Ethernet port is actively running EtherNet/IP. From the factory the DXM is configured to read and write registers on DX80 wireless devices 1 through 16. Custom configurations can be set using the DXM Configuration Software.

By default, EtherNet/IP is active.

1.6 DXM Modbus Overview

The DXM uses internal 32-bit registers to store information. The processor’s internal Local Registers serve as the main global pool of registers and are used as the common data exchange mechanism. External Modbus device registers can be read into the Local Registers or written from the local data registers.

The DXM, as a Modbus master or slave, exchanges data using the Local Registers. Modbus over Ethernet (Modbus/TCP) uses the Local Registers as the accessible register data.
Using Action, Read/Write, and Threshold Rules allows you to manipulate the processor’s Local Registers. The ScriptBasic programming capabilities extends the use of Local Registers with variables to create a flexible programming solution for more complex applications.

The processor’s Local Registers are divided into three different types: integer, floating point, and non-volatile. When using Local Registers internally, the user can store 32-bit numbers. Using Local Registers with external Modbus devices follows the Modbus standard of a 16-bit holding register. Local Registers are accessible as Modbus ID 199.

Accessing the I/O base board and the LCD follows the same communication as an external Modbus device. Each device has an ID number to uniquely identify itself. The I/O base board is Modbus ID 200 and the LCD is Modbus ID 201.
2 Quick Start Guide

2.1 Device Setup

2.1.1 Apply Power to the Controller

Follow these instructions to apply 12–30 V dc power to the controller using a wall plug.

Equipment used:

- DXM Wireless Controller
- MQDMC-501 0.3 m (1 ft) cordset with a 5-pin M12/Euro-style quick disconnect fitting
- PS24W Wall plug power supply; 24 V dc, 1 A

Important:

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

1. Connect the brown wire from the MQDMC-501 cordset to the DXM’s PW (+ power) terminal.
2. Connect the blue wire from the MQDMC-501 cordset to the DXM’s GD (- ground) terminal.
3. Connect the PS24W power supply to the MQDMC-501 cordset.
4. Plug in the PS24W wall plug power supply.

2.1.2 Binding and Conducting a Site Survey with the ISM Radio

The DXM internal ISM radio will either be a MultiHop master radio or a DX80 Gateway radio. Before the ISM radio can communicate, the ISM radios within the DXM must be bound to the other radios in the wireless network.

Use the DXM LCD menu to bind radios to the internal ISM radio.

Some configurations of the DXM Controller will make it difficult to run binding or site survey. If you are having trouble accessing these features, disable the XML configuration file using DIP switch 4 on the processor board or load in a blank XML file.

Bind a DX80 Node to a DXM Gateway and Assign the Node Address

Before beginning the binding procedure, apply power to all the devices. Separate radios by 2 meters when running the binding procedure. Put only one DXM Gateway into binding mode at a time to prevent binding to the wrong Gateway.

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

1. Enter binding mode on the DXM 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.
2. Assign the Node address to the Node.
   - For Nodes without rotary dials: Use the DXM arrow keys to select the Node address to assign to the DX80 Node about to enter binding mode. The DXM assigns this Node address to the next Node that enters binding mode. Only bind one Node at a time.
   - For Nodes with rotary dials: Use the Node’s rotary dials to assign a valid decimal Node Address (between 01 and 47). The left rotary dial represents the tens digit (0 through 4) and the right dial represents the ones digit (0 through 9) of the Node Address.
3. Start binding mode on the DXM radio by pressing ENTER on the DXM radio.
4. Enter binding mode on the DX80 Node.
   - For housed radios, triple-click button 2.
   - For board-level radios, triple-click the button.
   - For Nodes without buttons, refer to the Node’s datasheet for instructions on entering binding mode.
The left and right red LEDs flash alternately and the Node searches for a Gateway in binding mode. After the Node binds, the LEDs stay solid momentarily, then they flash together four times. The Node automatically exits binding mode.

5. Label the Node with the assigned address number for future reference.
6. Press **BACK** on the DXM to exit binding mode for that specific Node address.
7. Repeat steps 2 through 5, for as many DX80 Nodes as are needed for your network.
8. When you are finished binding, press **BACK** on the DXM until you return to the main menu.

**Bind a MultiHop Radio to a DXM and Assign the Device ID**

Before beginning the binding procedure, apply power to all the devices. Separate radios by 2 meters when running binding procedure. Put only one DXM MultiHop master radio into binding mode at a time to prevent binding the slave radios to the wrong master radio.

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

1. Enter binding mode on the DXM radio:
   a) Use the arrow keys select the **ISM Radio** menu on the LCD and press **ENTER**.
   b) Highlight the **Binding** menu and press **ENTER**.
2. Assign the device address to the repeater or slave radios.
   • For MultiHop radios without rotary dials: Use the DXM arrow keys to select the device ID to assign to the MultiHop radio about to enter binding mode. The DXM assigns this device ID to the next radio that enters binding mode. Only bind one slave radio at a time.
   • For MultiHop radios with rotary dials: Use the repeater or slave’s rotary dials to assign a valid decimal device ID (11 through 60). The left rotary dial represents the tens digit (1 through 6) and the right dial represents the ones digit (0 through 9) of the device ID.
3. Start binding mode on the DXM radio by pressing **ENTER** on the DXM radio.
4. After entering binding mode on the DXM, put the MultiHop repeater or slave radio into binding mode.
   • For housed radios, triple-click button 2.
   • For board-level radios, triple-click the button.
   • For radios without buttons, refer to the radio’s datasheet for instructions on entering binding mode.
   After binding is completed, the MultiHop slave automatically exits binding mode and begins operation.
5. Press **BACK** on the DXM to exit binding mode for that specific device address.
6. Label the MultiHop slave radio with the assigned address number for future reference.
7. Repeat steps 2 through 6, changing the device address for as many MultiHop slaves as are needed for your network.
8. When you are finished binding, press **BACK** on the DXM until you return to the main menu.

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

**Conduct a Site Survey**

Although the MultiHop and DX80 devices are architecturally different, the site survey process is similar when conducted from the DXM LCD menu.

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

For a DX80 network, the Gateway controls the site survey and the results display on the LCD. Running a site survey on a DX80 network does not affect the throughput of the DX80 network. The DX80 Gateway-Node system can run a site survey analysis while the network is operational.

For a MultiHop network, the master device passes the site survey request to the intended Modbus slave device. The Site Survey runs and the results display on the LCD. Running a site survey on a MultiHop network stops all network traffic to that device.

1. From the **ISM Radio** menu, use the down arrow to highlight the **Site Survey** menu. Press **ENTER**.
2. Use the Up or Down arrows to select the Node number (DX80 network) or Modbus Slave ID (MultiHop network). Press **ENTER** to run the site survey with that Node or slave.

The site survey results display as green, yellow, red, and missed packets. Green indicates the highest signal strength, then yellow, and red. Missed packets were not received.
2.1.3 Set the IP Address

Change the IP address of the DXM-B1R1 to connect to a Modbus TCP/IP or Ethernet/IP host controller.

Equipment needed:
- DXM-B1R1 Wireless Controller

There are two ways to set the IP address: using the DXM’s LCD menu or using the DXM Configuration Software to change the XML file.

IP addresses entered into the LCD menu system override the IP addresses in the XML configuration files. To use the IP addresses set in the XML configuration file, clear the IP addresses from the menu system.

1. On the DXM, use the arrows and move to the System Config menu. Press Enter.
2. Use the arrow keys to select the Ethernet menu. Press Enter.
3. Use the arrow keys to select IP. Press Enter.
   The octet of the IP address displays (for example, 192.168.10.1).
4. Use the up and down arrows to change the IP address. Press Enter to move to the next octet.
5. Press Enter on the final octet to accept the changes.
6. Cycle power to the DXM.
   The changes are saved on the DXM and the new IP address will be used.

Use this same procedure to set the subnet mask (SN) and default gateway (GW) to match your network requirements.

2.2 Configuration Instructions

2.2.1 Configuring the Controller

Configure the DXM using the configuration software.

To configure the DXM, connect the DXM’s USB or Ethernet port to a computer.

The DXM Configuration Software allows the user to define parameters for the DXM, then saves the configuration in an XML file on the PC.

After the configuration file is saved, upload the XML configuration file to the DXM for operation.

This quick start guide outlines the basic operations to set up a DXM using the configuration software. For a more comprehensive explanation of features, refer to the DXM Configuration Software Instruction Manual (p/n 209933).

For a complete list of all associated product documentation, go to Product Support and Maintenance (p. 87).

2.2.2 Configuration Example: Reading Registers on a Modbus Slave Device

The opening page of the DXM Configuration Software displays the Local Registers tab.

The local registers are the main global pool of registers that are defined by the user to store data within the DXM.

The bottom status bar displays the communications status, application status, and the DXM Configuration Software version.

In this short example, we will configure the DXM to read six registers on an external Modbus Slave device and save the data into the local registers.
Step 1: Define the Local Registers

Change the name and parameter settings for each Local Register under the Local Registers in Use screen. You may change them individually (Edit Register) or in groups (Modify Multiple Registers).

1. Click on the Modify Multiple Registers section of the Local Registers in Use screen. Use this screen to quickly modify multiple local registers at a time.
2. Select the range of registers to change.
3. Select the fields to change in each local register. In our example, registers one through six will be changed and the names will be GPS Reg followed by an auto-incremented number. This example will also change the LCD permissions flag to Set, then Read to allow the values of the local registers to display on the LCD.
4. Click Modify Registers to apply your changes.

Step 2: Read the Registers

Under Register Mapping, the Read Rules or Write Rules interact with the Local Registers to exchange data with external Modbus devices.

This example screen shows a read rule created to read six registers (address 1 through 6), from Modbus Slave 4. The results are stored in the Local Registers 1 through 6.

1. Go to the Register Mapping > RTU or Modbus TCP > Read Rules tab to define a Modbus read rule.
2. Click Add Read Rule.
3. Click the arrow next to the new rule to display all parameters.
4. Type in a name into the name field.
5. Select the slave address. In this example, we will read from Slave ID 4.
6. Select the starting register and ending register. In this example, we will read from register 1 through register 6.
7. Select the beginning local register on the DXM.
8. Enter a polling frequency. In this example we have entered five seconds.
9. If necessary, select the error condition. For this example, if the read function fails after three attempts, the read rule writes 12345 to the DXM local registers. Notice the list of local register names this read rule is using.
Step 3: Define the Time Zone and Set the Time Clock

Use the Settings > System screen to define the time zone and daylight saving option. The time zone and DST options are saved into the configuration file.

If you connect the DXM to a computer, click Sync PC Time with Device to set the time on the DXM to match the time of the computer.

Step 4: Save the Configuration File

To save your configuration file:

1. Go to File > Save As.
2. Enter a file name and save the file. The file name cannot contain spaces or special characters.

Step 5: Connect the DXM

1. Connect the DXM to the computer using the USB port.
2. From the Device menu, select Connection Settings.
3. From the dialog box, select the appropriate com port for the DXM communications.
4. Click Connect to connect to the DXM.

Step 6: Send the Configuration File to the DXM

1. From the Device menu, select Send XML Configuration to Device.
2. Select the configuration file to load. The software will have pre-selected the file name you have previously saved.

Important: The software only loads a file to the DXM. Internal parameter settings that are changed in the tool but not saved to the file will not be sent to the device.

After the file is selected, the software uploads the file to the DXM. The DXM Configuration Software reboots the controller after the configuration file finishes uploading. The new configuration is only read at startup and always requires a reboot or power cycle to take effect. It will take a few seconds for the DXM to reboot.

Important: If the power cycles to the DXM while the DXM Configuration Software is connected, close the USB port from the software and unplug the USB cable. Reconnect the DXM by plugging the USB cable into the DXM, then select Device > Connection Settings.

The DXM is now running the new configuration. On the DXM’s LCD screen, select the Registers menu by clicking the Enter button with the Registers menu highlighted. The local registers defined in the configuration tool display.
3 ISM Radio Board (Slave ID 1)

The ISM embedded radio boards are available in either DX80 MultiHop or DX80 Performance.

Plug the ISM radio into the I/O base board with the U.FL antenna connector closest to the SMA connectors.

A - Antenna connector
B - Button
C - LED
D1 - DIP switches
D2 - DIP Switches

Figure 7. ISM radio board

**Button Operation**

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

**LED Operation**

The LED located on the ISM radio module indicates power and communications traffic.

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

ISM board LED operations also display on the LED on the right side of the I/O base board.

### 3.1 MultiHop Radio DIP Switches

The DX80 MultiHop architecture creates a tree network with a Master radio and one or more Repeater/Slave devices. The MultiHop architecture is suited for networks requiring repeater devices to provide extended range or obstacle avoidance. MultiHop ISM radio devices are defined with R2, R4, and R5 in the model number.

- DXMxxx-xxR2 - MultiHop 900 MHz
- DXMxxx-xxR4 - MultiHop 2.4 GHz
- DXMxxx-xxR5 - MultiHop 900 MHz, 100 mW
- DXMxxx-xxR9 - MultiHop 900 MHz, (Australia)

Making changes to the baud or parity settings requires that you make the same settings to the Modbus Master Communications section within the DXM Configuration Software (Settings > General).

**Important:** Disabling the serial port disables the ISM radio in the DXM. Selecting Transparent mode causes radio communications to be slower and denies access to device I/O register data.

<table>
<thead>
<tr>
<th>Device Settings</th>
<th>D1 Switches</th>
<th>D2 Switches</th>
</tr>
</thead>
<tbody>
<tr>
<td>Serial line baud rate 19200 OR User defined receiver slots</td>
<td>OFF*</td>
<td>OFF*</td>
</tr>
</tbody>
</table>

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### 3.1.1 Application Mode

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

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

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

### 3.1.2 Baud Rate and Parity

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

### 3.1.3 Disable Serial

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

---

<table>
<thead>
<tr>
<th>Device Settings</th>
<th>D1 Switches</th>
<th>D2 Switches</th>
</tr>
</thead>
<tbody>
<tr>
<td>Serial line baud rate 38400 OR 32 receiver slots</td>
<td>OFF</td>
<td>ON</td>
</tr>
<tr>
<td>Serial line baud rate 9600 OR 128 receiver slots</td>
<td>ON</td>
<td>OFF</td>
</tr>
<tr>
<td>Serial line baud rate Custom OR 4 receiver slots</td>
<td>ON</td>
<td>ON</td>
</tr>
<tr>
<td>Parity: None</td>
<td>OFF*</td>
<td>OFF*</td>
</tr>
<tr>
<td>Parity: Even</td>
<td>OFF</td>
<td>ON</td>
</tr>
<tr>
<td>Parity: Odd</td>
<td>ON</td>
<td>OFF</td>
</tr>
<tr>
<td>Disable serial (low power mode) and enable the receiver slots select for switches 1-2</td>
<td>ON</td>
<td>ON</td>
</tr>
<tr>
<td>Transmit power</td>
<td>OFF</td>
<td></td>
</tr>
<tr>
<td>900 MHz radios: 1.00 Watt (30 dBm)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>2.4 GHz radios: 0.065 Watts (18 dBm) and 60 ms frame</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Transmit power</td>
<td>ON*</td>
<td></td>
</tr>
<tr>
<td>900 MHz radios: 0.25 Watts (24 dBm)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>2.4 GHz radios: 0.065 Watts (18 dBm) and 40 ms frame</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Application mode: Modbus</td>
<td>OFF*</td>
<td></td>
</tr>
<tr>
<td>Application mode: Transparent</td>
<td>ON</td>
<td></td>
</tr>
<tr>
<td>MultiHop radio setting: Repeater</td>
<td>OFF</td>
<td>OFF</td>
</tr>
<tr>
<td>MultiHop radio setting: Master</td>
<td>OFF</td>
<td>ON</td>
</tr>
<tr>
<td>MultiHop radio setting: Slave</td>
<td>ON</td>
<td>OFF</td>
</tr>
<tr>
<td>MultiHop radio setting: DXM LCD Menu Control</td>
<td>ON*</td>
<td>ON*</td>
</tr>
</tbody>
</table>

* Default configuration

The default settings for D2 DIP switches 1, 3, and 4 are ON. This allows for forcing the device into Master mode and DXM menu control for the radio power settings.
3.1.4 Transmit Power Levels/Frame Size

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

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

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

3.2 DIP Switch Settings for the Gateway Radio Board Module

The 900 MHz radios transmit at 1 Watt (30 dBm) or 250 mW (24 dBm). While the Performance radios operate in 1 Watt mode, they cannot communicate with the older 150 mW radios. To communicate with 150 mW radios, operate this radio in 250 mW mode. For 2.4 GHz models, this DIP switch is disabled. The transmit power for 2.4 GHz is fixed at about 65 mW EIRP (18 dBm), making the 2.4 GHz Performance models automatically compatible with older 2.4 GHz models.

The DX80 Performance architecture is a star-based architecture with one Gateway radio and 1 to 47 Node devices. The Nodes communicate with the Gateway in a time slot method that is very predictable. DX80 Performance Gateway ISM radio devices are defined with R1, R3, and R8 in the model number.

- DXMxxxx-xxR1 - DX80 Performance 900MHz
- DXMxxxx-xxR3 - DX80 Performance 2.4GHz
- DXMxxxx-xxR8 - DX80 Performance 900MHz (Australia)

Important: To adjust the transmit power on the Gateway radio, Banner recommends using the LCD menu (System Conf > ISM Radio > RF CNTRL).

<table>
<thead>
<tr>
<th>DIP Switch Bank D1</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>DIP Switch 1</strong></td>
</tr>
<tr>
<td>OFF *</td>
</tr>
<tr>
<td>ON</td>
</tr>
</tbody>
</table>
4 Processor Board

4.1 Processor Board for the DXM1x0 Models

Button Operation—Use the processor board button (B) or force a cloud push. To force a push to the cloud, press and hold this button for five (5) seconds to send an immediate push message from the device (if properly configured).

LED Operation—By default, the four LEDs indicate the following conditions:
- LED 1—Heartbeat, indicates the processor is running
- LED 2—Indicates the cellular modem power cutoff is active; if the incoming power is less than 11.2 V, the cellular modem is powered down
- LED 3—XML configuration file was rejected; or file load in process; or the second phase of boot loading is in process (flashing)
- LED 4—ScriptBasic program failed to load; or the beginning phase of boot loading is in process (flashing = in process, on = complete)

Cellular Modem Connection—Install the cellular modem onto the processor board with the cellular modem’s U.FL connector on the left. The antenna cable will go between the cellular U.FL connector and the left I/O base board U.FL connector. Always disconnect the power to the device before installing or removing a cellular modem.

4.2 Processor Board for the DXM1x00 Models
**Cellular Modem Connection**—Install the cellular modem onto the processor board with the cellular modem’s U.FL connector on the left. The antenna cable will go between the cellular U.FL connector and the left I/O base board U.FL connector. Always disconnect the power to the device before installing or removing a cellular modem.

**Button Operation**—Pressing and holding the button down during power up puts the processor into manual programming mode. Programming requires Microchip SAM-BA programming application. To force a push to the cloud, press and hold this button for five (5) seconds to send an immediate push message from the device (if properly configured)

**LED Operation**—The single LED indicates the processor is running.
- Flashing green—Processor is running
- Single red flash at power up time—Bootloader is present
- Toggling Red/Orange—Bootloader is examining the new file
- Toggling Red/Green—Bootloader is loading the new image

### 4.3 DIP Switch Settings for the Processor Board

After making changes to the DIP switch settings, cycle power to the device.

<table>
<thead>
<tr>
<th>Settings</th>
<th>DIP Switches</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>1</td>
</tr>
<tr>
<td>Disable Ethernet Port</td>
<td>OFF *</td>
</tr>
<tr>
<td></td>
<td>ON</td>
</tr>
<tr>
<td>Disable LCD Display</td>
<td>OFF *</td>
</tr>
<tr>
<td></td>
<td>ON</td>
</tr>
<tr>
<td>Not used</td>
<td></td>
</tr>
<tr>
<td>Bypass XML</td>
<td>OFF *</td>
</tr>
</tbody>
</table>

**Bypass XML**
- Turn on to have the XML file ignored at boot time. This is useful for ignoring a corrupt or questionable XML configuration file. After the device is running, a new XML file can be loaded using the DXM configuration tool. Turn on to stop the processor from executing defined configuration. This is useful if the loaded configuration is using all the processing time and not allowing DXM Configuration Tool operations. The factory default position is OFF.

**Disable Ethernet Port**
- Set to on to power down the Ethernet interface. Disabling the unused Ethernet port reduces power consumption. The factory default position is OFF.

**Disable LCD Display**
- Set to on to disable the LCD. This DIP switch should be on when the LCD display board is not connected. The factory default position is OFF.

### 4.4 Ethernet

Before applying power to the DXM, verify the Ethernet cable is connected.

The number of times the processor attempts to connect to the Ethernet network is configured in the DXM Configuration Software (Settings > Network Ethernet Connection Acquisition). The default setting is two retries one minute after the device boots up another retry two minutes later.

The Ethernet connection supports the DXM Configuration Software, Modbus/TCP, and EtherNet/IP. ScriptBasic also has access to Ethernet for custom programming. Use the software or LCD menu system to configure the characteristics of the Ethernet connection, including the IP address. Any parameters not changeable from the menu system are configurable from the configuration software.

Ethernet parameter changes entered through the LCD menu override the XML configuration parameters. To return to using the network settings in the XML configuration file, remove the Ethernet parameters defined by the LCD menu using the System Config > Ethernet > Reset menu.
4.5 USB

The USB port is used with the DXM Configuration Software to program the DXM Wireless Controller. The USB port is also used as the console output for the processor and ScriptBasic.

