

Sure Cross® DXM100-Bx Wireless Controller

Instruction Manual

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190037

Contents

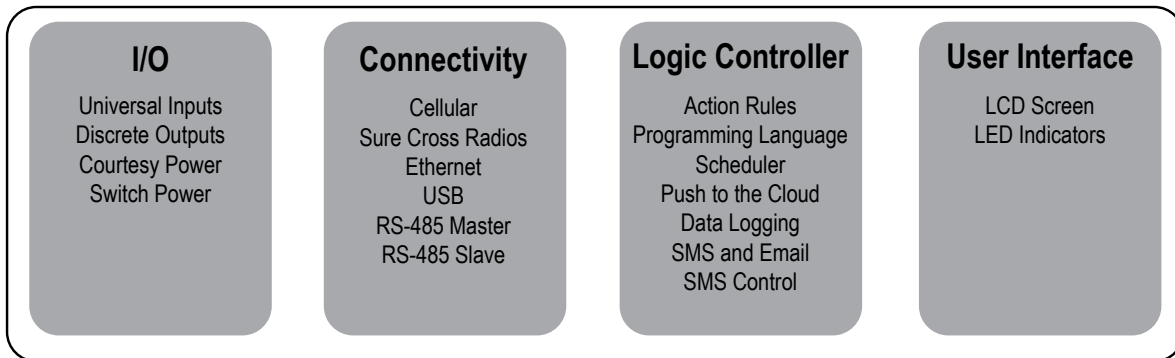
1 DXM100-Bx System Overview	5
1.1 DXM Hardware Configuration Overview	6
1.2 DXM Automation Protocols	7
1.3 DXM Modbus Overview	7
1.4 DXM Configuration Tool Overview	8
2 Quick Start Guide	9
2.1 Device Setup	9
2.1.1 Apply 12–30 V DC to the DXM100 Controller	9
2.1.2 Binding and Conducting a Site Survey with the ISM Radio	9
2.1.3 Set the IP Address	10
2.2 Configuration Instructions	11
2.2.1 Configuring the DXM100	11
2.2.2 Configuration Example: Reading Registers on a Modbus Slave Device	11
3 ISM Radio Board (Modbus Slave ID 1)	15
3.1 DIP Switch Settings for the MultiHop Radio Board Module	15
3.1.1 Application Mode	16
3.1.2 Baud Rate and Parity	16
3.1.3 Disable Serial	16
3.1.4 Transmit Power Levels/Frame Size	17
3.2 Modbus Registers for the MultiHop Radio Board Module	17
3.3 DIP Switch Settings for the Gateway Radio Board Module	17
3.4 Modbus Registers for the Gateway Radio Board Module	17
3.4.1 Alternative Modbus Register Organization	18
4 SAM4 Processor Board	22
4.1 DIP Switch Settings for the SAM4 Processor Board	23
4.2 Ethernet	23
4.3 USB	23
4.4 Modbus Registers for the Internal Local Registers (Modbus Slave 199)	24
4.4.1 Local Registers 1–850 (Internal Processor Memory, 32-bit, Unsigned)	24
4.4.2 Local Registers 851–900 (Data Flash, Non-volatile, 32-bit, Unsigned)	24
4.4.3 Local Registers 1001–1900 (32-bit IEEE Floating Point)	24
4.4.4 Virtual Registers	24
4.4.5 Reset Codes	26
5 I/O Base Board for the DXM100-B1 Models	27
5.1 DXM100-B1 I/O Base Board Connections	27
5.1.1 DIP Switches for the I/O Board	28
5.1.2 I/O Board Jumpers	28
5.2 Applying Power to the DXM100-Bx Wireless Controller	28
5.2.1 Using Courtesy Power or Switch Power	28
5.2.2 Associating a Switched Power Output to an Input	29
5.2.3 Connecting a Battery to the DXM100	31
5.2.4 Supplying Power from a Solar Panel	31
5.3 Working with Solar Power	32
5.3.1 Setting the DXM100 for Solar Power	32
5.3.2 Solar Components	33
5.3.3 Recommended Solar Configurations	34
5.3.4 Monitoring Solar Operation	34
5.4 Connecting the Communication Pins	34
5.4.1 Modbus RTU Master/Modbus RTU Slave	35
5.5 Modbus Master Port and Slave Port	35
5.5.1 Modbus Master and Slave Port Settings	35
5.5.2 DXM Modbus Slave Port ID	36
5.6 Inputs and Outputs	36
5.6.1 Universal Inputs	37
5.6.2 NMOS Outputs	38
5.6.3 Analog (DAC) Outputs	38
5.6.4 Modbus I/O Registers for the DXM100-B1 I/O Base Board	40
5.7 Restoring Factory Default Settings	42
5.8 Setting the Modbus Slave ID on the I/O Base Board	43
6 I/O Base Board for the DXM100-B2 Models	44
6.1 DXM100-B2 and S2 I/O Base Board Connections	44
6.1.1 DIP Switches for the I/O Board	44
6.2 Applying Power to the DXM100-Bx Wireless Controller	45