Turn on debug messages to the serial console by selecting Print push debug messages to serial console in the DXM Configuration Software Settings > Cloud Services screen.
5 I/O Base Boards

5.1 I/O Base Board Connections for the B1 Models

<table>
<thead>
<tr>
<th>No.</th>
<th>Description</th>
<th>Ref.</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>No connection</td>
<td>12</td>
<td>CT. RS-232 CTS</td>
</tr>
<tr>
<td>2</td>
<td>PW. 12 to 30 V dc or solar power in (+)</td>
<td>13</td>
<td>S-, Secondary RS-485 –</td>
</tr>
<tr>
<td>3</td>
<td>GD. Ground</td>
<td>14</td>
<td>S+, Secondary RS-485 +</td>
</tr>
<tr>
<td>4</td>
<td>B+. Battery in (&lt; 15 V dc)</td>
<td>15</td>
<td>CL. CANL</td>
</tr>
<tr>
<td>5</td>
<td>GD. Ground</td>
<td>16</td>
<td>CH. CANH</td>
</tr>
<tr>
<td>6</td>
<td>M-. Primary RS-485 –</td>
<td>17</td>
<td>GD. GND</td>
</tr>
<tr>
<td>7</td>
<td>M+. Primary RS-485 +</td>
<td>18</td>
<td>P3. Courtesy Power 5 V</td>
</tr>
<tr>
<td>8</td>
<td>GD. Ground</td>
<td>19</td>
<td>A2. Analog OUT 2</td>
</tr>
<tr>
<td>10</td>
<td>RX. RS-232 Rx</td>
<td>21</td>
<td>P2. Adjustable Courtesy Power (5 V or 16 V)</td>
</tr>
<tr>
<td>11</td>
<td>RT. RS-232 RTS</td>
<td>22</td>
<td>N4. NMOS OUT 4</td>
</tr>
</tbody>
</table>

| Letters | Description                                                |                |                        |                |                        |
|---------|-------------------------------------------------------------|----------------|------------------------|----------------|
| A       | Base board LED                                              | E              | Jumpers - Configures Analog Out 1 and 2 for mA or V | J              | Modbus Slave 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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5.2 I/O Base Board for the B2 and S2 Models

The DXM Wireless Controller I/O board DIP switches are set from the factory to Modbus Slave ID 200.
5.4 Setting the Modbus Slave ID on the I/O Base Board

Only DXM100-S1 and -S1R2 Slave models require that the Modbus Slave ID to be adjusted on the I/O base board. The DXM Wireless Controller models use DIP switches J and K to set the Modbus Slave ID. This device can use a Modbus register 6804 in the I/O board to access the full range of Modbus Slave IDs.

On the DXM Wireless Controller models, use the DIP switches at location K to define the lower digit of the Modbus Slave ID. DIP Switch location J defines the course group of Modbus Slave IDs. DIP Switch 4 must be set to ON for DXM100-S1, DXM100-S2, DXM100-S1R2, and DXM100-S2R2 models.

<table>
<thead>
<tr>
<th>Settings</th>
<th>Location J DIP Switches</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>1</td>
</tr>
<tr>
<td>Modbus Slave ID set to 11 through 19</td>
<td>OFF</td>
</tr>
<tr>
<td>Modbus Slave ID set to 20 through 29</td>
<td>ON</td>
</tr>
<tr>
<td>Modbus Slave ID set to 30 through 39</td>
<td>OFF</td>
</tr>
<tr>
<td>Modbus Slave ID set to 40 through 49</td>
<td>ON</td>
</tr>
<tr>
<td>Not Used</td>
<td>-</td>
</tr>
<tr>
<td>Modbus Slave Configuration (DX100-S1 and -S1R2 models only)</td>
<td>ON</td>
</tr>
<tr>
<td>Standard Communication Mode</td>
<td>OFF</td>
</tr>
</tbody>
</table>

DXM Wireless Controller Example—To set the DXM Wireless Controller to a Modbus Slave 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 Slave ID digit to 3 while the location K DIP switches set the lower digit to 4.

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

- For the DXM Wireless Controller model, all switches on DIP switch K should be in the OFF position to use the Modbus register slave ID.

5.5 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.

---

1 Must be in the ON position for the -S1 and -S1R2 model
2 Uses value in Modbus register 6804.
### 5.6 Applying Power

Apply power to the DXM Wireless Controller using either 12 to 30 V dc or a 12 V dc solar panel and 12 V sealed lead acid battery operating together.

The DXM100 has three power input and three power output options:

- **Input Power:**
  - 12 to 30 V dc
  - 12 to 30 V dc solar panel
  - 12 V dc sealed lead acid battery with automatic charging

- **Courtesy Output Power Supplies:**
  - One 5 V dc fixed
  - Two 5 V dc or 16 V dc (DXM100-B1 models) or Two 5 V to 24 V dc (DXM100-B2 models)

The DXM continuously monitors the health of the power inputs. If a power input fault is detected, the DXM automatically switches over to battery with continuous uninterrupted operation.

If the incoming voltage drops below 11.2 V dc, the cellular modem does not turn on and will not turn on until the voltage is above 11.8 V dc. A text file (`CmVMon.txt`) on the internal micro SD card saves the periodic sampling of the incoming voltage. If cellular operation stops because of voltage, it is logged in this file.

<table>
<thead>
<tr>
<th>Pin</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pin 1</td>
<td>No connection</td>
</tr>
<tr>
<td>Pin 2</td>
<td>12 to 30 V dc input (+) or solar panel connection (+)</td>
</tr>
<tr>
<td>Pins 3, 5, 8, 17, 26, 29</td>
<td>Main logic ground for the DXM Wireless Controller</td>
</tr>
<tr>
<td>Pin 4</td>
<td>Solar or backup battery positive input. Battery voltage must be less than 15 V dc. Use only a sealed lead acid (SLA) battery.</td>
</tr>
</tbody>
</table>

#### 5.6.1 Connecting a Battery

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

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

#### 5.6.2 Supplying Power from a Solar Panel

To power the DXM Wireless Controller from a 12 V dc solar panel, connect the solar panel to power pins 2(+) and 3(-).

Connect a 12 V dc sealed lead acid (SLA) rechargeable battery to pins 4(+) and 5(-).

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

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

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

To change the charging configuration by writing to Modbus register 6071 on the I/O base board (Slave ID 200):

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

## 5.7 Connecting the Communication Pins

The base board communications connections to the DXM100-B1 Wireless Controller are RS-485 (primary), RS-485 (secondary) or RS-232. The base board communications connections to the DXM100-B2 Wireless Controller are RS-485 (primary) and RS-485 (secondary).

**RS-485.** The primary RS-485 bus is a common bus shared with the ISM radio board (Modbus Slave ID 1) or optional cellular board. The DXM Wireless Controller is defined as the Modbus Master on this bus. Other internal Modbus slaves include the local processor registers (Modbus Slave ID 199), the base I/O controller (Modbus Slave ID 200), and the display board (Modbus Slave ID 201). When assigning Modbus Slave IDs to externally connected devices, only use IDs 2 through 198.

**RS-232.** The RS-232 bus is not currently defined for the DXM100-B1 models. There is no RS-232 for the DXM100-B2 models.

<table>
<thead>
<tr>
<th>Pin</th>
<th>Parameter</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pin 6</td>
<td>Primary RS-485 –</td>
<td>Running Modbus protocol at 19.2k baud, use this bus to connect to other Modbus Slave devices.</td>
</tr>
<tr>
<td>Pin 7</td>
<td>Primary RS-485 +</td>
<td>The DXM Wireless Controller is a Modbus Master device on this RS-485 port.</td>
</tr>
<tr>
<td>Pin 9</td>
<td>RS-232 Tx</td>
<td>Serial RS-232 connection. This bus must use a ground connection between devices to operate correctly. (DXM100-B1 models only; not available on the DXM100-B2 models)</td>
</tr>
<tr>
<td>Pin 10</td>
<td>RS-232 Rx</td>
<td></td>
</tr>
<tr>
<td>Pin 13</td>
<td>Secondary RS-485 –</td>
<td>The DXM Wireless Controller is a Modbus slave on this bus (see <em>I/O Base Board Connections for the B1 Models</em> (p. 23)).</td>
</tr>
<tr>
<td>Pin 14</td>
<td>Secondary RS-485 +</td>
<td></td>
</tr>
<tr>
<td>Pin 15</td>
<td>CANL –</td>
<td>DXM100-B1 models only. Not available on the DXM100-B2 models.</td>
</tr>
<tr>
<td>Pin 16</td>
<td>CANH +</td>
<td></td>
</tr>
</tbody>
</table>

## 5.8 Modbus RTU Master and Slave Ports

The DXM can be a Modbus RTU master device to other slave devices and can be a Modbus slave device to another Modbus RTU master. The DXM uses the primary RS-485 port (M+/M-) as a Modbus RTU master to control external slave devices. All wired devices connected to the master RS-485 port must be slave devices. The secondary port (S+/S-) is the Modbus RTU slave connection.

- As a Modbus RTU master device, the DXM controls external slaves connected to the primary RS-485 port, the local ISM radio, local I/O base board, and the local display board.
- As a Modbus RTU slave device, the DXM local registers can be read from or written to by another Modbus RTU master device.

The secondary (slave) Modbus RS-485 port (S+/S-) is controlled by another Modbus master device, not the DXM. The slave port is used by an external Modbus master device that will access the DXM as a Modbus slave device.

Use the DXM Configuration Software to define operational settings for both the Modbus RTU master port and the Modbus RTU slave port.

Set the Modbus Slave ID for the secondary RS-485 port using the LCD display menu: **System > DXM Slave ID**.

### 5.8.1 Modbus Master and Slave Port Settings

The basic communications parameters for the RS-485 ports are set in the DXM Configuration Software and are saved in the XML configuration file. All basic settings are available under *Settings > System* screen.

Master port parameters include:

- **Baud rate and parity**
- **Set the Communications Timeout parameter** to cover the expected time for messages to be sent throughout the wireless network. For the DXM, the **Communications Timeout** parameter is the maximum amount of time the DXM should wait after a request is sent until the response message is received from the Modbus slave device.
• Maximum Polling Rate sets the minimum wait time from the end of a Modbus transaction to the beginning of the next Modbus transaction.

The Modbus Slave port settings include:
• Baud rate and parity (also set on this screen)
• Set the Modbus Slave port ID using the DXM LCD
• Set the Wireless Modbus Backbone parameter when there is an ISM radio plugged into the processor board. When this is done, the Modbus slave port uses the MultiHop radio as the slave port instead of the terminal block connection on the I/O base board.

5.8.2 DXM Modbus Slave Port ID
Set the DXM Modbus slave port ID using the LCD menu system.
1. On the LCD, use the down arrow to highlight System Config. Click the Enter button.
2. Highlight DXM Modbus ID and click Enter.
3. Use the up and down arrow buttons to change the DXM Modbus Slave Port ID.
4. Press Enter to accept the ID change.
5. Use the DXM Configuration Software to cycle power to the device.

After cycling power to the device, the updated DXM Modbus ID is listed under the System Config menu.

5.9 Inputs and Outputs
The I/O base board is a Modbus slave device (Slave ID 200) that communicates to the processor board using Modbus commands. Use the DXM Configuration Software to create a configuration using read/write maps that will access inputs or outputs on the I/O board.

Communication with the I/O board runs at a maximum rate of 10 ms per transaction. The parameter setting for the bus with the I/O board and the processor board are fixed. External Modbus communication runs at a maximum rate of 50 ms per transaction. The parameter settings for the external RS-485 buses are controlled by the DXM Configuration Software.

Refer to Modbus Register Summary (p. 63) for more descriptions of each Modbus register on the DXM Wireless Controller.

5.9.1 Universal Inputs
The universal inputs on the DXM Wireless Controller 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.
Use the DXM Configuration Software tool to write to the appropriate Modbus registers in the I/O board to configure the input type. The universal inputs are treated as analog inputs. When the universal inputs are defined as mA, V, or temperature, use Modbus registers to configure the operational characteristics of the inputs. These parameters are temperature conversion type, enable full scale, threshold and hysteresis. 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 I/O Registers for the B1 I/O Base Board (p. 72) for universal input register definitions.

<table>
<thead>
<tr>
<th>Pin</th>
<th>Universal Input</th>
<th>Modbus Register</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>27</td>
<td>4</td>
<td>4</td>
<td>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 I/O Registers for the B1 I/O Base Board (p. 72).</td>
</tr>
<tr>
<td>28</td>
<td>3</td>
<td>3</td>
<td>0 = NPN</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>1 = PNP</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>2 = 0 to 20 mA</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>3 = 0 to 10 V dc</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>4 = 10k Thermistor</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>5 = Not used</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>6 = Not used</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>7 = Bridge</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>8 = NPN Raw Fast (default)</td>
</tr>
<tr>
<td>31</td>
<td>2</td>
<td>2</td>
<td></td>
</tr>
<tr>
<td>32</td>
<td>1</td>
<td>1</td>
<td></td>
</tr>
</tbody>
</table>

**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 I/O Registers for the B1 I/O Base Board (p. 72).

**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 Using Universal Inputs to Read a Potentiometer (p/n b_4462775) for more information.

**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 (p. 29).

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. Connect the DXM to the PC.
2. Launch the DXM Configuration Software software.
3. Connect to the DXM by selecting the Device > Connection Settings menu option. You may connect using either USB or Ethernet.
4. Select a COMM port from the drop-down list and click Connect.
5. Click on the Register View tab on the left part of the page.
6. Change the Source Register selection to I/O Board Registers.
7. In the Write Registers area, write Modbus register 4908 to 1 to enable counting on the rising edge of the input signal.
8. Read Modbus registers 4910 and 4911 to get the 32-bit value of the count.
Example: Change Universal Input 2 to a 0 to 10 V dc Input
1. Connect the DXM to the PC.
2. Launch the DXM Configuration Software software.
3. Connect to the DXM by selecting the Device > Connection Settings menu option. You may connect using either USB or Ethernet.
4. Select a COMM port from the drop-down list and click Connect.
5. Click on the Register View tab on the left part of the page.
6. Change the Source Register selection to I/O Board Registers.
7. Write a 3 to Modbus register 3326 on Modbus Slave ID 200 (I/O board).
8. Cycle power to the device.
9. Using the Register View tab, read register 3326 to verify it is set to 3.

Example: Change Analog Output 1 to a 0 to 10 V dc Output
1. Connect the DXM to the PC.
2. Launch the DXM Configuration Software software.
3. Connect to the DXM by selecting the Device > Connection Settings menu option. You may connect using either USB or Ethernet.
4. Select a COMM port from the drop-down list and click Connect.
5. Click on the Register View tab on the left part of the page.
6. Change the Source Register selection to I/O Board Registers.
7. Set jumper 1 on the I/O base board to the 0 to 10 V position. Refer to the base board image for the analog output jumper position.
8. Write a 3 to Modbus register 4008 on Modbus Slave ID 200 (I/O board).
9. Cycle power to the device.
10. Using the Register View tab, read register 4008 to verify it is set to 3.

5.9.2 NMOS Outputs

<table>
<thead>
<tr>
<th>Pin</th>
<th>NMOS Discrete Outputs</th>
<th>Modbus Register</th>
<th>Description</th>
<th>Wiring</th>
</tr>
</thead>
<tbody>
<tr>
<td>22</td>
<td>4</td>
<td>504</td>
<td></td>
<td></td>
</tr>
<tr>
<td>23</td>
<td>3</td>
<td>503</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
| 24  | 2                      | 502             | 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 |        |
| 35  | 1                      | 501             |             |        |

5.9.3 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 I/O Base Board Connections for the B1 Models (p. 23) 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, Slave 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).
5.9.4 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.

<table>
<thead>
<tr>
<th>Pin</th>
<th>Analog Output</th>
<th>Modbus Register</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>20</td>
<td>1</td>
<td>509</td>
<td>0 to 10 V dc output</td>
</tr>
<tr>
<td>19</td>
<td>2</td>
<td>510</td>
<td>Accuracy: 0.1% of full scale +0.01% per °C</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Resolution: 12-bit</td>
</tr>
</tbody>
</table>

5.9.5 DC Latching Outputs for the B2 and S2 Models

<table>
<thead>
<tr>
<th>Pin</th>
<th>DC Latching Outputs</th>
<th>Modbus Register</th>
<th>Description</th>
<th>Wiring</th>
</tr>
</thead>
<tbody>
<tr>
<td>9</td>
<td>D1A</td>
<td>507</td>
<td>Write a 1 to the output register to activate the DC Latching output from A to B.</td>
<td>DA 2-wire self-latching solenoid</td>
</tr>
<tr>
<td>10</td>
<td>D1B</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>11</td>
<td>D2A</td>
<td>508</td>
<td>Write a 0 to the output register to deactivate the DC Latching output from B to A.</td>
<td></td>
</tr>
<tr>
<td>12</td>
<td>D2B</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

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

5.9.6 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 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 DXM 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).

Supported M! Commands

<table>
<thead>
<tr>
<th>SDI-12 Command</th>
<th>Register Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>xM!</td>
<td>0 or 10</td>
</tr>
<tr>
<td>xM1!</td>
<td>11</td>
</tr>
<tr>
<td>xM2!</td>
<td>12</td>
</tr>
<tr>
<td>xM3!</td>
<td>13</td>
</tr>
<tr>
<td>xM4!</td>
<td>14</td>
</tr>
<tr>
<td>xM5!</td>
<td>15</td>
</tr>
<tr>
<td>xM6!</td>
<td>16</td>
</tr>
<tr>
<td>xM7!</td>
<td>17</td>
</tr>
<tr>
<td>xM8!</td>
<td>18</td>
</tr>
<tr>
<td>xM9!</td>
<td>19</td>
</tr>
</tbody>
</table>

Supported C! Commands

<table>
<thead>
<tr>
<th>SDI-12 Command</th>
<th>Register Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>xC!</td>
<td>1 or 20</td>
</tr>
<tr>
<td>xC1!</td>
<td>21</td>
</tr>
<tr>
<td>xC2!</td>
<td>22</td>
</tr>
<tr>
<td>xC3!</td>
<td>23</td>
</tr>
<tr>
<td>xC4!</td>
<td>24</td>
</tr>
<tr>
<td>xC5!</td>
<td>25</td>
</tr>
<tr>
<td>xC6!</td>
<td>26</td>
</tr>
<tr>
<td>xC7!</td>
<td>27</td>
</tr>
<tr>
<td>xC8!</td>
<td>28</td>
</tr>
<tr>
<td>xC9!</td>
<td>29</td>
</tr>
</tbody>
</table>

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.

<table>
<thead>
<tr>
<th>Device/CMD Configuration</th>
<th>Enable</th>
<th>Device Address</th>
<th>Device Command</th>
</tr>
</thead>
<tbody>
<tr>
<td>SDI-12 Device/CMD 1</td>
<td>1751 (1)</td>
<td>11001 (48)(^3)</td>
<td>11002 (10)</td>
</tr>
<tr>
<td>SDI-12 Device/CMD 2</td>
<td>1701 (0)</td>
<td>11201 (49)</td>
<td>11202 (10)</td>
</tr>
<tr>
<td>SDI-12 Device/CMD 3</td>
<td>1651 (0)</td>
<td>11401 (50)</td>
<td>11402 (10)</td>
</tr>
<tr>
<td>SDI-12 Device/CMD 4</td>
<td>1601 (0)</td>
<td>11601 (51)</td>
<td>11602 (10)</td>
</tr>
<tr>
<td>SDI-12 Device/CMD 5</td>
<td>1551 (0)</td>
<td>11801 (52)</td>
<td>11802 (10)</td>
</tr>
</tbody>
</table>

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.

<table>
<thead>
<tr>
<th>Result Registers</th>
<th>Register 1</th>
<th>Register 2</th>
<th>Register 3</th>
<th>Register 4</th>
<th>Register 5</th>
<th>Register 6</th>
</tr>
</thead>
<tbody>
<tr>
<td>SDI-12 Device/CMD 1 Result Upper</td>
<td>11101</td>
<td>11103</td>
<td>11105</td>
<td>11107</td>
<td>11109</td>
<td>11111</td>
</tr>
<tr>
<td>SDI-12 Device/CMD 1 Result Lower</td>
<td>11102</td>
<td>11104</td>
<td>11106</td>
<td>11108</td>
<td>11110</td>
<td>11112</td>
</tr>
</tbody>
</table>

\(^3\) The default device addresses 48 through 52 are in ASCII.
**Result Registers**

<table>
<thead>
<tr>
<th>Register 1</th>
<th>Register 2</th>
<th>Register 3</th>
<th>Register 4</th>
<th>Register 5</th>
<th>Register 6</th>
</tr>
</thead>
<tbody>
<tr>
<td>11301</td>
<td>11303</td>
<td>11305</td>
<td>11307</td>
<td>11309</td>
<td>11311</td>
</tr>
<tr>
<td>11302</td>
<td>11304</td>
<td>11306</td>
<td>11308</td>
<td>11310</td>
<td>11312</td>
</tr>
<tr>
<td>11501</td>
<td>11503</td>
<td>11505</td>
<td>11507</td>
<td>11509</td>
<td>11511</td>
</tr>
<tr>
<td>11502</td>
<td>11504</td>
<td>11506</td>
<td>11508</td>
<td>11510</td>
<td>11512</td>
</tr>
<tr>
<td>11701</td>
<td>11703</td>
<td>11705</td>
<td>11707</td>
<td>11709</td>
<td>11711</td>
</tr>
<tr>
<td>11702</td>
<td>11704</td>
<td>11706</td>
<td>11708</td>
<td>11710</td>
<td>11712</td>
</tr>
<tr>
<td>11901</td>
<td>11903</td>
<td>11905</td>
<td>11907</td>
<td>11909</td>
<td>11911</td>
</tr>
<tr>
<td>11902</td>
<td>11904</td>
<td>11906</td>
<td>11908</td>
<td>11910</td>
<td>11912</td>
</tr>
</tbody>
</table>

**Result Registers**

<table>
<thead>
<tr>
<th>Register 7</th>
<th>Register 8</th>
<th>Register 9</th>
<th>Register 10</th>
<th>Register 11</th>
<th>Register 12</th>
</tr>
</thead>
<tbody>
<tr>
<td>11113</td>
<td>11115</td>
<td>11117</td>
<td>11119</td>
<td>11121</td>
<td>11123</td>
</tr>
<tr>
<td>11114</td>
<td>11116</td>
<td>11118</td>
<td>11120</td>
<td>11122</td>
<td>11124</td>
</tr>
<tr>
<td>11313</td>
<td>11315</td>
<td>11317</td>
<td>11319</td>
<td>11321</td>
<td>11323</td>
</tr>
<tr>
<td>11314</td>
<td>11316</td>
<td>11318</td>
<td>11320</td>
<td>11322</td>
<td>11324</td>
</tr>
<tr>
<td>11513</td>
<td>11515</td>
<td>11517</td>
<td>11519</td>
<td>11521</td>
<td>11523</td>
</tr>
<tr>
<td>11514</td>
<td>11516</td>
<td>11518</td>
<td>11520</td>
<td>11522</td>
<td>11524</td>
</tr>
<tr>
<td>11713</td>
<td>11715</td>
<td>11717</td>
<td>11719</td>
<td>11721</td>
<td>11723</td>
</tr>
<tr>
<td>11714</td>
<td>11716</td>
<td>11718</td>
<td>11720</td>
<td>11722</td>
<td>11724</td>
</tr>
<tr>
<td>11913</td>
<td>11915</td>
<td>11917</td>
<td>11919</td>
<td>11921</td>
<td>11923</td>
</tr>
<tr>
<td>11914</td>
<td>11916</td>
<td>11918</td>
<td>11920</td>
<td>11922</td>
<td>11924</td>
</tr>
</tbody>
</table>

**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 value is 22,500, which calculates to a sample rate of $22500 \times 0.010$ 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 50, or $50 \times 0.010$ seconds. Adjusting this value affects the battery life.