6.2.1 Using Courtesy Power or Switch Power	45
6.2.2 Associating a Switched Power Output to an Input	46
6.2.3 Connecting a Battery to the DXM100	48
6.2.4 Supplying Power from a Solar Panel	48
6.3 Working with Solar Power	49
6.3.1 Setting the DXM100 for Solar Power	49
6.3.2 Solar Components	49
6.3.3 Recommended Solar Configurations	50
6.3.4 Monitoring Solar Operation	51
6.4 Connecting the Communication Pins	51
6.4.1 Modbus RTU Master/Modbus RTU Slave	52
6.5 Modbus Master Port and Slave Port	52
6.5.1 Modbus Master and Slave Port Settings	52
6.5.2 DXM Modbus Slave Port ID	53
6.6 Inputs and Outputs	53
6.6.1 Universal Inputs	54
6.6.2 NMOS Outputs	55
6.6.3 Analog (DAC) Outputs	56
6.6.4 DC Latching Outputs	57
6.6.5 SDI-12 Interface	57
6.6.6 Modbus I/O Registers for the DXM100-B2 I/O Base Board	60
6.7 Restoring Factory Default Settings	62
6.8 Setting the Modbus Slave ID on the I/O Base Board	62
7 Cellular Modem Boards	64
7.1 Cellular Modem Board for CDMA	64
7.2 Cellular Modem Board for GSM and LTE	64
7.3 Cellular Power Requirements	64
7.4 Using the DXM Cellular Modem	65
7.4.1 Activating a Cellular Modem	65
7.5 Accessing the DXM Using SMS	67
7.5.1 HTTP Push	68
7.5.2 Reboot	68
7.5.3 Get Register	68
7.5.4 Set Register	68
7.5.5 Configuring the DXM100 for SMS Controlling	68
8 LCD and Menu System	69
8.1 Registers	69
8.2 Push	69
8.3 ISM Radio	70
8.3.1 Binding	70
8.3.2 Site Survey	70
8.4 I/O Board	70
8.5 System Config	72
8.5.1 ISM Radio	72
8.5.2 I/O Board	73
8.5.3 Ethernet	74
8.5.4 Provision Cell	74
8.5.5 DXM Modbus ID	74
8.5.6 LCD Contrast	74
8.5.7 Reset	74
8.6 System Info	75
8.7 Display Lock	76
8.8 Using the Display LEDs	76
8.9 Modbus Registers for the LCD Board (Modbus Slave ID 201)	77
9 Working with Modbus Devices	79
9.1 Overview	79
9.2 Assigning Modbus Slave IDs	79
9.3 Modbus Operation	80
9.4 Wireless and Wired Devices	80
9.5 Modbus Communication Timeouts	80
9.5.1 MultiHop Networks vs DX80 Star Networks	81
9.5.2 Calculating the Communications Timeout for Battery-Powered MultiHop Radios	81
9.5.3 Calculating the Communication Timeout for 10–30 VDC MultiHop Radios	81
9.5.4 Adjusting the Receive Slots and Retry Count Parameters	81
9.5.5 Calculating the Communication Timeout for a DX80 Star Network	82
9.6 Modbus TCP Client	82
10 Configuration Instructions	83
10.1 Scheduler	83
10.1.1 Create a Weekly Event	83
10.1.2 Create a One-Time Event	83

10.1.3 Create a Holiday Event	84
10.2 Authentication Setup	84
10.2.1 Set the DXM100 to use Authentication	84
10.2.2 DXM100 Configuration Authentication	85
10.3 Register Flow and Configuration	86
10.3.1 Basic Approach to Configuration	87
10.3.2 Troubleshooting a Configuration	87
10.3.3 Saving and Loading Configuration Files	87
10.3.4 Uploading or Downloading Configuration Files	87
10.4 Setting Up EtherNet/IP™	87
10.4.1 Configuring the Host PLC	87
10.4.2 Configuring the DXM100	88
10.5 Setting up Email and Text Messaging	89
10.5.1 Mail Server Authentication	89
10.5.2 Define the Network Interface Settings	89
10.5.3 Configure your Ethernet Connection	90
10.5.4 Configure your Cellular Connection	91
10.5.5 Set the Email and Messaging Parameters	91
10.5.6 Define Threshold Rules for Email	92
10.5.7 Define Log File Parameters for Emailing Log Files	93
10.6 Ethernet and Cellular Push Retries	93
10.6.1 Ethernet Push Retries	93
10.6.2 Cellular Push Retries	94
10.6.3 Event/Action Rule or Log File Push Retries	94
10.6.4 Email and Text Message Push Retries	94
10.7 DXM Modbus Registers	94
11 File System and Archive Process	95
11.1 EEPROM Files	95
11.2 Micro SD Card Files	95
12 Updating the DXM Processor Firmware	97
12.1 Update Your DXM Processor Firmware (Prior to Version 2.0)	97
12.2 Updating Your DXM100 Processor Firmware (Version 2 or Later)	98
12.2.1 Update Your DXM Processor Firmware Using the DXM Configuration Tool	99
12.2.2 Update Your Processor Firmware Using the Banner Connected Data Solutions Website	99
12.2.3 Update Your Processor Firmware Manually	100
13 DXM100 Dimensions	101
14 Accessories	102
15 Additional Information	103
15.1 DXM100 Documentation	103
15.2 DXM100 Support Policy	103
15.2.1 Firmware Updates	103
15.2.2 Website Information	103
15.2.3 Feature Requests	103
15.2.4 Potential DXM Issues	103
15.2.5 DXM Security	104
15.3 Contact Us	104
15.4 Warnings	105
15.5 Banner Engineering Corp. Limited Warranty	105

1 DXM100-Bx System Overview

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
- DC latching outputs (DXM100-B2 models only)
- SDI-12 sensor interface (DXM100-B2 models only)

Connectivity—The DXM100'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 CAN

Wireless Connectivity

Sure Cross Wireless Radio: DX80 900 MHz, DX80 2.4 GHz, MultiHop 900 MHz, or MultiHop 2.4 GHz
 Cellular modem: CDMA (Verizon) or GSM

Logic Controller—Program the DXM100'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
 Low complexity solutions
 SMS text message Notifications
 E-mail Notifications
 Push data on conditions

Text Programming Language

ScriptBasic
 Medium complexity solutions

Scheduler

Time/calendar-based events
 Astronomical clock

Data Logging

Cyclic Data/Event logging
 E-mail log files

SMS Commanding

Read/Write Local Registers
 Force a push to the cloud
 Reboot controller

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 DXM100, processes, or equipment.