- **Voltage.** The default voltage setting is 6 volts or a register value of 168. Adjusting this value affects the battery life.

<table>
<thead>
<tr>
<th>Device / Cmd Configuration</th>
<th>Enable</th>
<th>Device Address</th>
<th>Switch Power Enable</th>
<th>Device Command</th>
<th>Sample HI</th>
<th>Sample Low</th>
<th>Warmup Time</th>
<th>Voltage</th>
</tr>
</thead>
<tbody>
<tr>
<td>SDI-12 Device/CMD 1</td>
<td>1751 (1)</td>
<td>11001 (48)</td>
<td>1754 (1)</td>
<td>11002 (10)</td>
<td>1752 (0)</td>
<td>1753 (2500)</td>
<td>1755 (50)</td>
<td>1756 (148)</td>
</tr>
<tr>
<td>SDI-12 Device/CMD 2</td>
<td>1701 (0)</td>
<td>11201 (49)</td>
<td>1704 (0)</td>
<td>11202 (10)</td>
<td>1702 (0)</td>
<td>1703 (2500)</td>
<td>1705 (50)</td>
<td>1706 (148)</td>
</tr>
<tr>
<td>SDI-12 Device/CMD 3</td>
<td>1651 (0)</td>
<td>11401 (50)</td>
<td>1654 (0)</td>
<td>11402 (10)</td>
<td>1652 (0)</td>
<td>1653 (2500)</td>
<td>1655 (50)</td>
<td>1656 (148)</td>
</tr>
<tr>
<td>SDI-12 Device/CMD 4</td>
<td>1601 (0)</td>
<td>11601 (51)</td>
<td>1604 (0)</td>
<td>11602 (10)</td>
<td>1602 (0)</td>
<td>1603 (2500)</td>
<td>1605 (50)</td>
<td>1606 (148)</td>
</tr>
<tr>
<td>SDI-12 Device/CMD 5</td>
<td>1551 (0)</td>
<td>11801 (52)</td>
<td>1554 (0)</td>
<td>11802 (10)</td>
<td>1552 (0)</td>
<td>1553 (2500)</td>
<td>1555 (50)</td>
<td>1556 (148)</td>
</tr>
</tbody>
</table>

* The default device addresses 48 through 52 are in ASCII.
These SDI-12 probes have been tested and are functional with the factory default settings.

<table>
<thead>
<tr>
<th>MFG</th>
<th>Models</th>
<th>Technical Note</th>
</tr>
</thead>
<tbody>
<tr>
<td>Acclima</td>
<td>SEN-SDI (TDT SDI-12 Soil Moisture Sensor)</td>
<td><strong>SDI-12 and the Acclima TDT SDI-12 Soil Moisture Probe</strong></td>
</tr>
<tr>
<td>Adcon Telemetry</td>
<td>HydraProbell</td>
<td></td>
</tr>
<tr>
<td>AquaCheck</td>
<td>Sub-surface Probe</td>
<td><strong>SDI-12 and the AquaCheck Sub-Surface Soil Moisture Probe</strong></td>
</tr>
</tbody>
</table>
| Decagon        | MPS-2, MPS-6, 5TE, TS1, T8                  | **SDI-12 and the Decagon 5TE Soil Moisture Probe**  
|                |                                             | **SDI-12 and the Decagon GS3 Soil Moisture Probe**  
|                |                                             | **SDI-12 and the Decagon MPS-2 Soil Moisture Probe** |
| HSTI           | HydraScout                                  | **SDI-12 and the HydraScout HSTI Probe**             |
| Sentek         | EnviroSCAN                                  | **SDI-12 and the Sentek EnviroScan Soil Moisture Probe** |

Sure Cross® DXM100-Bx and DXM1000-Bx Wireless Controllers
6 Cellular Modem Boards

6.1 Cellular Modem Board

The LTE (United States) or GSM (outside the United States) cellular modem is an optional accessory that is installed on the processor board on the two 12-pin sockets.

The U.FL connector should be to the left, with the antenna cable going to the left antenna U.FL connector.

A - U.FL antenna connection

The SIM card slides into the socket on the back of this board.

6.2 Cellular Power Requirements

If the incoming voltage drops below 11.2 V dc, the cellular modem does not turn on and will not turn on until the voltage is above 11.8 V dc. A text file (CmVMon.txt) on the internal micro SD card saves the periodic sampling of the incoming voltage. If cellular operation stops because of voltage, it is logged in this file.

6.3 Using the DXM Cellular Modem

The DXM cellular modem provides a remote network connectivity solution for the DXM.

To use the cellular modem:
1. Verify the cellular modem is installed and the correct antenna (BWA-CELLA-002) is connected to the cellular antenna port.
2. Activate the cellular service.
3. Configure the DXM to use the cellular network as the network interface.

6.4 Activating a Cellular Modem

Activating the DXM cellular capabilities requires these basic steps:
1. Purchase a cellular modem kit from Banner Engineering Corp.
2. Activate a cellular plan to the SIM card, then insert the SIM card into the cellular modem.
3. Install the cellular modem, connect the antenna cable, and connect the cellular antenna.

<table>
<thead>
<tr>
<th>Cellular Kit Model Number</th>
<th>Kit Description</th>
<th>Notes</th>
</tr>
</thead>
<tbody>
<tr>
<td>SXI-GSM-001</td>
<td>3G GSM worldwide cellular modem using Telit HE910-D modem kit. The kit includes cellular modem, antenna, and antenna cable.</td>
<td>Requires a GSM cellular wireless plan attached to the SIM card, IMEI (International Mobile Equipment Identity) number.</td>
</tr>
</tbody>
</table>
For additional information, refer to the Banner Connected Data Solutions support center (https://support.sensonix.net/hc/en-us). The support center includes video tutorials, product documentation, technical notes, and links to download configuration software.

6.4.1 Install the Cellular Modem

Follow these steps to install the cellular modem and antenna cable.

**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.

Before you activate your cellular plan, verify you have one of the following cellular modem kits.

<table>
<thead>
<tr>
<th>Cell Modem Kit</th>
<th>Cell Service</th>
</tr>
</thead>
<tbody>
<tr>
<td>SXI-GSM-001</td>
<td>3G GSM (HSPA+ networks; GSM/EGPRS fallback)</td>
</tr>
<tr>
<td>SXI-LTE-001</td>
<td>Verizon 4G LTE</td>
</tr>
</tbody>
</table>

1. Insert the SIM card into the socket on the underside of the cellular modem. Verizon LTE SIM cards come in a credit card sized carrier. Snap it out and insert the SIM card into the holder on the cellular modem.
   The SIM card number is on the SIM card and on the credit card sized carrier. You will need the SIM number to associate a wireless plan to this SIM card.

![Figure 9. Cellular modem (bottom view)](image)

2. Orient the cellular modem as shown and verify the pins are properly aligned.
3. Firmly press the modem into the 24-pin socket.
4. Attach the antenna cable as shown.
5. Install the external cellular antenna on the DXM’s SMA connector located next to the antenna cable.

![Figure 10. Cellular modem (top view)](image)

Cellular modem and antenna installed; note that the antenna cable uses the top antenna connection. The LTE modem is shown; the HE910 GSM installation is the same.
6.4.2 Activate a 3G GSM Cellular Plan

The GSM cellular modem is operational world-wide and requires an activated card to operate. GSM wireless cellular plans cannot be purchased through the Banner Connected Data Solutions website.

1. Work with the local Banner technical support person to identify and purchase machine-to-machine (M2M) (data plan only) SIM cards in 3FF ‘micro’ form factor.
   Typical monthly data use will be 20–50 MB per month. When choosing a plan, pay close attention to data rates and to SMS (text) rates.
2. When activating the SIM:
   - Note the Access Point Name, or APN, that the SIM provider says to use with their SIM
   - The IMEI is the 15-digit number on top of the cell module PCB, below the words “Telit HE910-D” and above the 2-d bar code
   - The ICCID is the 20-digit number printed on the SIM card itself

6.4.3 Activate a Verizon 4G LTE Cellular Plan

Activate a cellular plan for your DXM using the Banner Connected Data Solutions website.

1. Go to https://bannercds.com to purchase DXM cellular data plans.
2. If you have previously created an account, enter your username and password to continue.
3. If you are creating a login for the first time:
   a) Select the subscription type and subscription plan.
   b) Create a username and password (use an email address for the username).
   c) Enter your payment information and mailing address.
4. Go to the **Activate a New Verizon 4G Device Here** section.
5. Enter the SIM Number (ICCID) and the Module Number (IMEI).

   The **ICCID** is the 20-digit number of the SIM, the bottom barcode number on the SIM card carrier. If the carrier card is not available, the ICCID is also printed on the SIM card, but must be removed from its socket to be read.

   The **IMEI** is the 15-digit number on top of the 4G LTE device.

6. Click **Activate**.

   **Note:** Although new activations are typically functional in 20 minutes or less, it may take up to 24 hours for the cellular plan to become active on the wireless network.

6.4.4 Configure the DXM Controller for a Cellular Modem

Use the DXM Configuration Software to create a configuration using a cellular connection.

1. Go to the **Settings > Cloud Services** screen.
2. Set the **Push Interface** to **Cell**
   All push data, SMS messages, or email alerts will be sent using the cellular modem.
3. On the **Settings > Cellular** screen, **Cell Configuration** section, select the **Cell module** from the drop-down list.
   - For LTE, select LE910 4G VZW and set APN to **vzwinternet**. Requires a SIM module to be purchased from a wireless carrier based on the IMEI number of the cellular modem. The wireless carrier will provide the APN parameters. Not all parameters may be required.
   - For GSM, select HE910 3G GSM and set the APN based on your provider's settings. Requires a SIM module to be purchased with a cellular carrier to activate the DXM cellular capability. The wireless carrier will provide the APN parameters. Not all parameters may be required.
4. To send data to the webserver, return to the Settings > Cloud Services screen. Set the Cloud push interval and the Web Server settings. (For more information, refer to the DXM Configuration Software Instruction Manual (p/n 201127).

When the DXM is configured to use the cellular modem, the information on the cellular modem is found on the LCD menu under System Info > Cell. The menu does not display values until a transaction with the wireless cell tower is complete.

If there are no webserver parameters defined, the user must force a push to retrieve the data from the cellular network. On the LCD menu, select Push > Trigger Data Push.

Obtaining LTE service outside of Banner CDS—Customers have the option of securing a data plan for the Verizon network themselves without using the Banner Connected Data Solutions platform. Suitable plans would include those available from Verizon directly or from a Mobile Virtual Network Operator (MVNO) licensed to resell Verizon network data plans. (The SXI-LTE-001 will not function on AT&T, T-Mobile, or Sprint networks.) When purchasing a data plan, it is important to refer to the modem by its official Verizon network name, SENSX002 and give the IMEI number (found on the cellular modem) to the plan provider. To use the SIM card that comes with the cellular modem kit, give the SIM card number to the provider. The required SIM card form factor is 3FF - Micro.

6.5 Accessing the DXM Using SMS

The DXM with a cellular modem can be remotely accessed using SMS messages. Simple text messages can:

- Force a push to the cloud
- Reboot the controller
- Read/write local registers

The incoming firewall provides security; only defined phone numbers are permitted to access the controller. Use the DXM Configuration Software to configure the SMS commanding feature. This feature requires firmware version 2.01 or later.

SMS command messages sent from approved phone numbers to the DXM cause the DXM to respond. See the examples below for SMS responses. Responses may take 20 seconds or more, depending upon the network.

A DXM requires a few minutes after powering up before it can accept SMS messages. Initial cellular connection times vary based on the wireless network. A SMS message sent to the controller while a push session is active delays any response or the SMS message may be dropped based on the length of the push session.

Configuring the DXM for SMS Controlling— Configure the DXM for SMS messaging capability using the DXM Configuration Software.

1. On the Settings > Cloud Services screen, set the network interface to Cell.
2. On the Settings > Network screen, enter the phone numbers that are allowed access to the DXM.
3. Save the configuration file (File > Save).
4. Load the XML file to the DXM.
5. After the device has been running for a few minutes, the cellular network should be operational. The phone number (MDN) is visible on the DXM LCD menu (System Info > Cell).
6. Send a text message to the DXM from an approved phone number.

HTTP Push

Push triggers a http push to a webserver. The DXM accepts the message, executes the action, and sends an acknowledgment text message back to the user.

Example: Texting push forces defined local registers to be sent to a webserver
push <send>

DXM acknowledgment text message: Register push requested

Reboot

Reboot triggers the DXM to reboot. The processor reloads the XML configuration file and zeroes all local register data. This does not affect the other components of the DXM (ISM radio, I/O board, cellular modem). The DXM accepts the message, executes the action, and sends an acknowledgment text message back to the user.

Example: Texting reboot forces the processor to reboot.
reboot <send>

DXM acknowledgment text message: rebooting..
Get Register

gRN gets register number N (DXM Local Register) and sends a text with the value back to the user. The response text message shows the value in floating point format regardless of register number.

Example: Text gr1 to retrieve the value for register 1.

gr1 <send>

DXM acknowledgment text message: Register 1 is 0

Set Register

srN,X sets a register value, where N is the register number and X is the value. The DXM responds with a SMS message indicating the register was set.

Example: Texting sr1,10 sets register 1 to value of 10

sr1,10 <send>

DXM acknowledgment text message: Register 1 has been set to 10

Additional information may be available in the DXM Controller API Protocol instruction manual, p/n 186221.
7 LCD and Menu System

The LCD has four user-defined LED indicators, four control buttons, and an LCD display. The four buttons control the menu system on the LCD menu.

The top-level menu always displays the time in a 24-hour format.
- 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.

The DXM can be configured to require a passcode be entered before the LCD and Menu system will operate. The passcode configuration is defined in the DXM Configuration Software.

7.1 Registers

The Registers submenu displays the processor’s local registers that can be configured using the DXM Configuration Software.

To configure these local registers, launch the DXM Configuration Software. Go to Local Registers and expand the view for a local register by clicking on the down arrow next to the register number. In the LCD Permissions field, select None, Read, Write, or Read/Write.

Read allows the register to be displayed, and Write or Read/Write allows the register value to be changed using the LCD. The Units and Scaling parameters are optional and affect the LCD.

7.2 Push

The Push menu displays information about the last data sent to the Webserver.

The user can force an immediate push to the webserver using Trigger Push. If a current push is in process it may take several minutes to complete over cellular.
- The Trigger Push submenu forces an immediate push to the web server.
- The status and time fields indicate success or failure of the last attempted push and time of the last attempted push.
7.3 ISM Radio

The ISM Radio menu allows the user to view the Modbus ID of the internal ISM radio, enter binding mode, or run a site survey. This top-level ISM Radio menu is different from the System Config > ISM Radio submenu.

The first option under the ISM Radio menu only displays the type of radio in the DXM (MultiHop or DX80 Star) and the Modbus ID of the radio. To change the ISM Radio Modbus ID refer to the System menu.

Select Binding to enter binding mode or select Site Survey to run a site survey.

**Binding**—All ISM radio devices must be bound to the internal Gateway/master device before the DXM can access the wireless devices. The first submenu under binding allows the user to set the wireless address of the device to bind with. This is required to bind with wireless devices that do not have rotary dials (for example: M-GAGEs, ultrasonic sensors, and Q45 devices). See Binding and Conducting a Site Survey with the ISM Radio (p. 12). For more information on binding a particular device, refer to the individual datasheet.

**Site Survey**—After creating a wireless network using the binding process, run a site survey on each device to see the link quality. See Conduct a Site Survey (p. 13).

7.4 I/O Board

Use the I/O Board menu to view input values, output values, input counters values, and the charger status on the DXM I/O board. To change the configuration parameters, use the System Config menu.
The I/O Board menu includes the following submenus.

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

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

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

**Charger**
The on-board solar/battery charger of the DXM 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.
7.5 System Config

Use the **System Config** menu to set DXM system parameters.

### 7.5.1 ISM Radio

**DX80/MultiHop ID**—The ISM radio is set at the factory to be Modbus device address 1 (Modbus ID 1). For some applications, you may need to change the Modbus ID. Adjust the Modbus device address using the LCD menu system. Any other method may cause issues with the DXM not knowing which Modbus device address is assigned to the radio, which causes issues with running Binding or Site Survey from the LCD menu.

Set the radio Modbus ID to a valid number (1 through 247) that is not being used by the DXM system. Processor Local Registers allocate ID 199, the I/O board is set to ID 200, and the display board is set to ID 201. With a DX80 Gateway (star network), it's easy to choose a new ID. With a MultiHop network, remember that the master MultiHop radio allocates a range of Modbus IDs for wireless devices, typically 11 through 110.

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. The reference Modbus ID is what the DXM uses to access the internal radio when running Binding or Site Survey.

**Auto Detect Radio**—If the internal Modbus ID of the radio was changed or the internal radio was changed, but not recorded, use Auto Detect Radio to determine the radio ID and radio type. The auto-detect routine broadcasts discovery messages and waits for a response. If other devices are connected to the external RS-485 ports, they may need to be disconnected for this process to work properly.

**Advanced Options**—The Advanced Options menu is typically not used unless the Modbus ID is changed without the DXM being involved, such as when you write directly to the radio Modbus registers.

- **Reference Type** selects the radio type between DX80 star architecture radios and a MultiHop radio. The DXM uses this reference to determine how to communicate to the internal radio. If set incorrectly, the DXM may not be able to run Site Survey from the LCD menu. Unless you are changing or adding the internal radio device, there should be no reason to change the radio type.

---

After making changes to the Ethernet settings, restart the DXM.
• **Reference Modbus ID** defines the Modbus ID the DXM uses when communicating with the internal radio. If this is set incorrectly, the DXM will not be able to run Binding or Site Survey through the LCD menu.

**Max Node Count**—Defines the maximum number of devices for the DX80 wireless network.

**Binding #**—This parameter allows the user to define the Binding code within the ISM radio. Typically, you will not have to adjust this number unless you are replacing an existing Gateway or master radio.

**RF Ctrl**—Displays the status of the ISM radio DIP switch 1 (off or on). The menu doesn’t allow the user to change the DIP switch setting through the display.

### 7.5.2 I/O Board

Use the **System Config > I/O Board** submenu to change the configuration parameters for the inputs, outputs, counters, and charger.

Use the **Inputs** menu to change the input type. The universal inputs on the DXM are defined from the factory as sinking inputs. To change the input type:

1. Go to the **System Config > I/O Board > Inputs** menu.
2. Select which input to change.
3. Select the input type. The available parameters include the Input Type and the Counter Edge Detect.

#### Input Type Description

<table>
<thead>
<tr>
<th>Input Type</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sinking</td>
<td>Discrete input, low active, 0 = ON, 1 = OFF</td>
</tr>
<tr>
<td>Sourcing</td>
<td>Discrete input, high active, 1 = ON, 0 = OFF</td>
</tr>
<tr>
<td>Current</td>
<td>Analog input, 0–20 mA</td>
</tr>
<tr>
<td>Voltage</td>
<td>Analog input, 0–10 V dc</td>
</tr>
<tr>
<td>Thermistor 2*</td>
<td>Thermistor input, 10k - J (r-t curve), beta(K) 3890</td>
</tr>
<tr>
<td>Thermistor 1*</td>
<td>Thermistor input, 10k - G (r-t curve), beta(K) 3575</td>
</tr>
</tbody>
</table>

#### Counter Description

<table>
<thead>
<tr>
<th>In Type</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>In Type</td>
<td>Sinking or sourcing</td>
</tr>
<tr>
<td>Cnt Rise</td>
<td>Increment the count when the input transitions from 0 -&gt; 1</td>
</tr>
<tr>
<td>Cnt Fall</td>
<td>Increment the count when the input transitions from 1 -&gt; 0</td>
</tr>
</tbody>
</table>

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

#### Output Parameters Description

<table>
<thead>
<tr>
<th>Default</th>
<th>Force output registers to a default condition if the I/O board has not been communicated with for a user-defined time period. The communications timeout parameter must be set to use the Default condition.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Type</td>
<td>Select the output type: NMOS Sinking, Switch Power (Swch Pwr), Analog.</td>
</tr>
<tr>
<td>Voltage</td>
<td>Outputs defined as switched power can adjust the voltage: 5 V or 16 V</td>
</tr>
</tbody>
</table>

Use the **Charger** menu to change the charging algorithm for the battery. This parameter can also be set by writing Modbus register 6071 of the I/O board. See **Supplying Power from a Solar Panel** (p. 26).

#### Charger Parameters Description

<table>
<thead>
<tr>
<th>DC</th>
<th>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)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Solar</td>
<td>Select Solar when a solar panel is connected to the power pins of the DXM. Solar panels are current limited by their design and therefore can charge the battery without managing the input power.</td>
</tr>
</tbody>
</table>
7.5.3 Ethernet

Use the Ethernet submenu to set the IP Address, Gateway Address, and Subnet mask of the DXM's Ethernet interface. You may change these settings either from the LCD menu (System Config > Ethernet) or from the XML configuration file created by the DXM Configuration Software.

The network address settings from the LCD menu have the highest priority and override settings in the XML configuration file. To use the parameter settings from the XML configuration file or use DHCP, execute the Reset under System Config > Ethernet or use the LCD display to set the IP Address, Gateway Address, and Subnet Mask to 255.255.255.255. Reboot the DXM after changing the Ethernet parameters.

The Ethernet cable should be attached before powering up the DXM.

7.5.4 Provision Cell

If the DXM has a cellular modem installed, the modem must be provisioned on the network. This menu provisions the cellular modem on the network. For step by step directions, see Using the DXM Cellular Modem (p. 35).

7.5.5 DXM Modbus ID

Use the secondary Modbus RS-485 port when the DXM is connected to a Modbus RTU network as a Modbus slave device. Set the Modbus ID for the secondary RS-485 port using the LCD display menu System Config > DXM Modbus ID.

7.5.6 LCD Contrast

Use the LCD Contrast option to adjust the LCD contrast. Adjust the starting number lower to decrease the display contrast. The factory default is 28. Do not set a number less than 15 or the display may not be bright enough to see to change back.

7.5.7 Reset

Use the Restart menu to force the main processor to restart. This does not affect the other boards in the system.
7.6 System Info

Various DXM system settings are shown in this menu. The Push, Ethernet, and Cell parameters are helpful for debugging network connections. This is a read only menu.

**Controller**
Displays the date, build, model, and serial number.

**Push**
Shows the current parameters loaded from the XML configuration that applies to pushing data to a webserver, including method (Ethernet or cellular), interval, URL, page, HTTPS, and site ID.
ISM Radio
Displays the serial number, model, date, firmware part numbers, and version numbers.

I/O Board
Displays the serial number, model, date, firmware part numbers, and version numbers.

Ethernet
Displays the IP address, MAC address, DHCP, Gateway address, and DNS settings.

Cell
Shows the cellular MEID number (Mobil Equipment Identifier), MDN (Mobil Device Number), version, signal, firewall setting, and firewall mask. Some of these parameters are not visible until the cellular network is accessed.

Wifi
Displays the Wifi IP address and other settings.

Sript
Displays the name of the ScriptBasic file running.

LCD Board
Displays the serial number, model, date, firmware part numbers, and version numbers.

7.7 Display Lock
Display Lock protects the DXM LCD menu system from being used until the proper pass code is entered.

Display Lock → Enter password
   >> x
   ↑down to change the value
   ENTER to accept
   BACK to return to the previous menu

The display lock feature uses the DXM Configuration Software to set a passcode within the DXM. A valid passcode is 1 to 9 digits long and uses numbers 0 through 9. For example 1234 or 209384754.
8 Configuration Instructions

8.1 DXM Configuration Software

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 DXM Configuration Software configures the DXM by creating an XML file that is transferred to the DXM using a USB or Ethernet connection. The DXM 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 operation.

The wireless network devices are a separate configurable system. Use the DX80 User Configuration Software to configure the internal DX80 wireless Gateway and the attached wireless Nodes. Use the MultiHop Configuration Software if the internal radio is a MultiHop device.

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

8.2 Save and Upload the Configuration File

After making any changes to the DXM configuration, you must save the configuration files to your computer, then upload it to the DXM.

Changes to the XML file are not automatically saved. Any adjustments require that the file be manually saved before exiting the tool and/or before sending the XML file to the DXM.

1. Save the XML configuration file to your hard drive by going to the File > Save As menu.
2. Go to the Device > Send XML Configuration to DXM menu.
   - If the Application Status indicator is red, close and restart the DXM Configuration Tool, unplug and re-plug in the USB cable and reconnect the DXM to the software.
   - If the Application Status indicator is green, the file upload is complete.
   - If the Application Status indicator is yellow, the file transfer is in progress.

The DXM reboots and begins running the new configuration.
8.3 Register Flow and Configuration

The DXM register data flow goes through the Local Registers, which are data storage elements that reside within the processor. Using the DXM Configuration Software, the controller can be programmed to move register data from the Local Register pool to remote devices, the internal radio, the I/O base, or the display.

![Register Flow Diagram](image)

**Figure 13. Register flow**

8.3.1 Basic Approach to Configuration

When programming an application in the DXM, first plan the overall data structure of the Local Registers. The Local Registers are the main storage elements in the DXM. Everything goes into or out of the Local Registers.

1. In the DXM Configuration Software, name the Local Registers to provide the beginning structure of the application.
2. Configure the read/write rules to move the data. The Read/Write rules are simple rules that move data between devices (Nodes, Modbus slaves, sensors, etc) and the Local Registers.
3. Most applications require the ability to manipulate the Local Register data, not just move data around. Use the **Action rules** to make decisions or transform the data after the data is in the Local Registers. Action rules can apply many different functions to the Local Register data, including conditional statements, math operations, copy operations, or trending.
4. To perform scheduled events in Local Registers, go to the **Scheduler** screen in the DXM Configuration Software. These rules provide the ability to create register events by days of the week. The scheduler can also create events based on sunrise or sunset.

8.3.2 Troubleshooting a Configuration

View Local Registers using the **Local Registers > Local Registers in Use** screen of the DXM Configuration Software.

When a configuration is running on the DXM, viewing the Local Registers can help you to understand the application's operation. This utility can also access data from remote devices.

To configure the Local Register data to display on the LCD menu, go to the **Local Registers** screen, set the **LCD permissions** to read or read/write.

8.3.3 Saving and Loading Configuration Files

The DXM Configuration Software saves its configuration information in a XML file. Use the **File** menu to Save or Load configuration files.

Save the configuration file before attempting to upload the configuration to the DXM. The DXM Configuration Software uploads the configuration file saved on the PC to the DXM; it will not send the configuration loaded in the tool.
8.3.4 Uploading or Downloading Configuration Files

The DXM requires a XML configuration file to become operational. To upload or download configuration files, connect a computer to the DXM using the USB port or Ethernet port. Then use the Upload Configuration to Device or Download Configuration from Device under the Device menu.

8.4 Scheduler

Use the Scheduler screens to create a calendar schedule for local register changes, including defining the days of the week, start time, stop time, and register values.

Schedules are stored in the XML configuration file, which is loaded to the DXM. Reboot the DXM to activate a new schedule.

If power is cycled to the DXM in the middle of a schedule, the DXM looks at all events scheduled that day and processes the last event before the current time.

For screens that contain tables with rows, click on any row to select it. Then click Clone or Delete to copy/paste or remove that row.

8.4.1 Create a Weekly Event

Use the Scheduler > Weekly Events screen to define weekly events.

1. Click Add Weekly Event. A new schedule rule is created.
2. Click on the arrow to the left of the new rule to expand the parameters into view. The user-defined parameters are displayed.
3. Name your new rule.
4. Enter the local register.
5. Select the days of the week this rule applies to.
6. Enter the starting value for the local register.
7. Use the drop-down list to select the type of Start at time: a specific time or a relative time.
8. Enter the starting time.
9. Enter the end time and end value for the local register.

Register updates can be changed up to two times per day for each rule. Each rule can be set for any number of days in the week by clicking the buttons M, T, W, Th, F, S, or Su.

If two register changes are defined for a day, define the start time to be before the end time. Select End Value to enable the second event in a 24 hour period. To span across two days (crossing the midnight boundary), set the start value in the first day, without selecting End Value. Use the next day to create the final register state.

Start and end times can be specified relative to sunrise and sunset, or set to a specific time within a 24 hour period. When using sunrise or sunset times, set the GPS coordinates on the device so it can calculate sunrise and sunset.

8.4.2 Create a One-Time Event

Define one-time events to update registers at any time within a calendar year.

Similar to Weekly events, the times can be specific or relative to sunrise or sunset. Define one-time events using the Scheduler > One Time Events screen.
1. Click on Add One Time Event. A new one-time event is created.
2. Click on the arrow to expand the parameters into view. The user-defined parameters are displayed.
3. Name your one-time event by clicking on the name link and entering a name.
4. Enter the local register.
5. Enter the starting time, date, and starting value for the local register.
6. Enter the ending time, date, and ending value for the local register.

8.4.3 Create a Holiday Event

Use the Scheduler > Holidays screen to create date and/or time ranges that interrupt weekly events.

1. Click on Add Holiday. A new rule is created.
2. Enter a name your new holiday rule.
3. Select the start date and time for the new holiday.
4. Select the stop date and time for the new holiday.

8.5 Authentication Setup

The DXM has three different areas that can be configured to require a login and password authentication.

- Webserver/ Cloud Services Authentication
- Mail Server Authentication
- DXM Configuration Authentication

The webserver and mail server authentication depends upon the service provider.

8.5.1 Set the Controller to use Authentication

The DXM can be configured to send login and password credentials for every HTTP packet sent to the webserver. This provides another layer of security for the webserver data.

Configuration requires both the webserver and the DXM to be given the same credentials for the login and password. The webserver authentication username and password are not stored in the XML configuration file and must be stored in the DXM.

1. From within the DXM Configuration Software, go to the Settings > Cloud Services screen.
2. In the upper right, select Show advanced settings.
3. Define the username and password in the Web Server Authentication section of the screen.

The first time you select Require Authentication, a pop-up box appears with additional instructions. Since the data is not stored in the XML configuration file, it is hidden from view of the DXM Configuration Software.
4. Click on **Send Authentication**.
   The controller must be connected to the PC for this operation to succeed.
   The data transmits directly to the DXM's non-volatile memory. If successful, a pop-up window appears, asking to reboot the device.
5. Select **Yes** to reboot the device.

### 8.5.2 Set the Web Services to Use Authentication

1. At the Banner Connected Data Solutions website, go to **Settings > Sites**.
2. To edit the site settings, click **Edit** on the line of the site name.

   ![Settings > Sites screen of the Banner CDS website](image)

   At the bottom of the pop-up window is a checkbox to enable authentication/validation.
3. Enter the same username and password as used in the DXM Configuration Software. The username and password do not need to be a defined user within the Banner Connected Data Solutions website.

### 8.5.3 Mail Server Authentication

Complete the mail server settings to have the DXM send email alert messages or to email the log files.

The SMTP password is stored in the DXM, not the XML configuration file. Use the **Settings > Notifications** screen to complete this configuration.

![Mail server settings](image)
After selecting **Enable SMTP Authentication** for the first time, a pop-up box appears with additional instructions to complete the mail server authentication process.

After entering the user name and password, click on **Send SMTP Password** to save the user name and password to the DXM. The DXM must be connected to the PC to complete this operation. If successful, a pop-up window appears, asking to reboot the device. Select **Yes** to reboot the device.

### 8.5.4 Controller Configuration Authentication

The DXM can be programmed to allow changes to the configuration files only with proper authentication by setting up a password on the **Settings > Administration** screen in the DXM Configuration Software.

With the DXM connected to the PC, click **Get Device Status**. The DXM status displays next to the button.

Use the DXM Configuration Software to:

- Set the Admin Password
- Change the Admin Password
- Remove the Admin Password

To change or remove an admin password, the current password must be supplied. The DXM must be connected to the PC to change the administration password.

The DXM can be unlocked without knowing the administration password, but doing this erases the configuration program, logging files, and any ScriptBasic program on the device. For instruction on how to do this, see the **Additional Information** (p. 60) section.

### 8.6 Setting Up EtherNet/IP™

The DXM is defined from the factory to send/receive register data from the Gateway and the first 16 Nodes with an EtherNet/IP™ host.

To expand the number devices going to Ethernet/IP, change the **Devices in system** parameter in the DX80 Gateway (default setting is 8) to 32. To change this value:

1. Launch the the DX80 Configuration Software.
2. In the **Configuration > Device Configuration** screen, click on the arrow next to the Gateway to expand and display the Gateway’s parameters.
3. In the **System** section, use the **Devices in system** drop-down list to make your selection.

This allows the user to maximize the use of the EtherNet/IP buffer to 28 devices. To expand the number of devices further, customize the data collection for EtherNet/IP using the DXM Configuration Software and only selecting the needed registers. A maximum of 228 registers can be read or written with Ethernet/IP.

EDS (Electronic Data Sheet) files allow users of the EtherNet/IP protocol to easily add a Banner DXM device. Download the EDS files from the Banner website.

- DXM EDS Configuration File (for PLCs) (p/n b_4205242)
- DXM EIP Config File for DXM Controller with Internal Gateway (Models: DXM1xx-BxR1, DXM1xx-BxR3, and DXM1xx-BxCxR1) (p/n 194730)

### 8.6.1 Configuring the Controller

Use the DXM Configuration Software to define the **Protocol conversion** for each local register to be **EIP Originator -> DXM** or **EIP DXM -> Originator** from the **Edit Register** or **Modify Multiple Register** screens.

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8 EtherNet/IP is a trademark of Rockwell Automation.
• Define a DXM local register as **EIP Originator -> DXM** when the host PLC (Originator) will send data to the DXM local register (DXM).

• Define a DXM local register as **EIP DXM -> Originator** when that register data will be sent from the DXM (DXM) to the host PLC (Originator).

Data from an EIP controller in assembly instance 112 is data destined for the DXM local registers. The first two bytes of the assembly instance are stored in the first local register defined as an **EIP Originator -> DXM** register. The next two bytes of the assembly instance are stored in the next local register defined as an **EIP Originator -> DXM** register. For example, if DXM local registers 5, 12, 13, and 15 are configured as **EIP Originator -> DXM**, the first eight bytes (four words) of data from the assembly instance are stored into these registers in order (5, 12, 13, and 15). The system ignores the rest of the bytes in the assembly instance.

Data from the DXM local registers is sent to the EIP controller using assembly instance 100. Each local register in the DXM defined as **EIP DXM -> Originator** is collected in numerical order and placed into the data buffer destined for assembly instance 100. DXM local registers are capable of 32-bits, but only the lower 2-bytes for each local register are transferred. For example, if DXM registers 1, 10, 20, and 21 are defined as **EIP DXM -> Originator** registers, the assembly instance 100 will have the first eight bytes of data coming from the DXM local registers 1, 10, 20, and 21. The rest of the data is in assembly instance 100 is zero.

For example, define register 1 as an **EIP Originator -> DXM** (target) register. The EIP PLC will write data into register 1. For local registers to be sent to the EIP controller, define registers as **EIP DXM -> Originator**. Use the Modify Multiple Registers screen to change many registers parameters at one time.

The DXM is big endian: the upper bits of a local register (15:8) are stored in the first byte of the assembly instance and the second byte of the assembly instance is stored in the lower bits of a local register (7:0).

The following table shows DXM local registers 1, 5, and 10 being written from the EIP controller using assembly instance 112. Only registers 1, 5, and 10 are defined in the DXM Configuration Software as **EIP Originator -> DXM** registers.

<table>
<thead>
<tr>
<th>EIP Assembly Instance 112</th>
<th>DXM Local Registers</th>
</tr>
</thead>
<tbody>
<tr>
<td>Adrs</td>
<td>Data</td>
</tr>
<tr>
<td>00</td>
<td>11</td>
</tr>
<tr>
<td>01</td>
<td>22</td>
</tr>
<tr>
<td>02</td>
<td>33</td>
</tr>
<tr>
<td>03</td>
<td>44</td>
</tr>
<tr>
<td>04</td>
<td>55</td>
</tr>
<tr>
<td>05</td>
<td>66</td>
</tr>
</tbody>
</table>

The following table shows DXM local registers 10, 11, and 19 defined as **EIP DXM -> Originator**. The lower 2-bytes of each register data is placed into assembly instance 100.

<table>
<thead>
<tr>
<th>EIP Assembly Instance 112</th>
<th>DXM Local Registers</th>
</tr>
</thead>
<tbody>
<tr>
<td>Adrs</td>
<td>Data</td>
</tr>
<tr>
<td>00</td>
<td>77</td>
</tr>
<tr>
<td>01</td>
<td>88</td>
</tr>
<tr>
<td>02</td>
<td>99</td>
</tr>
<tr>
<td>03</td>
<td>10</td>
</tr>
<tr>
<td>04</td>
<td>11</td>
</tr>
<tr>
<td>05</td>
<td>12</td>
</tr>
</tbody>
</table>

### 8.6.2 Configuring the Host PLC

On the host PLC, install the DXM using an EDS file or by using the following parameters:

- **Assembly1**: Originator to DXM = Instance 112, 456 bytes (228 words)
- **Assembly2**: DXM to Originator = Instance 100, 456 bytes (228 words)

The Originator is the host PLC system, and the DXM is the DXM. The host system sees the DXM as a generic device with the product name of Banner DXM (ProdType: 43 - Generic Device, ProdName: Banner DXM).
8.7 Setting up Email and Text Messaging

The DXM can be configured to send email or SMS messages based on threshold conditions (see the DXM Configuration Software Instruction Manual (p/n 209933). Internal log files may be sent using email.

Cellular-connected systems can use email or SMS. Ethernet-connected systems can only use email, but can send email to cellular phones as a SMS message depending upon the network carrier. To send email to a Verizon phone, use the phone number followed by @vtext.com, for example, 1234567890@vtext.com.

Follow these instructions and use the DXM Configuration Software to program the controller for email and/or SMS.

1. On the Settings > System screen, set the Device Time on the DXM.
2. On the Settings > Cloud Services screen, select either Ethernet or Cell for the Push Interface.
3. If you selected Ethernet, configure your Ethernet connection by setting the IP settings on the Ethernet screen. If you selected a Push interface of Cell, use the Cellular screen to define parameters.
4. Set the email and message parameters on the Notifications screen.
5. To send alert messages, define the threshold rule to use email and/or SMS.
6. To send log files, define the log file parameters.

8.7.1 Define the Network Interface Settings

On the Cloud Services screen (shown with Show advanced settings selected), define the network connection settings by selecting Ethernet or Cell from the Network Interface drop-down list. This determines how the DXM sends data.

If you don’t require pushing data to a web server, set the Cloud Push interval to zero.

8.7.2 Configure your Ethernet Connection

To send email based on a threshold rule or to email log files, first define the network and email servers. When selecting Ethernet, go to the Settings > Ethernet screen.

1. To define the Ethernet IP address, give the DXM a static IP address. In most cases you may select the device to use DHCP and have the IP address automatically assigned.
2. DNS settings are not typically required. The DXM uses a public service to resolve Domain names, but if the network connection does not have Internet access, the DNS settings may be required.
8.7.3 Configure your Cellular Connection

To use a cellular connection, select Cell as the network connection on the Settings > Cloud Services screen (see Configure the DXM Controller for a Cellular Modem (p. 37)). The Cellular screen does not display unless the Network interface is set to Cell.

Using a 4G LTE cell module requires a cellular plan; follow the instructions on p/n 205026 to activate a cell modem.

1. On the Settings > Cellular screen, select your cellular modem from the drop-down list.
2. Set the APN.
   - If you are using a Banner 4G LTE Verizon Module (LE910), set the APN to vzwinternet.
   - If you are using an Emnify 3G GSM Cellular Radio (HE910), set the APN to EM. This module does not require an APN username or password.
   - If you are using a third-party SIM card, the APN, APN Username, and Password must be provided by the cellular service provider.

8.7.4 Set the Email and Messaging Parameters

From the Settings > Notifications screen, enter the SMTP definition, login, and password for a mail server. You must supply the SMTP Server, Server Port, and login credentials to send email. When only sending SMS messages over cellular, the SMTP Server is not required. The default SMTP port is 25 but may need to be adjusted for Ethernet-based networks. Note that many facilities block port 25. Port 587 is another common SMTP submission port.

The SMTP password is not stored in the XML configuration file, but on the DXM. After the password is entered, click on Send SMTP Password to send it to the DXM. The password is stored in non-volatile memory, so reboot the DXM to recognize the new password.

When using a GMail server, select Situational encryption and Enable SMTP authentication. The GMail server will not allow you to send email alerts using the cellular interface. GMail may notify you that you must allow access for less secure apps in your email settings.

For other email servers, the parameters may vary and will require information from the provider.
At the bottom of the screen, define the recipient to receive emails. These recipients selected in the threshold definition for sending alert messages.

Sending SMS alerts requires that the Cellular Radio chip be installed and configured, regardless of the Push Interface used. This setting allows a user to receive SMS alerts directly on their cell phone in the case of critical component changes or failures.

1. On the Settings > Notifications screen, add recipients for SMS alerts.
2. In this section, you may change the Name of the recipient, add a phone Number, and insert a Message for the recipient.
3. SMS alerts will be received in the format: Message Active/Inactive or Threshold Rule Name Active/Inactive depending on the configuration.
4. Enter the phone numbers for SMS messages.
   • 4G LTE cellular: Enter phone numbers without dashes. For example, a US phone number of (234) 555-1212 would be entered as 2345551212.
   • Emnify GSM cellular: Enter phone numbers using the country code, area code, and phone number. For example, a US phone number of (234) 555-1212 would be entered as 12345551212. These cellular modems are not certified for use in the US.

8.7.5 Define Threshold Rules for Email

To define a threshold, go to Local Registers > Action Rules > Thresholds.

Depending upon which recipients are defined, select the appropriate email or SMS checkbox for the threshold rule (under Email/SMS on state transition). When the threshold rules goes active or inactive, an email is generated.

For more information on how to set up threshold rules, refer to the DXM Configuration Software Instruction Manual (p/n 209933).

8.7.6 Define Log File Parameters for Emailing Log Files

The DXM can email log files generated on the device.

Before emailing log files, set the Mail and Messaging parameters to provide the login credentials. When using Ethernet, verify the IP address settings are defined on the Ethernet screen. Set the DXM time, under Settings > System, so that all data is properly time stamped.

Use the Local Registers > Local Registers in Use > Edit Register screen to select which registers to log which log file (set the SD card logging to the log file. Define the setup of the log file using the Settings > Logging screen. Typical settings are shown.