User programmable LCD

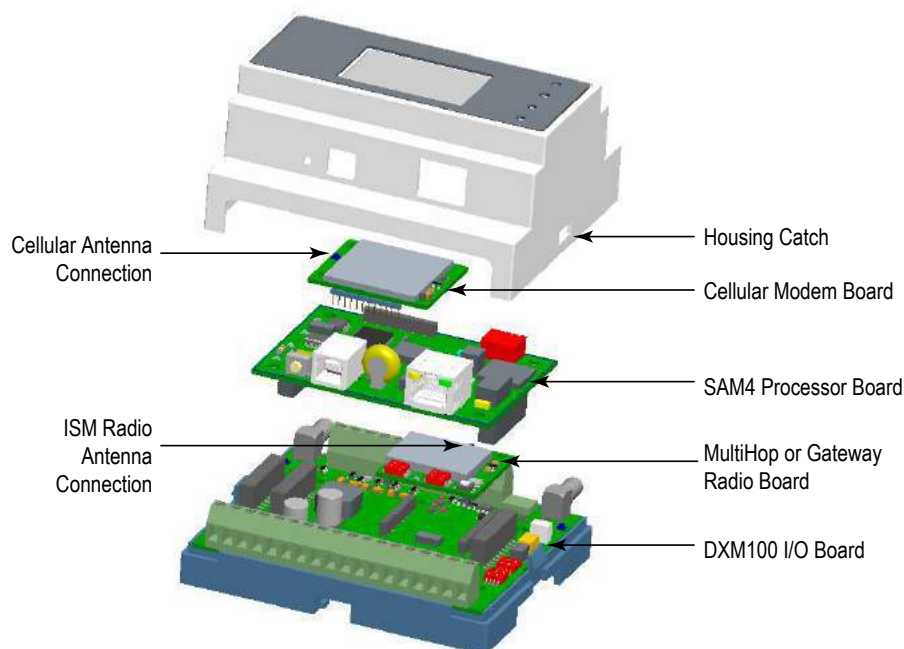
- Bind Sure Cross Radios
- Site Survey
- View Sensor Information
- System Status

User Defined LED indicators

1.1 DXM Hardware Configuration Overview

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

When opening the DXM100-Bx Wireless Controller, follow proper ESD grounding procedures. Refer to the ESD warning in the appendix.



The DXM100-Bx Wireless Controller I/O base board provides connections for all inputs, outputs and power. The base board also contains a 12 V solar controller that accepts connections to a solar panel and SLA battery. The battery connection can also be used with line power to provide a battery backup in case of line power outages.

The ISM radio, either a MultiHop or DX80 Gateway, fits on the 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 or a 2.4 GHz radio.

The SAM4 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.

The top plugin PCB is the optional cellular modem. This plugs into the SAM4 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.

The top housing contains the LCD display board. The display board is connected to the base board using a ribbon cable with a 20 pin connector.

In some DXM models, the cellular modem may be replaced with an ISM radio. The top ISM radio antenna connection will be to the left SMA connector.

1.2 DXM Automation Protocols

The DXM100 supports the following automation protocols.

Modbus RTU

The DXM100 manages two separate physical ports running the Modbus RTU protocol. The DXM100 is the Modbus Master when operating the Modbus master RTU port. The DXM100 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 DXM100 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 Tool.

Modbus TCP/IP

A host system acting as a Modbus client can access the DXM100 using the Modbus TCP/IP protocol over Ethernet. Standard Modbus port 502 is used by the DXM100 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. The DXM100 as a client is configured using Modbus TCP rules in the DXM Configuration Tool.

EtherNet/IP™

The Ethernet port is actively running EtherNet/IP. From the factory the DXM100 is configured to read and write registers on DX80 wireless devices 1 through 16. Custom configurations can be set using the DXM Configuration Tool.

By default, EtherNet/IP is active.