1. Enable the log and timestamp with every entry.
2. Enter the filename, log rate, and the maximum file size to send via email (5 to 10k is an efficient size for a cellular connection). Banner does not recommend setting the log file size larger than 100 kB as this cannot be read through the configuration software and must be read directly from the SD card.

3. Define the email address.

4. Define the local register data put into the log file using the Local Registers > Local Register Configuration screen, under the Logging and Protocol Conversion section. From the SD Card Logging drop-down list, select the log file to write to. Log files are written in CSV format.

5. Use the DXM Configuration Software to read back the log files. Under Settings > Logging, click Refresh List, highlight the file to download, then click Save Selected.

8.8 Ethernet and Cellular Push Retries

The DXM can be configured to send register data packets to a webserver. When the Ethernet or cell communications path is not operating, the DXM retries the send procedure. The communications retry process is outlined below for each configuration.

Regardless of the communications type (Ethernet or cellular), a failed attempt results in the register data packet being saved on the local micro SD card. The number of retries will depend upon the network connection type.

When there is bad cellular signal strength or there is no Ethernet connection, the transmission attempts are not counted as failed attempts to send data. Only when there is a good network connection and there are 10 failed attempts will the controller archive the data on the SD card. Data archived on the SD card must be manually retrieved.

8.8.1 Ethernet Push Retries

With an Ethernet-based network connection, the DXM retries a message five times. The five retry attempts immediately follow each other. After all attempts are exhausted, the register data packet is saved on the micro SD card.

At the next scheduled time, the DXM attempts to send the saved packet as well as the newly created register data packet. If it cannot send the new register data packet, the new register data packet is appended to the saved file on the micro SD card to be sent later. After 10 rounds of retries, the data set is archived on the micro SD card under folder _sxi. No additional attempts to resend the data are made; the data file must be manually retrieved.

Using SSL on Ethernet will have no retries, but will save each failed attempt to the micro SD card until 10 failed rounds. At this time, the register data packet is archived.

8.8.2 Cellular Push Retries

In a cellular-connected system there are no retries. Failed transmissions are saved on the micro SD card.

After 10 successive failed attempts, the data is archived in the _sxi folder. Send attempts with a low signal quality are not counted against the 10 count limit. For example, if the cellular antenna is disconnected for period that the DXM controller would have sent 20 messages under normal circumstances, all 20 messages would be saved and will be retried when the antenna is reconnected. If the signal quality was good, but the cellular network was not responding, the DXM archives the register data packets after 10 failed attempts.

---

6 Enable HTTP logging to save data on the SD card; this is the factory default. See SETTINGS -> LOGGING in the DXM Configuration Tool.
8.8.3 Event/Action Rule or Log File Push Retries
Event-based pushes caused by Action rules and locally stored log files sent using email follow the same process when failures occur, based on the network connection. The failed Event-based messages are resent with the next cyclical schedule or the next event message that triggers a push message.

8.8.4 Email and Text Message Push Retries
There are no retries for emails or SMS messages that fail to be sent from the DXM.
9 Additional Information

9.1 Working with Modbus Devices

The DXM has two physical RS-485 connections using Modbus RTU protocol.

The DXM can be a Modbus RTU master device to other slave devices and can be a Modbus slave device to another Modbus RTU master. The DXM uses the primary RS-485 port (M+/M-) as a Modbus RTU master to control external slave devices. All wired devices connected to the master RS-485 port must be slave devices. The secondary port (S+/S-) is the Modbus RTU slave connection.

- As a Modbus RTU master device, the DXM controls external slaves connected to the primary RS-485 port, the local ISM radio, local I/O base board, and the local display board.
- As a Modbus RTU slave device, the DXM local registers can be read from or written to by another Modbus RTU master device.

The secondary (slave) Modbus RS-485 port (S+/S-) is controlled by another Modbus master device, not the DXM. The slave port is used by an external Modbus master device that will access the DXM as a Modbus slave device.

The DXM has dual Modbus roles: a Modbus slave device and a Modbus master device. These run as separate processes. The Modbus slave port can only access the DXM local registers. To operate as a Modbus slave device, the DXM needs to be assigned a unique Modbus slave ID as it pertains to the host Modbus network. This slave ID is separate from the internal Modbus slave IDs the DXM uses for its own Modbus network. The DXM Modbus slave ID is defined through the LCD menu. Other Modbus slave port parameters are defined by using the DXM Configuration Software.

The DXM operates the Modbus master port. Each device on the master port must be assigned a unique slave ID. There are slave IDs that are reserved for internal devices in the DXM.

<table>
<thead>
<tr>
<th>Modbus Slave ID</th>
<th>Device</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>DX80 Performance Gateway or MultiHop ISM Radio—MultiHop wireless devices connected to the internal MultiHop radio should be assigned Modbus Slave addresses starting at 11.</td>
</tr>
<tr>
<td>199</td>
<td>Local Registers—Internal storage registers of the DXM</td>
</tr>
<tr>
<td>200</td>
<td>I/O Base Board—All data and parameters for each input or output of the DXM.</td>
</tr>
<tr>
<td>201</td>
<td>LCD Display—The user has access to the LED indicators on the DXM.</td>
</tr>
</tbody>
</table>

9.1.1 Assigning Modbus Slave IDs

Assign the DXM Modbus Slave ID only if a Modbus master device is reading or writing the DXM Local Register data through the Modbus RS-485 slave port (S+, S-).
Set the DXM Slave ID from the LCD menu under **System > DXM Slave ID**. The DXM can have any unique slave ID between 1 and 246, depending upon the host Modbus network. Other RS-485 slave port parameters are set in the DXM Configuration Software under the **Settings > General** tab.

**DXM Master Configuration**—When the DXM operates as a Modbus master device, use the DXM Configuration Software to configure read or write operations of the DXM Modbus network. The DXM communicates with all internal and external peripheral devices using the external Modbus bus RS-485 (M+, M-)

There are four internal Modbus slave devices that are configured from the factory with slave IDs. Assign slave IDs of 2 through 10 to Modbus slave devices that are physically wired to the DXM. Assign slave IDs or 11 through 60 to wireless slaves within the MultiHop network.

Do not assign a slave ID of greater than 10 to Modbus slave devices that are physically wired using the RS-485 port if there is an internal MultiHop ISM radio in the DXM. The MultiHop ISM radio attempts to send any Modbus data intended for slaves 11–60 across the radio network, which conflicts with wired slave devices if the slave IDs overlap. The MultiHop master radio can be changed from the factory default of 11–60 Modbus slave IDs if more hardwired slaves are required.

### 9.1.2 Wireless and Wired Devices

**Wireless DX80 Gateway**—The DX80 Gateway architecture is a star architecture in which all Nodes in the system send their data back to the Gateway. The host can access the entire network data from the Gateway, which is Modbus slave ID 1. Because the DXM will not be sending any Modbus messages across the wireless link, the timeout parameter can be set low (less than 1 second) and the device is treated like a directly connected device.

**MultiHop Master**—The MultiHop master radio forms a wireless tree network using repeaters and slave devices. Each device in a MultiHop network must be assigned a unique Modbus Slave ID and is accessed as a separate device.

For the DXM to talk with a MultiHop device in the wireless network, the master MultiHop device interrogates every message on the RS-485 bus. If they are within the wireless devices range (slave IDs 11 though 60), the message is sent across the wireless network. To change this range, the user must adjust the offset and range setting in the MultiHop master radio (Modbus Slave ID 1). Modbus register 6502 holds the Modbus offset, default 11. Modbus register 6503 holds the number of Modbus slaves allowed (maximum of 100).

<table>
<thead>
<tr>
<th>Modbus Slave ID</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Allocated for the internal ISM radio device, either a DX80 Gateway or MultiHop Master</td>
</tr>
<tr>
<td>2–10</td>
<td>Slave addresses available for direct connected Modbus slave devices to the master RS485 port (M+, M-)</td>
</tr>
<tr>
<td>11–60</td>
<td>Allocated for wireless MultiHop radio network devices. If there is not an internal MultiHop in the DXM, these slave addresses are available to use for directly connected devices.</td>
</tr>
<tr>
<td>61–198</td>
<td>Available to user for direct connected Modbus slave devices or the expansion of the wireless network slave IDs to go past 50 wireless devices.</td>
</tr>
<tr>
<td>199</td>
<td>Allocated for internal Local Register</td>
</tr>
<tr>
<td>200</td>
<td>Allocated for the I/O base board, will be different for special DXM slave only models.</td>
</tr>
<tr>
<td>201</td>
<td>Allocated for the LCD display board, the user can read/write LEDs.</td>
</tr>
</tbody>
</table>

### 9.1.3 Modbus Communication Timeouts

A Modbus timeout is the amount of time a Modbus slave is given to return an acknowledgment of a message sent by the Modbus master. If the Modbus master waits for the timeout period and no response is seen, the Modbus master considers it a lost message and continues on to the next operation.

The timeout parameter is simple to set for Modbus devices directly connected to the DXM, if there are no MultiHop wireless devices. Special considerations need to be made to set the timeout parameter when a MultiHop network uses the DXM as the master radio.

Configure controllers operating wireless networks to allow for enough time for hardware transmission retries. Set the **Communications Timeout** parameter to cover the expected time for messages to be sent throughout the wireless network. For the DXM, the **Communications Timeout** parameter is the maximum amount of time the DXM should wait after a request is sent until the response message is received from the Modbus slave device. Use the DXM Configuration Software to set the timeout parameter on the **Settings > System** screen (select **Show advanced settings**).

The default setting for the timeout parameter is 5 seconds.
MultiHop Networks vs DX80 Star Networks

The DX80 star Gateway collects all the data from the Nodes, which allows the host system to directly read the data from the Gateway without sending messages across the wireless network. This allows for DX80 Gateway to be treated like any other wired Modbus device.

In a MultiHop network, the data resides at each device, forcing the controller to send messages across the wireless network to access the data. For this reason, carefully consider the value of the wireless timeout parameter.

Calculating the Communications Timeout for Battery-Powered MultiHop Radios

Battery-powered MultiHop radios are configured to run efficiently to maximize battery life. By optimizing battery life, the allowed communications window for receive messages is slow (once per 1.3 seconds) and sending message rates are standard (once per 0.04 seconds).

A MultiHop device is set from the factory with the retry parameter of 8. This means that under worst-case conditions, a message is sent from the DXM to an end device a total of nine times (one initial message and eight retry messages). The end device sends the acknowledgment message back to the DXM a maximum of nine times (one initial message and eight retries). A single Modbus transaction may send up to two messages + 16 retry messages before the transaction is complete. In addition, the radios randomly wait up to one time period before retransmitting a retry message. So to allow for the random wait time, add one extra time period for each in-between time of retries.

To calculate the communication timeout parameter for a Master radio to a slave radio (no repeaters):

- Master to Slave Send time = (9 × 1.3 sec) + (8 retry wait × 1.3 sec) = 22 seconds
- Slave to Master Send time = (9 × 0.04 sec) + (8 retry wait × 0.04 sec) = 1 second
- Total Send/Receive time = 23 seconds
- Minimum Timeout period = 23 seconds

If the link quality of the network is poor, the maximum transfer times may happen. Set the timeout parameter to accommodate the maximum number of retries that may happen in your application.

When MultiHop repeaters are added into the wireless network, each additional level of hierarchical network increases the required timeout period. Since MultiHop repeaters are running at the highest communications rate, the overall affect is not as great.

- Master to Repeater Send time = (9 × 0.04 sec) + (8 retry wait × 0.04 sec) = 1 second
- Repeater to Master Send time = (9 × 0.04 sec) + (8 retry wait × 0.04 sec) = 1 second
- Additional Timeout period for a repeater = 2 seconds

Using the timeout calculation above of 23 seconds, if a repeater is added to the network the timeout should be set to 25 seconds. For each additional MultiHop repeater device creating another level of network hierarchy, add an additional two seconds to the timeout period.

Calculating the Communication Timeout for 10–30 VDC MultiHop Radios

Line-powered (10–30 V dc) MultiHop devices operate at the maximum communication rate, resulting in a much lower timeout parameter setting. For each repeater added to the network, increase the timeout parameter 2 seconds.

For a Master radio to a 10–30 V dc powered slave radio (no repeaters):

- Master to Slave Send time = (9 × 0.04 sec) + (8 retry wait × 0.04 sec) = 1 second
- Slave to Master Send time = (9 × 0.04 sec) + (8 retry wait × 0.04 sec) = 1 second
- Total Send/Receive time = 2 seconds
- Minimum Timeout period = 2 seconds

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 DXM. 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.
Calculating the Communication Timeout for a DX80 Star Network

In the DX80 network, all Node data is automatically collected at the Gateway to be read. The DXM does not use the wireless network to access the data, which allows for much faster messaging and much lower timeout values.

For a DXM with an internal DX80 Gateway, set the timeout value 0.5 seconds. If other Modbus slave devices are connected to the RS-485 lines, the timeout parameter governs all communication transactions and must be set to accommodate all devices on the bus.

9.1.4 Modbus TCP Client

The DXM can operate as a Modbus TCP client on Ethernet. Users may define up to five socket connections for Modbus TCP server devices to read Modbus register data over Ethernet. Use the DXM Configuration Software to define and configure Modbus TCP client communications with other Modbus TCP servers.

9.2 Modbus Register Summary

9.2.1 DXM Modbus Registers

The DXM Wireless Controller may have up to four internal Modbus slave devices:

<table>
<thead>
<tr>
<th>Modbus Slave ID</th>
<th>Device</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>DX80 Performance Gateway or MultiHop ISM Radio—MultiHop wireless devices connected to the internal MultiHop radio should be assigned Modbus Slave addresses starting at 11.</td>
</tr>
<tr>
<td>199</td>
<td>Local Registers—Internal storage registers of the DXM</td>
</tr>
<tr>
<td>200</td>
<td>I/O Base Board—All data and parameters for each input or output of the DXM.</td>
</tr>
<tr>
<td>201</td>
<td>LCD Display—The user has access to the LED indicators on the DXM.</td>
</tr>
</tbody>
</table>

All Modbus registers are defined as 16-bit Modbus Holding Registers. When connecting external Modbus slave devices, only use Modbus slave IDs 2 through 198. The local registers, the I/O base, and the LCD slave IDs are fixed, but the internal radio slave ID can be changed if needed.

9.2.2 Modbus Registers for the MultiHop Radio Board Module

The DX80 MultiHop master radio is a tree-based architecture device that allows for repeater radios to extend the wireless network. Each device in a MultiHop network is a Modbus device with a unique Modbus ID.

Modbus registers in a MultiHop network are contained within each individual radio device. To obtain Modbus register data from a MultiHop device, configure the DXM to access each device across the wireless network as an individual Modbus slave device.

Example: MultiHop Modbus Register Table

Example MultiHop Modbus registers with generic devices.

<table>
<thead>
<tr>
<th>MultiHop Device</th>
<th>Slave ID</th>
<th>Modbus Registers</th>
</tr>
</thead>
<tbody>
<tr>
<td>DXM Master radio</td>
<td>1</td>
<td>none</td>
</tr>
<tr>
<td>Slave radio</td>
<td>11</td>
<td>Modbus register 1–16 are inputs, 501–516 are outputs</td>
</tr>
<tr>
<td>Repeater radio</td>
<td>12</td>
<td>Modbus register 1–16 are inputs, 501–516 are outputs</td>
</tr>
<tr>
<td>Slave radio</td>
<td>15</td>
<td>Modbus register 1–16 are inputs, 501–516 are outputs</td>
</tr>
</tbody>
</table>

9.2.3 Modbus Registers for the Gateway Radio Board Module

The DX80 Performance Gateway is a star-based architecture device that contains all the Modbus registers for the wireless network within the Gateway. To access any input or output values within the entire wireless network, read the appropriate Modbus register from Gateway.
There are 16 Modbus registers allocated for each device in the wireless network. The first 16 registers (1–16) are allocated for the Gateway, the next 16 (17–32) are allocated for Node 1, the next 16 (33–48) are allocated for Node 2 and so forth. There are no inputs or outputs on the DXM embedded Gateway but the Modbus registers are still allocated for them.

Although only seven Nodes are listed in the table, the Modbus register numbering continues for as many Nodes as are in the network. For example, the register number for Node 10, I/O point 15, is 175. Calculate the Modbus register number for each device using the equation:

\[
\text{Register Number} = \text{I/O#} + (\text{Node#} \times 16)
\]

<table>
<thead>
<tr>
<th>I/O Point</th>
<th>Gateway</th>
<th>Node 1</th>
<th>Node 2</th>
<th>Node 3</th>
<th>Node 4</th>
<th>Node 5</th>
<th>Node 6</th>
<th>Node 7</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>1</td>
<td>17</td>
<td>33</td>
<td>49</td>
<td>65</td>
<td>81</td>
<td>97</td>
<td>113</td>
</tr>
<tr>
<td>2</td>
<td>2</td>
<td>18</td>
<td>34</td>
<td>50</td>
<td>66</td>
<td>82</td>
<td>98</td>
<td>114</td>
</tr>
<tr>
<td>3</td>
<td>3</td>
<td>19</td>
<td>35</td>
<td>51</td>
<td>67</td>
<td>83</td>
<td>99</td>
<td>115</td>
</tr>
<tr>
<td>4</td>
<td>4</td>
<td>20</td>
<td>36</td>
<td>52</td>
<td>68</td>
<td>84</td>
<td>100</td>
<td>116</td>
</tr>
<tr>
<td>5</td>
<td>5</td>
<td>21</td>
<td>37</td>
<td>53</td>
<td>69</td>
<td>85</td>
<td>101</td>
<td>117</td>
</tr>
<tr>
<td>6</td>
<td>6</td>
<td>22</td>
<td>38</td>
<td>54</td>
<td>70</td>
<td>86</td>
<td>102</td>
<td>118</td>
</tr>
<tr>
<td>7</td>
<td>7</td>
<td>23</td>
<td>39</td>
<td>55</td>
<td>71</td>
<td>87</td>
<td>103</td>
<td>119</td>
</tr>
<tr>
<td>8</td>
<td>8</td>
<td>24</td>
<td>40</td>
<td>56</td>
<td>72</td>
<td>88</td>
<td>104</td>
<td>120</td>
</tr>
<tr>
<td>9</td>
<td>9</td>
<td>25</td>
<td>41</td>
<td>57</td>
<td>73</td>
<td>89</td>
<td>105</td>
<td>121</td>
</tr>
<tr>
<td>10</td>
<td>10</td>
<td>26</td>
<td>42</td>
<td>58</td>
<td>74</td>
<td>90</td>
<td>106</td>
<td>122</td>
</tr>
<tr>
<td>11</td>
<td>11</td>
<td>27</td>
<td>43</td>
<td>59</td>
<td>75</td>
<td>91</td>
<td>107</td>
<td>123</td>
</tr>
<tr>
<td>12</td>
<td>12</td>
<td>28</td>
<td>44</td>
<td>60</td>
<td>76</td>
<td>92</td>
<td>108</td>
<td>124</td>
</tr>
<tr>
<td>13</td>
<td>13</td>
<td>29</td>
<td>45</td>
<td>61</td>
<td>77</td>
<td>93</td>
<td>109</td>
<td>125</td>
</tr>
<tr>
<td>14</td>
<td>14</td>
<td>30</td>
<td>46</td>
<td>62</td>
<td>78</td>
<td>94</td>
<td>110</td>
<td>126</td>
</tr>
<tr>
<td>15</td>
<td>15</td>
<td>31</td>
<td>47</td>
<td>63</td>
<td>79</td>
<td>95</td>
<td>111</td>
<td>127</td>
</tr>
<tr>
<td>16</td>
<td>16</td>
<td>32</td>
<td>48</td>
<td>64</td>
<td>80</td>
<td>96</td>
<td>112</td>
<td>128</td>
</tr>
</tbody>
</table>

Example: Gateway Modbus Register Table

Access all wireless network registers by reading Modbus slave ID 1.

<table>
<thead>
<tr>
<th>DX80 Device</th>
<th>Slave ID</th>
<th>Modbus Registers</th>
</tr>
</thead>
<tbody>
<tr>
<td>DXM Gateway radio</td>
<td>1</td>
<td>Modbus registers 1–8 are inputs, 9–16 are outputs</td>
</tr>
<tr>
<td>Node 1</td>
<td>-</td>
<td>Modbus registers 17–25 are inputs, 26–32 are outputs</td>
</tr>
<tr>
<td>Node 2</td>
<td>-</td>
<td>Modbus registers 33–40 are inputs, 41–48 are outputs</td>
</tr>
<tr>
<td>Node 3</td>
<td>-</td>
<td>Modbus registers 49–56 are inputs, 57–64 are outputs</td>
</tr>
</tbody>
</table>

Alternative Modbus Register Organization

The Sure Cross DX80 Alternative Modbus Register Organization registers are used for reordering data registers to allow host systems to efficiently access all inputs or outputs using a single Modbus command. The register groups include the input/output registers, bit-packed registers, and analog registers. This feature is only available with the Performance models using version 3 or newer of the LCD firmware code.

<table>
<thead>
<tr>
<th>Name</th>
<th>Modbus Register Address (Dec.)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Inputs and Outputs, in order by device</td>
<td>2201 through 4784</td>
</tr>
<tr>
<td>Discrete Bit Packed (Status, Discrete Inputs, Discrete Outputs)</td>
<td>6601 through 6753</td>
</tr>
<tr>
<td>Analog Inputs (1–8) and Analog Outputs (1-8)</td>
<td>6801 through 9098</td>
</tr>
</tbody>
</table>
Input Registers and Outputs Registers

Modbus registers 2201 through 2584 are used to organize all inputs together. In this format, users can sequentially read all input registers using one Modbus message. Modbus registers 4401 through 4784 organize all outputs together to allow users to sequentially write to all outputs registers using one Modbus message.

### Discrete Bit-Packed Registers

Discrete bit-packed registers include the discrete status registers, discrete inputs, and discrete outputs.

Bit packing involves using a single register, or range of contiguous registers, to represent I/O values.

When networks use similar Nodes to gather data using the same I/O registers for each Node, discrete data from multiple Nodes can be bit packed into a single register on the Gateway. The bit-packed data is arranged by I/O point starting at Modbus register 6601. For example, Discrete IN 1 for all the Nodes in the network is stored in three contiguous 16-bit registers.

The most efficient way to read (or write) discrete data from a SureCross® DX80 Gateway is by using these bit-packed registers because users can read or write registers for all devices using one Modbus message. The following registers contain discrete bit-packed I/O values for the Gateway and all Nodes. Values are stored first for the Gateway, then for each Node in order of Node address.

#### Bit-Packed Device Status Registers

<table>
<thead>
<tr>
<th>Modbus Register Address (Dec)</th>
<th>Bit Position</th>
</tr>
</thead>
<tbody>
<tr>
<td>6601</td>
<td>Node 15</td>
</tr>
<tr>
<td>6602</td>
<td>Node 16</td>
</tr>
<tr>
<td>6603</td>
<td>Node 17</td>
</tr>
</tbody>
</table>

#### Bit-Packed Discrete Input 1

<table>
<thead>
<tr>
<th>Modbus Register Address (Dec)</th>
<th>Bit Position</th>
</tr>
</thead>
<tbody>
<tr>
<td>6611</td>
<td>Node 18</td>
</tr>
<tr>
<td>6612</td>
<td>Node 19</td>
</tr>
<tr>
<td>6613</td>
<td>Node 20</td>
</tr>
</tbody>
</table>

#### Bit-Packed Discrete Output 1

<table>
<thead>
<tr>
<th>Modbus Register Address (Dec)</th>
<th>Bit Position</th>
</tr>
</thead>
<tbody>
<tr>
<td>6691</td>
<td>Node 21</td>
</tr>
<tr>
<td>6692</td>
<td>Node 22</td>
</tr>
<tr>
<td>6693</td>
<td>Node 23</td>
</tr>
</tbody>
</table>

### Inputs and Outputs

Refer to your device’s datasheet for a list of the active inputs and outputs. Not all inputs or outputs listed in this table may be active for your system.
<table>
<thead>
<tr>
<th>Modbus Register Address (Decimal)</th>
<th>Description (Inputs)</th>
<th>Modbus Register Address (Decimal)</th>
<th>Description (Outputs)</th>
</tr>
</thead>
<tbody>
<tr>
<td>6641-6643</td>
<td>Input 4 from all devices</td>
<td>6721–6723</td>
<td>Output 4 from all devices</td>
</tr>
<tr>
<td>6651-6653</td>
<td>Input 5 from all devices</td>
<td>6731–6733</td>
<td>Output 5 from all devices</td>
</tr>
<tr>
<td>6661-6663</td>
<td>Input 6 from all devices</td>
<td>6741–6743</td>
<td>Output 6 from all devices</td>
</tr>
<tr>
<td>6671-6673</td>
<td>Input 7 from all devices</td>
<td>6751–6753</td>
<td>Output 7 from all devices</td>
</tr>
<tr>
<td>6681-6683</td>
<td>Input 8 from all devices</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**Status registers** (6601–6603) contain a bit-packed representation defining the devices that are operational in the wireless system.

**Input registers** from all devices use Modbus registers 6611 through 6683 to organize the least significant bit into a sequential array of registers. The first register contains the least significant bit from the input values for the Gateway through Node 15. The second register contains the input values for Node 16 through Node 31, and the third register contains the input values for Nodes 32 through 47.

For discrete inputs, only the least significant bit is used. For analog inputs, the least significant bit indicates if the analog value is above or below the selected threshold value (when using the threshold parameter). For example, a least significant bit of one (1) indicates the analog value is above the selected threshold value. A least significant bit of zero (0) indicates the analog value is below the threshold value.

**Output registers** from all devices use Modbus registers 6691 through 6753 to organize the least significant bit into a sequential array of registers. Output 8 (I/O point 16) cannot be written using the discrete format.

**Analog 16-Bit Registers (Registers 6801 through 9098)**

The most efficient way to read (or write) analog data from a Gateway is by using these 16-bit analog registers. Most networks consist of similar Nodes reporting data using the same I/O registers for each Node. For this reason, the analog data is arranged by I/O point using Modbus registers 6801 through 9098. For example, Input 1 for Gateway and all Nodes is stored in the first 48 contiguous blocks of 16-bit analog registers, beginning with register 6801.

In this format, users can read a 16-bit holding register for all devices or write to a register for all devices using one Modbus message. Using these registers is the most efficient way to read all status registers, read all analog inputs, or write all analog outputs.

The following registers contain analog I/O values for the Gateway and all Nodes. Values are stored first for the Gateway, then for each Node in order of Node address.
For example, 6801 contains the input 1 value for the Gateway, 6802 contains the input 1 value for Node 1, and 6848 contains the input 1 value for Node 47.

9.2.4 Internal Local Registers (Slave ID 199) for the DXM100 and DXM150

The main storage elements for the DXM are its Local Registers, which can store 4-byte values that result from register mapping, action rules, or ScriptBasic commands.

- Local Registers 1 through 850 are standard 32-bit unsigned registers.
- Local Registers 851 through 900 are non-volatile registers that are limited to 100,000 write cycles.
- Local Registers 1001 through 1900 are floating point format numbers. Each register address stores half of a floating point number. For example, registers 1001 and 1002 store the first full 32-bit floating point number.
- Local Registers 10001 through 19000 are system, read-only, registers that track DXM data and statistics.

<table>
<thead>
<tr>
<th>Local Registers</th>
<th>Type</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>1–845</td>
<td>32-bit unsigned</td>
<td>Internal processor memory</td>
</tr>
<tr>
<td>846–849</td>
<td>32-bit unsigned</td>
<td>Reset, Constant, Timer</td>
</tr>
<tr>
<td>851–900</td>
<td>32-bit unsigned</td>
<td>Data flash, non-volatile</td>
</tr>
<tr>
<td>1001–1900</td>
<td>32-bit IEEE Floating Point</td>
<td>Floating point registers, internal processor memory</td>
</tr>
<tr>
<td>&gt; 10000</td>
<td></td>
<td>Read-only virtual registers</td>
</tr>
</tbody>
</table>

Local Registers 1–850 (Internal Processor Memory, 32-bit, Unsigned)—The Local Registers are the main global pool of registers. Local Registers are used as basic storage registers and as the common data exchange mechanism. External Modbus device registers can be read into the Local Registers or written from the Local Registers. The DXM, as a Modbus master device or a Modbus slave device, exchanges data using the Local Registers. Modbus over Ethernet (Modbus/TCP) uses the Local Registers as the accessible register data.

Local Registers 851–900 (Data Flash, Non-volatile, 32-bit, Unsigned)—The top 50 Local Registers are special non-volatile registers. The registers can store constants or calibration type data that must be maintained when power is turned off. This register data is stored in a data flash component that has a limited write capability of 100,000 cycles, so these registers should not be used as common memory registers that change frequently.

Local Registers 1001–1900 (32-bit IEEE Floating Point)—These Local Registers are paired together to store a 32-bit IEEE floating point format number in big endian format. Registers 1001 [31:16], 1002 [15:0] store the first floating point value; registers 1003, 1004 store the second floating point number. There are a total of 500 floating point values; they are addressed as two 16-bit pieces to accommodate the Modbus protocol. Use these registers when reading/writing external devices that require Modbus registers in floating point format. Since Modbus transactions are 16-bits, the protocol requires two registers to form a 32-bit floating point number.

Virtual Registers—The DXM has a small pool of virtual registers that show internal variables of the main processor. Some register values will be dependent upon the configuration settings of the DXM. Do not use Read Rules to move Virtual Local Registers data into Local Registers. Use the Action Rule > Register Copy function to move Virtual Local Registers into Local Registers space (1–850).

<table>
<thead>
<tr>
<th>Virtual Registers</th>
<th>Definition</th>
</tr>
</thead>
<tbody>
<tr>
<td>10001</td>
<td>GPS latitude direction (N, S, E, W)</td>
</tr>
<tr>
<td>10002</td>
<td>GPS latitude</td>
</tr>
</tbody>
</table>

GPS Coordinate Data if the DXM is configured to read an external GPS unit.
<table>
<thead>
<tr>
<th>Registers</th>
<th>Definition</th>
</tr>
</thead>
<tbody>
<tr>
<td>10003</td>
<td>GPS longitude direction (N, S, E, W)</td>
</tr>
<tr>
<td>10004</td>
<td>GPS longitude</td>
</tr>
<tr>
<td>10011–10012</td>
<td>Resync timer</td>
</tr>
<tr>
<td>10013–10014</td>
<td>Resync timer rollover</td>
</tr>
<tr>
<td>10015–10016</td>
<td>Reboot cause (Restart Codes above)</td>
</tr>
<tr>
<td>10017–10018</td>
<td>Watchdog reset count</td>
</tr>
<tr>
<td>10021</td>
<td>IO Board Battery Voltage (mV)</td>
</tr>
<tr>
<td>10022</td>
<td>IO Board - Incoming Supply Voltage (mV)</td>
</tr>
<tr>
<td>10023</td>
<td>Cut-off Feature</td>
</tr>
<tr>
<td>10024</td>
<td>IO Board - Battery Charging Current (mA)</td>
</tr>
<tr>
<td>10025–10026</td>
<td>Http Push SSL Acquires</td>
</tr>
<tr>
<td>10027–10028</td>
<td>Http Push SSL Releases</td>
</tr>
<tr>
<td>10029–10030</td>
<td>Http Push SSL Forced Releases</td>
</tr>
<tr>
<td>10031–10032</td>
<td>Http Push Attempts</td>
</tr>
<tr>
<td>10033–10034</td>
<td>Http Push Successes</td>
</tr>
<tr>
<td>10035–10036</td>
<td>Http Push Failures</td>
</tr>
<tr>
<td>10037–10038</td>
<td>Http Push Last Status</td>
</tr>
<tr>
<td>10039–10040</td>
<td>Cellular Strength, BER</td>
</tr>
<tr>
<td>10055–10056</td>
<td>Alarms, smtp, attempts</td>
</tr>
<tr>
<td>10057–10058</td>
<td>Alarms, smtp, fails</td>
</tr>
<tr>
<td>10059–10060</td>
<td>Alarms, sms, attempts</td>
</tr>
<tr>
<td>10061–10062</td>
<td>Alarms, sms, fails</td>
</tr>
<tr>
<td>10100</td>
<td>Number of read maps in default</td>
</tr>
<tr>
<td>10101</td>
<td>Number of read map successes</td>
</tr>
<tr>
<td>10102</td>
<td>Number of read map timeouts</td>
</tr>
<tr>
<td>10103</td>
<td>Number of read map errors</td>
</tr>
<tr>
<td>10104</td>
<td>Read map success streak</td>
</tr>
<tr>
<td>10105</td>
<td>Number of write map successes</td>
</tr>
<tr>
<td>10106</td>
<td>Number of write map timeouts</td>
</tr>
<tr>
<td>10107</td>
<td>Number of write map errors</td>
</tr>
<tr>
<td>10108</td>
<td>Write map success streak</td>
</tr>
<tr>
<td>10109</td>
<td>Number of passthrough successes</td>
</tr>
</tbody>
</table>

- **Virtual Registers**
- **Registers**
- **Definition**
Virtual Registers

<table>
<thead>
<tr>
<th>Registers</th>
<th>Definition</th>
</tr>
</thead>
<tbody>
<tr>
<td>10110</td>
<td>Number of passthrough timeouts</td>
</tr>
<tr>
<td>10111</td>
<td>Number of passthrough errors</td>
</tr>
<tr>
<td>10112</td>
<td>Passthrough success streak</td>
</tr>
<tr>
<td>10113</td>
<td>Number of 43 buffer successes</td>
</tr>
<tr>
<td>10114</td>
<td>Number of 43 buffer timeouts</td>
</tr>
<tr>
<td>10115</td>
<td>Number of 43 buffer errors</td>
</tr>
<tr>
<td>10116</td>
<td>43 buffer success streak</td>
</tr>
<tr>
<td>11000</td>
<td>Read map success count</td>
</tr>
<tr>
<td>12000</td>
<td>Write map success count</td>
</tr>
<tr>
<td>13000</td>
<td>Read map timeout count</td>
</tr>
<tr>
<td>14000</td>
<td>Write map timeout count</td>
</tr>
<tr>
<td>15000</td>
<td>Read map error count</td>
</tr>
<tr>
<td>16000</td>
<td>Write map error count</td>
</tr>
<tr>
<td>17000</td>
<td>Read map success streak</td>
</tr>
<tr>
<td>18000</td>
<td>Write map success streak</td>
</tr>
<tr>
<td>19000</td>
<td>Read map is in default</td>
</tr>
</tbody>
</table>

Reset Codes — The reset codes are in virtual register 11015 and define the condition of the last restart operation.

<table>
<thead>
<tr>
<th>Reset Code</th>
<th>Definition</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>Undefined</td>
</tr>
<tr>
<td>1</td>
<td>Unknown</td>
</tr>
<tr>
<td>2</td>
<td>General</td>
</tr>
<tr>
<td>3</td>
<td>Brownout</td>
</tr>
<tr>
<td>4</td>
<td>Watchdog</td>
</tr>
<tr>
<td>5</td>
<td>User</td>
</tr>
<tr>
<td>6</td>
<td>Software</td>
</tr>
<tr>
<td>7</td>
<td>Return from backup mode</td>
</tr>
</tbody>
</table>

9.2.5 Internal Local Registers (Slave ID 199) for the DXM700, DXM1000, and DXM1500

The main storage elements for the DXM are its Local Registers, which can store 4-byte values that result from register mapping, action rules, or ScriptBasic commands.

Local Registers updated from Modbus transactions are restricted to a 16-bit data value to follow standard Modbus Holding Register definition.

The Local Registers defined in Action Rules must all be within the same register group. For example, an Action Rule cannot have inputs from an integer group with the result register defined as a floating point register. To move between integers and floats, use the Register Copy Rule.

- Local Registers 1–850 and 5001–7000 are 32-bit integer registers
- Local Registers 851–900 and 7001–8000 are non-volatile 32-bit integer registers
- Local Registers 901–1000 are reserved for internal use
- Local Registers 1001–5000 are floating point format numbers, each address stores half of a floating point number; for example, registers 1001 and 1002 store the first full 32-bit floating point number
• Local Registers 10000 and higher are read only virtual registers; virtual registers collect various system-level data

<table>
<thead>
<tr>
<th>Modbus Registers for Internal Local Registers (Modbus Slave ID 199)</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Local Registers</strong></td>
</tr>
<tr>
<td>1–845</td>
</tr>
<tr>
<td>846–849</td>
</tr>
<tr>
<td>851–900</td>
</tr>
<tr>
<td>901–1000</td>
</tr>
<tr>
<td>1001–5000</td>
</tr>
<tr>
<td>5001–7000</td>
</tr>
<tr>
<td>7001–8000</td>
</tr>
<tr>
<td>&gt; 10000</td>
</tr>
</tbody>
</table>

Local Registers 1–850 and 5001–7000 (Internal Processor Memory, 32-bit, Unsigned)—The Local Registers are the main global pool of registers. Local Registers are used as basic storage registers and as the common data exchange mechanism. External Modbus device registers can be read into the Local Registers or written from the Local Registers. The DXM, as a Modbus master device or a Modbus slave device, exchanges data using the Local Registers. Modbus over Ethernet (Modbus/TCP) uses the Local Registers as the accessible register data.

Local Registers 851–900 and 7001–8000 (Data Flash, Non-volatile, 32-bit, Unsigned)—The top 50 Local Registers are special non-volatile registers. The registers can store constants or calibration type data that must be maintained when power is turned off. This register data is stored in a data flash component that has a limited write capability of 100,000 cycles, so these registers should not be used as common memory registers that change frequently.

Local Registers 1001–5000—These Local Registers are paired together to store a 32-bit IEEE floating point format number in big endian format. Registers 1001 [31:16], 1002 [15:0] store the first floating point value; registers 1003, 1004 store the second floating point number. There are a total of 2000 floating point values; they are addressed as two 16-bit pieces to accommodate the Modbus protocol. Use these registers when reading/writing external devices that require Modbus registers in floating point format. Since Modbus transactions are 16-bits, the protocol requires two registers to form a 32-bit floating point number.

Virtual Registers—The DXM has a small pool of virtual registers that show internal variables of the main processor. Some register values will be dependent upon the configuration settings of the DXM. Do not use Read Rules to move Virtual Local Registers data into Local Registers. Use the Action Rule > Register Copy function to move Virtual Local Registers into Local Registers space (1–850).

<table>
<thead>
<tr>
<th>Modbus Registers for Virtual Registers</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Registers</strong></td>
</tr>
<tr>
<td>10001</td>
</tr>
<tr>
<td>10002</td>
</tr>
<tr>
<td>10003</td>
</tr>
<tr>
<td>10004</td>
</tr>
<tr>
<td>10011–10012</td>
</tr>
<tr>
<td>10013–10014</td>
</tr>
<tr>
<td>10015–10016</td>
</tr>
<tr>
<td>10017–10018</td>
</tr>
<tr>
<td>10021</td>
</tr>
<tr>
<td>10022</td>
</tr>
<tr>
<td>10023</td>
</tr>
<tr>
<td>10024</td>
</tr>
</tbody>
</table>

GPS Coordinate Data if the DXM is configured to read an external GPS unit.
<table>
<thead>
<tr>
<th>Modbus Registers for Virtual Registers</th>
<th>Definition</th>
</tr>
</thead>
<tbody>
<tr>
<td>10025–10026</td>
<td>Http Push SSL Acquires</td>
</tr>
<tr>
<td>10027–10028</td>
<td>Http Push SSL Releases</td>
</tr>
<tr>
<td>10029–10030</td>
<td>Http Push SSL Forced Releases</td>
</tr>
<tr>
<td>10031–10032</td>
<td>Http Push Attempts</td>
</tr>
<tr>
<td>10033–10034</td>
<td>Http Push Successes</td>
</tr>
<tr>
<td>10035–10036</td>
<td>Http Push Failures</td>
</tr>
<tr>
<td>10037–10038</td>
<td>Http Push Last Status</td>
</tr>
<tr>
<td>10039–10040</td>
<td>Cellular Strength, BER</td>
</tr>
<tr>
<td>10055–10056</td>
<td>Alarms, smtp, attempts</td>
</tr>
<tr>
<td>10057–10058</td>
<td>Alarms, smtp, fails</td>
</tr>
<tr>
<td>10100</td>
<td>Number of read maps in default</td>
</tr>
<tr>
<td>10101</td>
<td>Number of read map successes</td>
</tr>
<tr>
<td>10102</td>
<td>Number of read map timeouts</td>
</tr>
<tr>
<td>10103</td>
<td>Number of read map errors</td>
</tr>
<tr>
<td>10104</td>
<td>Read map success streak</td>
</tr>
<tr>
<td>10105</td>
<td>Number of write map successes</td>
</tr>
<tr>
<td>10106</td>
<td>Number of write map timeouts</td>
</tr>
<tr>
<td>10107</td>
<td>Number of write map errors</td>
</tr>
<tr>
<td>10108</td>
<td>Write map success streak</td>
</tr>
<tr>
<td>10109</td>
<td>Number of passthrough successes</td>
</tr>
<tr>
<td>10110</td>
<td>Number of passthrough timeouts</td>
</tr>
<tr>
<td>10111</td>
<td>Number of passthrough errors</td>
</tr>
<tr>
<td>10112</td>
<td>Passthrough success streak</td>
</tr>
<tr>
<td>10113</td>
<td>Number of 43 buffer successes</td>
</tr>
<tr>
<td>10114</td>
<td>Number of 43 buffer timeouts</td>
</tr>
<tr>
<td>10115</td>
<td>Number of 43 buffer errors</td>
</tr>
<tr>
<td>10116</td>
<td>43 buffer success streak</td>
</tr>
<tr>
<td>11000</td>
<td>Read map success count</td>
</tr>
<tr>
<td>12000</td>
<td>Write map success count</td>
</tr>
<tr>
<td>13000</td>
<td>Read map timeout count</td>
</tr>
<tr>
<td>14000</td>
<td>Write map timeout count</td>
</tr>
<tr>
<td>15000</td>
<td>Read map error count</td>
</tr>
<tr>
<td>16000</td>
<td>Write map error count</td>
</tr>
<tr>
<td>17000</td>
<td>Read map success count</td>
</tr>
</tbody>
</table>

Statistical counts of connections, disconnections and forced disconnects when the DXM creates a connection using SSL/TLS (Encrypted connections). Statistical counts of connections, disconnections and forced disconnects when the DXM controller creates a connection using HTTP non-encrypted. Last DXM push status:

- 0 = Initial state, no push attempt as finished yet
- 1 = Attempt complete
- 2 = Attempt aborted

Cellular signal strength. Value range: 0–31

- 0 = –113 dBm or less
- 1 = –111 dBm
- 2–30 = –109 dBm through –53 dBm in 2 dBm steps
- 31 = –51 dBm or greater
- 99 = not known or not detectable; BER not used

Email attempts

Email failures

Read Map statistics

Write Map statistics

API message passing statistics

DX80 Gateway automatic messaging buffer statistics

Read/Write maps statistics
Modbus Registers for Virtual Registers

<table>
<thead>
<tr>
<th>Registers</th>
<th>Definition</th>
</tr>
</thead>
<tbody>
<tr>
<td>18000</td>
<td>Write map success streak</td>
</tr>
<tr>
<td>19000</td>
<td>Read map is in default</td>
</tr>
</tbody>
</table>

TCP Client Stats—The “x” represents the socket 0 through 4. The flex socket is not used. This range repeats for the next socket.

<table>
<thead>
<tr>
<th>TCP Client Stats</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Register</td>
<td>Definition</td>
</tr>
<tr>
<td>2x001</td>
<td>Socket x connection attempts (20001 is the first socket, 21001 is the second socket...)</td>
</tr>
<tr>
<td>2x003</td>
<td>Socket x connections</td>
</tr>
<tr>
<td>2x005</td>
<td>Socket x disconnections</td>
</tr>
<tr>
<td>2x007</td>
<td>Socket x transmits</td>
</tr>
<tr>
<td>2x009</td>
<td>Socket x receives</td>
</tr>
<tr>
<td>2x011</td>
<td>Socket x resolver attempts (reserved)</td>
</tr>
<tr>
<td>2x013</td>
<td>Socket x resolvers (reserved)</td>
</tr>
<tr>
<td>2x015–2x020</td>
<td>Reserved</td>
</tr>
<tr>
<td>2x021</td>
<td>Socket x Rule 0 transmits</td>
</tr>
<tr>
<td>2x023</td>
<td>Socket x Rule 0 receives</td>
</tr>
<tr>
<td>2x025</td>
<td>Socket x Rule 0 timeouts</td>
</tr>
<tr>
<td>2x027</td>
<td>Socket x Rule 0 broadcasts</td>
</tr>
<tr>
<td>2x029</td>
<td>Reserved</td>
</tr>
<tr>
<td>2x031</td>
<td>Socket x Rule 1 transmits</td>
</tr>
<tr>
<td>2x033</td>
<td>Socket x Rule 1 receives</td>
</tr>
<tr>
<td>2x035</td>
<td>Socket x Rule 1 timeouts</td>
</tr>
<tr>
<td>2x037</td>
<td>Socket x Rule 1 broadcasts</td>
</tr>
<tr>
<td>2x039</td>
<td>Reserved</td>
</tr>
</tbody>
</table>

Reset Codes—The reset codes are in virtual register 11015 and define the condition of the last restart operation.

<table>
<thead>
<tr>
<th>Reset Code</th>
<th>Definition</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>Undefined</td>
</tr>
<tr>
<td>1</td>
<td>Unknown</td>
</tr>
<tr>
<td>2</td>
<td>General</td>
</tr>
<tr>
<td>3</td>
<td>Brownout</td>
</tr>
<tr>
<td>4</td>
<td>Watchdog</td>
</tr>
<tr>
<td>5</td>
<td>User</td>
</tr>
<tr>
<td>6</td>
<td>Software</td>
</tr>
<tr>
<td>7</td>
<td>Return from backup mode</td>
</tr>
</tbody>
</table>

9.2.6 Modbus I/O Registers for the B1 I/O 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 DXM to read or write the values on the I/O base board.
### Base Board Input Connection

<table>
<thead>
<tr>
<th>Modbus Register</th>
<th>Range</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>0–65535</td>
<td>Universal input 1</td>
</tr>
<tr>
<td>2</td>
<td>0–65535</td>
<td>Universal input 2</td>
</tr>
<tr>
<td>3</td>
<td>0–65535</td>
<td>Universal input 3</td>
</tr>
<tr>
<td>4</td>
<td>0–65535</td>
<td>Universal input 4</td>
</tr>
</tbody>
</table>

### Universal Input Register Ranges

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

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

### B1 Controller Base Board Output Connection

<table>
<thead>
<tr>
<th>Modbus Register</th>
<th>Range</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>501</td>
<td>0–1</td>
<td>NMOS Output 1</td>
</tr>
<tr>
<td>502</td>
<td>0–1</td>
<td>NMOS Output 2</td>
</tr>
<tr>
<td>503</td>
<td>0–1</td>
<td>NMOS Output 3</td>
</tr>
<tr>
<td>504</td>
<td>0–1</td>
<td>NMOS Output 4</td>
</tr>
<tr>
<td>505</td>
<td>0–1</td>
<td>Switched Power 1 (5 V or 16 V)</td>
</tr>
<tr>
<td>506</td>
<td>0–1</td>
<td>Switched Power 2 (5 V or 16 V)</td>
</tr>
<tr>
<td>507</td>
<td>0–20000</td>
<td>Analog Output 1 default (0–20.000 mA)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>0–10000</td>
</tr>
<tr>
<td>508</td>
<td>0–20000</td>
<td>Analog Output 2 default (0–20.000 mA)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>0–10000</td>
</tr>
</tbody>
</table>

### 9.2.7 Modbus I/O Registers for the B2 I/O 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 DXM to read or write the values on the I/O base board.
### Universal Input Register Ranges

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

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

### B2 Controller Base Board Output Connection

<table>
<thead>
<tr>
<th>Modbus Register</th>
<th>Range</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>501</td>
<td>0–1</td>
<td>NMOS Output 1</td>
</tr>
<tr>
<td>502</td>
<td>0–1</td>
<td>NMOS Output 2</td>
</tr>
<tr>
<td>503</td>
<td>0–1</td>
<td>NMOS Output 3</td>
</tr>
<tr>
<td>504</td>
<td>0–1</td>
<td>NMOS Output 4</td>
</tr>
<tr>
<td>505</td>
<td>0–1</td>
<td>Switched Power 1 (5 V to 24 V)</td>
</tr>
<tr>
<td>506</td>
<td>0–1</td>
<td>Switched Power 2 (5 V to 24 V)</td>
</tr>
<tr>
<td>507</td>
<td>0–1</td>
<td>DC Latching Output 1</td>
</tr>
<tr>
<td>508</td>
<td>0–1</td>
<td>DC Latching Output 2</td>
</tr>
<tr>
<td>509</td>
<td>0–10000</td>
<td>Analog Output 1 (0–10.000 V)</td>
</tr>
<tr>
<td>510</td>
<td>0–10000</td>
<td>Analog Output 2 (0–10.000 V)</td>
</tr>
</tbody>
</table>

9.2.8 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.

<table>
<thead>
<tr>
<th>Universal Input Parameters Registers</th>
</tr>
</thead>
<tbody>
<tr>
<td>Universal Inputs</td>
</tr>
<tr>
<td>Enable Full Scale Registers</td>
</tr>
<tr>
<td>Temperature °C/F Registers</td>
</tr>
<tr>
<td>Input Type Registers</td>
</tr>
<tr>
<td>Threshold Registers</td>
</tr>
<tr>
<td>Hysteresis Registers</td>
</tr>
<tr>
<td>Enable Rising Registers</td>
</tr>
<tr>
<td>Enable Falling Registers</td>
</tr>
<tr>
<td>High Register for Counter Registers</td>
</tr>
<tr>
<td>Low Register for Counter Registers</td>
</tr>
</tbody>
</table>

9.2.9 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 must be changed on the I/O board and a parameter Modbus register must be changed. For step by step instructions on changing the output characteristics see Analog (DAC) Outputs for the B1 and S1 Models (p. 30).

Parameters for Analog Output 1 start at 4001 through 4008. Parameters for Analog Output 2 start at 4021 through 4028.
<table>
<thead>
<tr>
<th>Analog output 1</th>
<th>Analog output 2</th>
<th>Description</th>
<th>Values</th>
</tr>
</thead>
<tbody>
<tr>
<td>4001</td>
<td>4021</td>
<td>Maximum Analog Value</td>
<td></td>
</tr>
<tr>
<td>4002</td>
<td>4022</td>
<td>Minimum Analog Value</td>
<td></td>
</tr>
<tr>
<td>4003</td>
<td>4023</td>
<td>Enable Register Full Scale</td>
<td>0 = Store readings in unit-specific data, 1 = Linear rate from 0 to 65535</td>
</tr>
<tr>
<td>4004</td>
<td>4024</td>
<td>Hold Last State Enable</td>
<td>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</td>
</tr>
<tr>
<td>4005</td>
<td>4025</td>
<td>Default Output State</td>
<td></td>
</tr>
<tr>
<td>4008</td>
<td>4028</td>
<td>Analog Output Type</td>
<td>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</td>
</tr>
<tr>
<td>2952</td>
<td></td>
<td>Enable Default Communication Timeout</td>
<td>0 = Disable, 1 = Enable</td>
</tr>
<tr>
<td>2953</td>
<td></td>
<td>Communication Default I/O Timeout (100 ms/Count)</td>
<td>Number of 100 ms periods</td>
</tr>
<tr>
<td>2954</td>
<td></td>
<td>Enable Default on Power Up</td>
<td>0 = Disable, 1 = Sends device outputs to their default condition</td>
</tr>
</tbody>
</table>

**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 conditions/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 master 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 I/O Timeout.
- **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 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.

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

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

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

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

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

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

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

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

Temperature °C/°F
Set to 1 to represent temperature units in degrees Fahrenheit, and set to 0 (default) to represent temperature units in degrees Celsius.

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

<table>
<thead>
<tr>
<th>Modbus Register</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>6071</td>
<td>Battery backup charging algorithm.</td>
</tr>
<tr>
<td></td>
<td>0 = Battery is recharged from a solar panel</td>
</tr>
<tr>
<td></td>
<td>1 = Battery is recharged from 12 to 30 V dc . (default)</td>
</tr>
<tr>
<td>6081</td>
<td>Battery voltage (mV)</td>
</tr>
<tr>
<td>6082</td>
<td>Battery charging current (mA)</td>
</tr>
</tbody>
</table>
### Modbus Registers for the LCD Board (Modbus Slave ID 201)

Control the four user-defined LEDs using the display board’s Modbus registers. Using write maps or ScriptBasic, write the Modbus registers shown below with 0 (off) or 1 (on). The LCD display is Modbus Slave 201.

<table>
<thead>
<tr>
<th>Modbus Register</th>
<th>I/O Connection</th>
<th>Modbus Register</th>
<th>I/O Connection</th>
</tr>
</thead>
<tbody>
<tr>
<td>1102 : bit 0</td>
<td>LED 1</td>
<td>1104 : bit 0</td>
<td>LED 3</td>
</tr>
<tr>
<td>1103 : bit 0</td>
<td>LED 2</td>
<td>1105 : bit 0</td>
<td>LED 4</td>
</tr>
</tbody>
</table>

#### Using the Display LEDs

Turn on the DXM LEDs by writing to the LEDs' Modbus registers.

This example shows how to configure the DXM using the DXM Configuration Software to read four universal inputs and write the state values to the display LEDs.

1. Using the DXM Configuration Software, go to the Local Registers > Local Registers in Use screen.
2. Define the local registers by assigning names to the first four registers and setting the LCD permissions parameter to read/write. The LCD permissions show the register contents on the LCD menu under the REGISTER menu. You can also set the value from the LCD menu.
3. Create a Read Rule to read the four universal inputs from the I/O board (Modbus slave 200) and write the values in local registers 1 through 4.
4. Create a Write Rule to write the four local register values to the DXM display registers 1102 through 1105 (Modbus Slave 201). Define the Write Rule to only write the display registers when the inputs change.

5. Save the XML configuration from the File > Save As menu.

6. Connect to the DXM using a USB cable and select Device > Connection Settings from the menu bar.

7. Upload the XML configuration file to the DXM by selecting Device > Upload Configuration to Device from the menu bar.

After a configuration file is uploaded, the DXM reboots. The new configuration is now running.

Turning on any one of the universal inputs 1 through 4 on the I/O base board of the DXM now turns on an LED on the display.

9.3 Using Courtesy Power or Switch Power

Pin 18 of the DXM Wireless Controller is a constant power source that supplies 5 volts 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 slave ID 200). The voltage options are:

- 5 volts or 16 volts 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.
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.

9.4 Associating a Switched Power Output to an Input

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

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.

<table>
<thead>
<tr>
<th>Courtesy Power Output Configuration Parameters</th>
<th>Modbus Registers to Write To</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Switched Power 1</td>
</tr>
<tr>
<td>Switched Power Enable</td>
<td>2201</td>
</tr>
<tr>
<td>Voltage</td>
<td>3601</td>
</tr>
<tr>
<td>Default Output</td>
<td>3602</td>
</tr>
<tr>
<td>Output Register</td>
<td>505</td>
</tr>
</tbody>
</table>

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.

† Only used when supply courtesy power to the output pin, not when associating switched power to an input.
**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.

<table>
<thead>
<tr>
<th>Input Parameter</th>
<th>Universal Input Configuration Parameter Modbus Registers to Write To</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Universal Input 1</td>
</tr>
<tr>
<td>Input Enable</td>
<td>1001</td>
</tr>
<tr>
<td>Sample Interval (high)</td>
<td>1002</td>
</tr>
<tr>
<td>Sample Interval (low)</td>
<td>1003</td>
</tr>
<tr>
<td>Switched Power Enable</td>
<td>1004</td>
</tr>
<tr>
<td>Mask</td>
<td></td>
</tr>
<tr>
<td>Switched Power Warmup</td>
<td>1005</td>
</tr>
<tr>
<td>Switched Power Voltage</td>
<td>1006</td>
</tr>
<tr>
<td>Extended Input Read</td>
<td>1007</td>
</tr>
<tr>
<td>Input Out-of-Sync Enable</td>
<td>1008</td>
</tr>
</tbody>
</table>

**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.

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 master radio, set to 1.
To disable the input when the device is not synchronized to the master 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 theCourtesy 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).

Associate Universal Input 1 with Switch Power 1
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).

9.5 Working with Solar Power
A reliable solar system requires careful planning and monitoring to size the components correctly. The recommendations provided are for the DXM system as an autonomous system.
Adding extra components increases the power requirements and likely requires increasing the solar system components. Depending upon the geographical location, the size of the solar panel and battery may vary.

9.5.1 Setting the DXM for Solar Power
By default, the DXM is set from the factory to charge a backup battery from a line power source. Use the LCD menu on the front of the DXM to change the charging algorithm to solar power.
Go to System Config > I/O Board > Charger. Use the up/down arrows to select Solar.
For DXM devices without an LCD, adjust the I/O board Modbus register 6071. Set the register to 0 to select battery charging from a solar panel, and set to 1 to select battery charging from incoming 12 to 30 V dc supply.
Here are a few DXM configuration tips to help minimize the power consumption (may not apply to all models).
- If Ethernet is not being used, save up to 25% of the consumed power by disabling Ethernet. Set DIP switch 1 to the ON position on the processor board then reboot.
- Instead of powering external devices all the time, take advantage of the switched power mechanisms to turn off devices when possible.
- Minimize the number of cellular transactions and the amount of data pushed across the cellular modem.

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

Battery
The DXM solar controller is designed to use a 12 V sealed lead acid (SLA) battery. The characteristics of a solar system require the battery to be of a certain type. There are two types of lead acid batteries:
- SLI batteries (Starting Lights Ignition) designed for quick bursts of energy, like starting engines
- Deep Cycle batteries - greater long-term energy delivery. This is the best choice for a solar battery.

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

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

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

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.

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.

<table>
<thead>
<tr>
<th>State of Charge (%)</th>
<th>Open Circuit Voltage</th>
</tr>
</thead>
<tbody>
<tr>
<td>100</td>
<td>13.0 or higher</td>
</tr>
<tr>
<td>75</td>
<td>12.6</td>
</tr>
<tr>
<td>50</td>
<td>12.1</td>
</tr>
<tr>
<td>25</td>
<td>11.66</td>
</tr>
<tr>
<td>0</td>
<td>11.4 or less</td>
</tr>
</tbody>
</table>

Use this as a guide to the approximate state of charge and in determining when to apply conservation measures.

**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.

<table>
<thead>
<tr>
<th>Solar Panel</th>
<th>Voltage</th>
<th>Current</th>
<th>Typical DXM Configurations</th>
</tr>
</thead>
<tbody>
<tr>
<td>5 Watt</td>
<td>17 V</td>
<td>0.29 A</td>
<td>DXM slave controller, ISM radio, I/O base board</td>
</tr>
<tr>
<td>20 Watt</td>
<td>21 V</td>
<td>1 A</td>
<td>DXM Controller with ISM radio and Cellular modem</td>
</tr>
</tbody>
</table>

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

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

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

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

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

**9.5.3 Recommended Solar Configurations**

These solar panel and battery combinations assume direct sunlight for 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

<table>
<thead>
<tr>
<th>Solar Panel</th>
<th>Battery Capacity</th>
<th>Days of Autonomy</th>
<th>DXM mA</th>
<th>DXM Controller</th>
</tr>
</thead>
<tbody>
<tr>
<td>5 watt</td>
<td>10 Ahr</td>
<td>10 days</td>
<td>25 mA</td>
<td>DXM Slave Controller - ISM radio and I/O base board</td>
</tr>
<tr>
<td>20 watt</td>
<td>14 Ahr</td>
<td>10 days</td>
<td>30 mA</td>
<td>DXM Controller with ISM radio</td>
</tr>
<tr>
<td>20 watt</td>
<td>20 Ahr</td>
<td>10 days</td>
<td>35 mA</td>
<td>DXM Controller with ISM radio and Cellular Modem</td>
</tr>
</tbody>
</table>

### 9.5.4 Monitoring Solar Operation

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

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

![Figure 24. Solar Panel Voltage (mV) -- Cloudy First Day](image)

![Figure 25. Battery Voltage (mV) - Cloudy First Day](image)

### 9.6 Clear the Password for the DXM100 and DXM150 Models Only

By default, the DXM Controllers do not require a password to load a configuration file. If a password is defined, the password must be entered before uploading a configuration file. To change the password, you must already know the current password. If you do not know the current password, follow these steps to clear the password.

**Important:** Clearing the password erases the current configuration and any program files, log files, or history files.

**Important:** DO NOT follow these instructions if you have a DXM700, DXM1000, or DXM1500 model. If you attempt to clear the password of a DXM700, DXM1000, or DXM1500 with these instructions, the firmware of your device will be erased and your controller will no longer function.

1. Turn the power OFF to the DXM Controller.

---

8 Battery capacity (amp hour) is standard amp rating taken for 20 hours. Battery capacity should be monitored for reliable system power and may need to be increased for cold weather locations.
2. Set DIP switch 4 to the ON position.
3. Press and hold the processor button.
4. Turn the power ON to the DXM Controller.
   The processor board’s LED flashes to indicate the process is complete (about 10-20 seconds).
5. Set DIP switch 4 to the OFF position.
6. Cycle power to the DXM Controller.
7. Reload the configuration file before resuming normal operation.

9.7 Clear the Password on DXM700-Bx, DXM1000-Bx, or DXM1500-Bx Models

By default, the DXM Controllers do not require a password to load a configuration file. If a password is defined, the password must be entered before uploading a configuration file. To change the password, you must already know the current password. If you do not know the current password, follow these steps to clear the password.

**Important:** Clearing the password erases the current configuration and any program files, log files, or history files.

1. Turn on the power to the DXM Controller.
2. Set DIP switch 4 to the ON position.
3. Press and hold the processor button until processor board LED flashes.
4. Set DIP switch 4 to the OFF position.
5. Cycle power to the DXM Controller.
6. Reload the configuration file before resuming normal operation.
10 DXM100 Dimensions

All measurements are listed in millimeters, unless noted otherwise.
11 Accessories

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

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

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

**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, qty 10
- 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, qty 1 each

**Antenna Cables**
- BWC-1MRSMN05—LMR100 RP-SMA to N-Type Male, 0.5 m
- BWC-2MRFSR6—LMR200, RP-SMA Male to RP-SMA Female Bulkhead, 6 m
- BWC-4MNFS6—LMR400 N-Type Male to N-Type Female, 6 m

**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

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

12.1 File System and Archive Process

The DXM file system consists of two physical components: the serial EEPROM that stores non-volatile configuration information and a removable micro SD card that stores file backup data and user created files.

**EEPROM Files**—The serial EEPROM stores basic data that is required to be non-volatile, including network configuration data, IP address, MAC address, network masks, firewall settings, and authentication information. The controller XML configuration file created by the DXM Configuration Software is stored in EEPROM. The small section of non-volatile local registers is also stored in EEPROM.

**Micro SD Card Files**—The micro SD card contains most files at the root level. The archive directory contains files kept by the system for history backup. Archive files are stored in the directory `_sxi` and are only accessible by removing the SD card.

- Data Log Files
- HTTP Push Files
- User created ScriptBasic file
- ScriptBasic program file
- CmVMon file
- `_sxi` Archive directory

**Data Log Files**

Users may create up to four data log files using the DXM Configuration Software. The log files are stored in the root directory on the SD card. When the file size limit is reached, the filename is changed to include the date and time and the file is moved into the archive directory `_sxi`. If a finished log file is to be e-mailed, it will be done at this time and then moved into the archive directory. Archived log files are deleted based on the Clear Logs parameter.

**HTTP Push File**

If the DXM is configured to send data to a webserver or host system, the device creates an HTTP.LOG file on the SD card. The HTTP log is created only if the Logging Interval is non-zero and the HTTP enable log is set. An entry is placed in the HTTP log file at the Logging Interval specified by the user. At the Push Interval time, the HTTP log file is sent to the webserver or host system. If the transmission is successful, the HTTP log file is time stamped and placed into the archive directory `_sxi`. If the transmission fails, the file remains in the root directory and subsequent Logging Intervals are appended to the file and are sent at the next Push Interval. See Ethernet and Cellular Push Retries (p. 58).

**User Created ScriptBasic Files**

Users may use ScriptBasic to create files on the SD card by using the FILEOUT function. The filenames are fixed and up to five files can be created in the root directory.

**ScriptBasic Program File**

The main ScriptBasic program that runs at boot time is stored on the SD card in the root directory.

**CmVMon File**

The CmVMon.txt file (Cellular milli-Volt Monitor) is created by the system and is used to track power events. Every power-up cycle is date/time stamped with the voltage read from the I/O board. The value 24487 is equal to 24.487 volts. If the voltage drops below 11.2 V, another entry is put in the log file indicating the cellular modem will shut down.

<table>
<thead>
<tr>
<th>Date/Time</th>
<th>Power Status</th>
</tr>
</thead>
<tbody>
<tr>
<td>CM 2015-09-22 18:52:43</td>
<td>Power entered normal range 24487</td>
</tr>
<tr>
<td>CM 2015-10-13 20:49:47</td>
<td>Power entered normal range 24004</td>
</tr>
<tr>
<td>CM 2015-10-16 15:00:20</td>
<td>Power entered normal range 24014</td>
</tr>
<tr>
<td>CM 2015-10-19 19:12:26</td>
<td>Power entered normal range 12845</td>
</tr>
</tbody>
</table>

**_sxi Archive Directory**

Only two types of files are moved into the archive directory: data log files and HTTP log files. Data log files are date/time stamped and placed into the archive directory when the size limit is reached. HTTP log files are date/time stamped then placed into the archive directory when they are successfully sent to the webserver or host system. If the HTTP log files were not successfully sent after the retries have been exhausted, the files are placed into a root directory called `sav`.
12.2 Troubleshooting

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

To reset the I/O base board to factory defaults, write to two Modbus registers in the base board. The default slave ID for the base board is 200.

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

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

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

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

<table>
<thead>
<tr>
<th>Register</th>
<th>Values</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>4151</td>
<td>0–255</td>
<td>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.</td>
</tr>
<tr>
<td>4152</td>
<td>0–1</td>
<td>0 = Reboots (cycles power) to the I/O base board 1 = Restores factory defaults for I/O parameters</td>
</tr>
</tbody>
</table>

12.2.2 Updating the DXM Processor Firmware

There are two different update procedures, depending on the DXM firmware version of your device.

Update Your DXM Processor Firmware (Prior to Version 2.0)

To update DXM Processor firmware prior to version 2.0, use the SAM-BA program from MicroChip/Atmel. Following these instructions to update the DXM100 or DXM150 processor firmware.

2. Install the SAM-BA program.
3. Set the processor board jumper (jumper C, shown below in the "boot load off" position).

   ![Diagram](image.png)

   a) Disconnect the DXM Controller from its power supply.
b) Open the hardware cover.

c) Using your fingers or tweezers, move the jumper to the "boot load on" position (jumper on the top two pins).

d) Connect the DXM back to its power supply.

e) The lower left LED on the I/O base board is solid when power is turned on. After the LED begins flashing, remove power.

f) Move the jumper back to its original position.

g) Replace the hardware cover.

h) Connect the DXM back to its power supply.

4. Launch the SAM-BA program. Select the COM port and correct board. Click CONNECT.

The SAM-BA program attempts to automatically detect the COM port and the correct device.

5. On the SCRIPTS pull-down menu select ENABLE FLASH ACCESS. Click EXECUTE.

6. In the SCRIPTS pull-down menu, select BOOT FROM FLASH (GPNVM1). Click EXECUTE. Click EXECUTE again if the message indicates it failed.

7. In the Flash tab, click on the folder icon for the Send File Name field. Select the boot load file (must be a *.bin file) and click SEND FILE. The file is: DXM PROCESSOR Firmware V2.02 or go to the software section of the Wireless Reference Library on www.bannerengineering.com.
The load process takes a few seconds.
8. After the load is complete, the program asks if you want to lock the flash region. Click **NO**.
9. Close the SAM-BA bootloader program.
10. Cycle the power to the DXM Controller.
The new code should now be running and the LEDs should be on.

### Updating Your DXM Processor Firmware (Version 2 or Later)

DXMs with processor firmware version 2.0 or later have a built-in boot loader program to update the firmware. Use the DXM Configuration Software version 3 or later, the Banner Connected Data Solutions webserver, or manually write the files on the SD card to update the firmware.

The new firmware file loads into the **BOOT** directory of the SD card on the DXM. The DXM Configuration Software or Banner Connected Data Solutions website handles the reprogramming process automatically. During the programming process, the internal LEDs on the processor board indicate the status of the programming.

#### Update Process Overview

<table>
<thead>
<tr>
<th>Reprogramming Step</th>
<th>Approximate time required</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Loading new firmware file (*HEX)</td>
<td>DXM Configuration Software: 2 minutes over Ethernet or 15 minutes over USB Banner Connected Data Solutions: 2 minutes over Ethernet or 5 minutes over Cellular</td>
<td>Send the new firmware image to the DXM. After the new image is on the device, the controller resets. LED3 is red during the loading process.</td>
</tr>
<tr>
<td>Verify the contents of the new firmware file</td>
<td>1 minute</td>
<td>When the DXM finds a file that should be installed, LED4 (amber) flashes at about a 1 second rate while the contents of the file are validated.</td>
</tr>
<tr>
<td>New firmware file is valid</td>
<td></td>
<td>After validation successfully completes, LED4 is on (amber).</td>
</tr>
<tr>
<td>New firmware file is being loaded</td>
<td>2 minutes; do not remove power to the DXM during the programming process.</td>
<td>LED3 (red) blinks approximately once per second. LED3 continues to blink during the application programming process.</td>
</tr>
<tr>
<td>Finished</td>
<td></td>
<td>After programming has completed, the DXM resets and begins running the new firmware</td>
</tr>
</tbody>
</table>

The firmware file names follow an 8.3 filename convention. The first 5 characters are the firmware part number in hexadecimal; the last 3 characters of the part number are the major/minor version number. For example, if `30FA9052.hex` is the firmware programming file, 200617 decimal (30FA9 hex) is the firmware part number and 0.5.2 (0502) is the decoded version number.
Update Your DXM Processor Firmware Using the DXM Configuration Tool

To update your processor firmware using the DXM Configuration Software, follow these instructions.

1. Using the DXM Configuration Software version 3 or later, connect to the DXM via USB® or Ethernet.
   File loads to the DXM will take about 15 minutes using USB or approximately 2 minutes using Ethernet.
2. On the DXM Configuration Software, go to Settings > General > Device Information to verify the current firmware version.
   You must load a different version with the same firmware number for the boot loader to operate. Download firmware files from the Banner website.

3. Under Settings > Reprogram, click Select upgrade file to select the firmware file to program.
   After the file load is completed, the DXM restarts and loads the new firmware file. It takes about 2 minutes to complete the programming process. The device reboots when finished. Verify the firmware has been updated, under Settings > General > Device Information.

Update Your Processor Firmware Using the Banner Connected Data Solutions Website

To update your processor firmware (version 2.0 or later) using the DXM website, follow these instructions.

To use the website to update the firmware file, first configure the DXM to push data to the website.

1. Go to Dashboard > Sites and click + to verify the current firmware part number and version on the DXM.

   Data collected from the DXM is displayed.
2. From the main Dashboard > Sites screen, click on Update.
   A popup box appears.
3. Set the Communications Type to Push Reply, and set the Update Type to Firmware file.
4. Choose the appropriate Upload File (*.HEX) and click Queue. Click Close.
   At the next scheduled push interval, the DXM retrieves the new firmware file. The new firmware file must be the same part number of firmware that is currently in the DXM.

Update Your Processor Firmware Manually

To manually update your processor firmware (version 2.0 or later) using SD card, follow these instructions.

The firmware file can manually be put on the SD card in the BOOT directory (must have version 2.0 or later on the DXM).

1. Disconnect the DXM from its power supply.
2. Remove the micro SD card from the DXM.

---

9 While the file download is in process over a USB connection, do not use other applications on the PC. After the DXM reboots for a firmware update, the USB port may be unresponsive. Clear the connection by disconnecting the USB cable and restarting the DXM Configuration Software software.
a) Open the cover housing to the DXM.
b) Use your fingernail to slide the top metal portion of SD card holder.
c) The metal cover hinges upward, allowing access to the remove the SD card.
d) Press down on the SD cover and slide back into position to close the SD card holder.

3. Insert the micro SD card into an SD card reader to access the data from a PC.
4. Load the new firmware file (*.hex) into the BOOT directory of the micro SD card.
5. Re-insert the micro SD card into the DXM by sliding the card into the holder.
6. Reconnect the DXM to its power supply.
   The automatic boot process should begin. If the boot process does not begin, verify the firmware file is correct and it is a different version than what is currently installed on the device.

12.2.3 Troubleshooting Issues

<table>
<thead>
<tr>
<th>Problem</th>
<th>Solution</th>
</tr>
</thead>
</table>
| Communication contention between the LCD and process | The LCD and the processor applications share the external Modbus connection. If the processor is configured to constantly interact with Modbus, it may cause issues with the LCD attempting to use the functions of the ISM radio. To alleviate the contention do one of these things:  
  • Load a DXM configuration file that slows down the read/write rules.  
  • Disable the DXM configuration file from loading into the processor by setting DIP switch 4 to ON (on the processor board). Reboot the device. When the processor reboots, it will not load the configuration file and remains idle. |
| Cellular modem did not turn on                     | If the incoming voltage drops below 11.2 V dc, the cellular modem does not turn on and will not turn on until the voltage is above 11.8 V dc. A text file (CmVMon.txt) on the internal micro SD card saves the periodic sampling of the incoming voltage. If cellular operation stops because of voltage, it is logged in this file. |

12.2.4 Modbus Operation

All Modbus transactions are managed by a central Modbus engine. If there are Modbus messages intended for a Modbus slave that doesn’t exist, the Modbus engine waits for a response until the timeout period is expired. This slows down the Modbus polling loop for read and write operations. For this reason, verify all Modbus read and write operations are intended for Modbus slave devices that are in the network.

If a Modbus slave is not in the network, either a wired or wireless device, the operation of the LCD menu system can be compromised. Operations like Binding, Site Survey, or accessing the ISM menu may be slower. This is because all internal devices of the DXM are also Modbus slaves, ISM radio, I/O base board, LCD, and internal Local registers.
12.3 DXM100 Documentation

For more information about the DXM100 family of products, please see additional documentation and videos on the Banner website: www.bannerengineering.com.

- 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 Slave Datasheet, p/n 195454
- DXM100-S2 Modbus Slave Datasheet, p/n 195231
- DXM100-Sx Modbus Slave 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
- SolutionsKit-AG1 Quick Start Guide, p/n 212028
- 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
- 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

Technical notes, configuration examples, and ScriptBasic program examples are available at www.bannerengineering.com.

12.4 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.

12.4.1 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.

12.4.2 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

12.4.3 Feature Requests

Our customer is our most valuable resource to improve our DXM. If you have suggestions for improvements to the DXM or configuration tools, please contact Banner Engineering Corp.
12.4.4 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.

12.4.5 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).

12.5 Contact Us

Banner Engineering Corp. headquarters is located at:

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

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

12.6 Warnings

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

Exporting Sure Cross® Radios. It is our intent to fully comply with all national and regional regulations regarding radio frequency emissions. Customers who want to re-export this product to a country other than that to which it was sold must ensure the device is approved in the destination country. The Sure Cross wireless products were certified for use in these countries using the antenna that ships with the product. When using other antennas, verify you are not exceeding the transmit power levels allowed by local governing agencies. This device has been designed to operate with the antennas listed on Banner Engineering’s website and having a maximum gain of 9 dBm. Antennas not included in this list or having a gain greater 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.

12.7 Banner Engineering Corp. Limited Warranty

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

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

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

Banner Engineering Corp. reserves the right to change, modify or improve the design of the product without assuming any obligations or liabilities relating to any product previously manufactured by Banner Engineering Corp. Any misuse, abuse, or improper application or installation of this product or use of the product for personal protection applications when the product is identified as not intended for such purposes will void the product warranty. Any modifications to this product without prior express approval by Banner Engineering Corp will void the product warranties. All specifications published in this document are subject to change; Banner reserves the right to modify product specifications or update documentation at any time. Specifications and product information in English supersede that which is provided in any other language. For the most recent version of any documentation, refer to: www.bannerengineering.com.

For patent information, see www.bannerengineering.com/patents.
12.8 Glossary of Wireless Terminology

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

**change of state**
Change of state reporting is a report initiated by the Node when a change to the sensor’s input state is detected. If the input does not change, nothing is reported to the Gateway.
channel
A channel may be either a path for communications or a range of radio frequencies used by a
transceiver during communication.

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

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

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

counter - event
The event counter counts the total number of times an input signal changes to the high/ON/1 state. The
counter increments on the falling edge of an input signal when the signal level crosses the threshold.
Event counters can be used to measure the total operational cycles of a spinning shaft or the total
number of items traveling down a conveyor.

counter - frequency
The frequency counter calculates the frequency of the input signal, in Hz.
Frequency counters can be used to measure flow rates, such as measuring the flow rate of items on a
conveyor or the speed at which a windmill spins.

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

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

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

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

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

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

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

Equation: $P_{mW} = 10^{x/10}$ where $x$ is the transmitted power in dBm, or $dBm = 10 \log(P_{mW})$
Another decibel rating, dBi, is defined as an antenna’s forward gain compared to an idealized isotropic antenna. Typically, $\text{dBi} = \text{dBm} + 2.15$ where dBi refers to an isotropic decibel, dBd is a dipole decibel, and dBm is relative to milliwatts.

**deep sleep mode**

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

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

**default output conditions/triggers**

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

- **Device Power Up**—Power-up events occur every time the device is powered up.
- **Out of Sync**—Out-of-sync events occur when the radio is out of sync with its master radio.
- **Host Link Failure**—Host link failure is when the defined timeout period has elapsed with no communications between the host system (or Modbus master device) and the DX80 Gateway, typically about four seconds. These events trigger when a host link failure has been detected.
- **Node Link Failure**—Node link failures are determined by the polling interval or the out-of-sync timing. When a Node detects a communications failure with the Gateway and the Node Link Failure flag is set, the output points are set to the user-defined states and the inputs are frozen.
- **Gateway Link Failure**—Gateway link failures are determined by three global parameters: Polling Interval, Maximum Missed Message Count and Re-link Count. When the Node’s Gateway Link Failure flag is set and the Gateway determines a timeout condition exists for a Node, any outputs linked from the failing Node are set to the user-defined default state.

**default output value**

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

**delta**

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

**determinism**

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

**device, node, or radio address/ID (DX80 Networks)**

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

**directional antenna**

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

**Direct Sequence Spread Spectrum (DSSS)**

Direct Sequence Spread Spectrum is a method for generating spread spectrum transmissions where the transmitted signal is sent at a much higher frequency than the original signal, spreading the energy over a much wider band. The receiver is able to de-spread the transmission and filter the original message. DSSS is useful for sending large amounts of data in low to medium interference environments.
The Ethernet Bridge acts as a communications bridge between the Modbus RTU network (Gateway) and Modbus/TCP or EtherNet/IP host systems and includes the ability to configure the network using a Web browser interface.

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

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

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

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

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

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

The radio signal loss occurring as the signal radiates through free space. Free Space Loss = 20 Log (4(3.1416)d/λ) where d is in meters. Remembering that c = 300 x 10^8 m/s, the equations reduce down to:

For the 900 MHz radio band: FSL = 31.5 + 20 Log d (where d is in meters).
For the 2.4 GHz radio band: FSL = 40 + 20 Log d (where d is in meters.)

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

Fresnel zones are the three-dimensional elliptical zones of radio signals between the transmitter and receiver. Because the signal strength is strongest in the first zone and decreases in each successive zone, obstacles within the first Fresnel zone cause the greatest amount of destructive interference.
gain  Gain represents how well the antenna focuses the signal power. A 3 dB gain increase doubles the effective transmitting power while every 6 dB increase doubles the distance the signal travels. Increasing the gain sacrifices the vertical height of the signal for horizontal distance increases. The signal is ‘squashed’ down to concentrate the signal strength along the horizontal plane.

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

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

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

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

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

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

hibernation/ storage mode  While in storage mode, the radio does not operate. All Sure Cross® radios powered from an integrated battery ship from the factory in storage mode to conserve the battery. To wake the device, press and hold button 1 for 5 seconds. To put any FlexPower® or integrated battery Sure Cross radio into storage mode, press and hold button 1 for 5 seconds. The radio is in storage mode when the LEDs stop blinking, but in some models, the LCD remains on for an additional minute after the radio enters storage mode. After a device has entered storage mode, you must wait 1 minute before waking it.

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

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

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

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

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

latency

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

lightning arrestor

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

line of sight

Line of sight is the unobstructed path between radio antennas.

link failures

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

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

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

local and non-local registers

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

master/slave relationship

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

maximum bad count

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

maximum misses

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

median filter

When the median filter is turned on, three samples are taken for each analog sensor reading. The high and low values are discarded and the middle value is used as the analog value. Set to zero (0) to turn off the median filter. Set to one (1) to turn on the median filter.
<table>
<thead>
<tr>
<th>Modbus</th>
<th>Modbus is a master-slave communications protocol typically used for industrial applications.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Modbus/TCP</td>
<td>Modbus/TCP is an open standard protocol very similar to Modbus RTU except that it uses standard Internet communication protocols.</td>
</tr>
<tr>
<td>MultiHop</td>
<td>MultiHop networks are made up of one master radio and many repeater and slave radios. The MultiHop networks are self-forming and self-healing networks constructed around a parent-child communication relationship. A MultiHop Radio is either a master radio, a repeater radio, or a slave radio. The master radio controls the overall timing of the network and is always the parent device for other MultiHop radios. The host system connects to this master radio. Repeater radios extend the range of the wireless network and slave radios are the end point of the wireless network. For more information, refer to the <em>Sure Cross MultiHop Radios Instruction Manual</em> (p/n 151317).</td>
</tr>
<tr>
<td>multipath fade</td>
<td>Obstructions in the radio path reflect or scatter the transmitted signal, causing multiple copies of a signal to reach the receiver through different paths. Multipath fade is the signal degradation caused by these obstructions.</td>
</tr>
<tr>
<td>network ID</td>
<td>The Network ID (NID) is a unique identifier you assign to each wireless network to minimize the chances of two collocated networks interfering with each other. Assigning different NIDs to different networks improves collocation performance in dense installations.</td>
</tr>
<tr>
<td>node</td>
<td>A node is any communications point within a network.</td>
</tr>
<tr>
<td>Node</td>
<td>Nodes are remote I/O slave devices within Banner’s wireless sensor networks. Sensors and other devices connect to the Node’s inputs or outputs, allowing the Node to collect sensor data and wirelessly transmit it to the Gateway. Every Sure Cross device is a transceiver, meaning it can transmit and receive data.</td>
</tr>
<tr>
<td>noise</td>
<td>Noise is any unwanted electromagnetic disturbances from within the RF equipment, especially the receiver. Noise is more of a concern when signal levels are low.</td>
</tr>
<tr>
<td>omni-directional antenna</td>
<td>Omni-directional antennas transmit and receive radio signals equally in all directions.</td>
</tr>
<tr>
<td>out of sync/link loss (loss of radio signal)</td>
<td>The Sure Cross wireless devices use a deterministic link time-out method to address RF link interruption or failure. When a radio link fails, all pertinent wired outputs are sent to the selected default value/state until the link is recovered, ensuring that disruptions in the communications link result in predictable system behavior. Following a time-out, all outputs linked to the Node in question are set to 0, 1, or hold the last stable state depending on the value selected.</td>
</tr>
<tr>
<td>path loss</td>
<td>Path loss describes attenuation as a function of the wavelength of the operating frequency and the distance between the transmitter and receiver.</td>
</tr>
</tbody>
</table>
| path loss (or link loss) calculations | Link loss calculations determine the capabilities of a radio system by calculating the total gain or loss for a system. If the total gain/loss is within a specific range, the radio signal will be received by the radio. The total gain/loss is calculated by: \[
\text{Total Gain} = \text{Effective output} + \text{Free space loss} + \text{Total received power} .
\] Because the transmitter and receiver gains are positive numbers and the free space loss is a larger negative number, the total gain of a system should be negative. A link loss calculation may also be called a link budget calculation. |
| peer to peer network | Peer-to-peer is a model for a communication protocol in which any device in the network can send or receive data. Any device can act as a Master to initiate communication. |
| polling interval/rate | The Gateway communicates with, or polls, each Node to determine if the radio link is active. The polling rate defines how often the Gateway communicates with each Node. Polling is always initiated by the Gateway and only verifies radio signal communications. |
| polling interval/rate and maximum misses | The Gateway communicates with, or polls, each Node to determine if the radio link is active. The polling rate, or interval, defines how often the Gateway communicates with each Node. Polling is always initiated by the Gateway and only verifies radio signal communications. Nodes that fail to respond are counted against the ‘Maximum Misses’ for that Node. If the ‘Maximum Misses’ is exceeded for any...
Node, the Gateway generates an RF timeout error in the Modbus I/O register 8 of the appropriate Node. The 'Maximum Misses' is defined as the number of consecutive polling messages that the Node fails to respond to.

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

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

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

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

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

- **rotary dial address mode**: See: address mode

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

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

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

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

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

- **sample interval/rate**: The sample interval, or rate, defines how often the Sure Cross device samples the input. For battery-powered applications, setting a slower rate extends the battery life.
Sample on demand allows a host system to send a Modbus command to any register and require the inputs to immediately sample the sensor and report readings back to the host system. Sampling on demand can be used between the normal periodic reporting.

To use the Sample on Demand feature requires using a host-controlled system capable of sending Modbus commands to the master radio.

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

The equations for calculating SNR are:

$$\text{SNR} = 20 \times \log \left( \frac{V_s}{V_n} \right)$$ where $V_s$ is the signal voltage and $V_n$ is the noise voltage;

$$\text{SNR} = 20 \times \log \left( \frac{A_s}{A_n} \right)$$ where $A_s$ is the signal amplitude and $A_n$ is the noise amplitude; or

$$\text{SNR} = 10 \times \log \left( \frac{P_s}{P_n} \right)$$ where $P_s$ is the signal power and $P_n$ is the noise power.

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

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

The slave ID is an identifying number used for devices within a Modbus system. By default, Gateways are set to Modbus Slave ID 1. When using more than one Modbus slave, assign each slave a unique ID number.

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

In slow scan mode, the radio wakes up every 15 minutes to search for its parent radio. If a parent or master radio is not found, the radio goes back to sleep for another 15 minutes.

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

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

A star topology network is a point to multipoint network that places the network master radio in a center or hub position. Slave radios only transmit messages to the master radio, not to each other. These network layouts can be very flexible and typically operate relatively quickly. Slave radios acknowledge receipt of messages transmitted from the master radio.
For more information on Banner’s star network products, refer to the Sure Cross Performance DX80 Wireless I/O Network Instruction Manual (p/n 132607).

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

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

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

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

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

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

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

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

**threshold and hysteresis**
Threshold and hysteresis work together to establish the ON and OFF points of an analog input. The threshold defines a trigger point or reporting threshold (ON point) for a sensor input. Setting a threshold establishes an ON point. Hysteresis defines how far below the threshold the analog input is required to be before the input is considered OFF. A typical hysteresis value is 10% to 20% of the unit’s range.
In the example shown, the input is considered on at 15 mA. To consider the input off at 13 mA, set the hysteresis to 2 mA. The input will be considered off when the value is 2 mA less than the threshold. Setting threshold and hysteresis points prevents inputs from oscillating between ‘on’ and ‘off’ when the input remains close to the threshold point.

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

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

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

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

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