1.3 DXM Modbus Overview

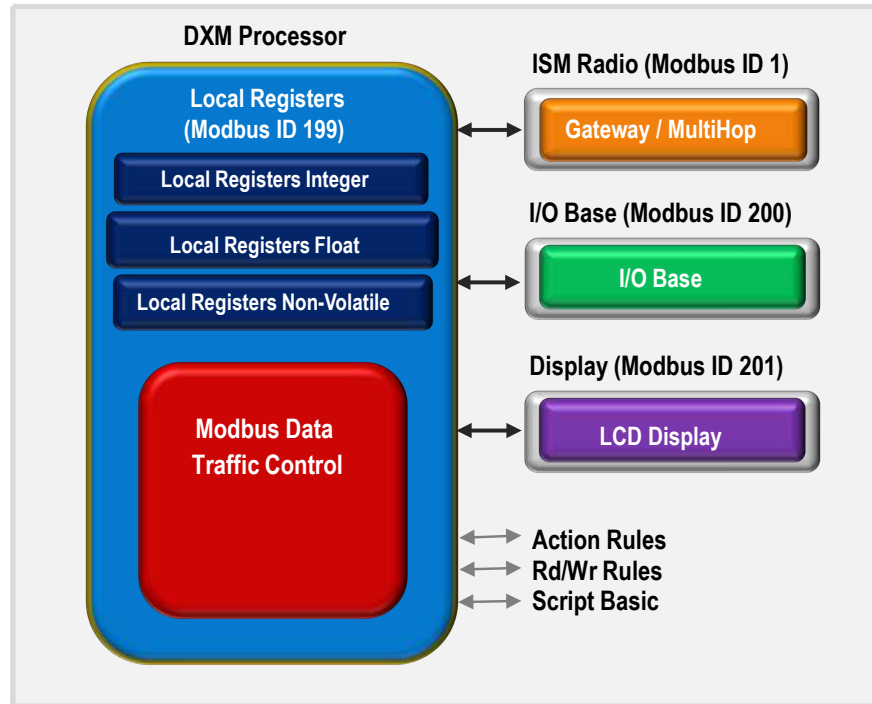
The DXM100 uses internal 32-bit registers to store information. The processor's internal Local Registers serve as the main global pool of registers and are used as the common data exchange mechanism. External Modbus device registers can be read into the Local Registers or written from the local data registers.

The DXM100, as a Modbus master device or slave device, 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 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 is Modbus ID 200 and the LCD is Modbus ID 201.

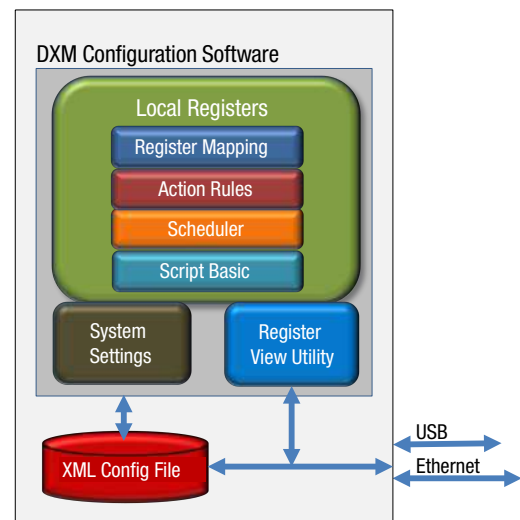


1.4 DXM Configuration Tool Overview

The DXM Configuration Tool configures the DXM100 by creating an XML file that is transferred to the DXM100 using a USB or Ethernet connection. The DXM100 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 DXM100 operation. The wireless network devices are a separate configurable system. Use the DX80 User Configuration Tool (UCT) to configure the internal DX80 wireless Gateway and the attached wireless Nodes. Use the MultiHop Configuration Tool (MCT) if the internal radio is a MultiHop device.

All tools can be connected to the DXM100 using a USB cable or an Ethernet connection.



2 Quick Start Guide

2.1 Device Setup

2.1.1 Apply 12–30 V DC to the DXM100 Controller

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

Equipment used:

- **DXM100** 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: Verify the antenna has been installed before applying power to any DX80 product.

1. Connect the brown wire from the **MQDMC-501** cordset to the DXM100's PWR terminal.
2. Connect the blue wire from the **MQDMC-501** cordset to the DXM100's GND 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 DXM100 internal ISM radio will either be a MultiHop master radio or a DX80 Gateway radio.

Before the ISM radio can communicate, the DXM100 must be bound to the other radios in the wireless network. Use the DXM100 LCD menu to bind radios to the internal ISM radio.

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. See the DXM100 Controller Instructional Manual (190037) for the processor DIP switch location.

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 binding procedure. Put only one DXM Gateway into binding at a time to prevent binding to the wrong Gateway.

1. Enter binding mode on the DXM radio:
 - a) Use the arrow keys to select the **ISM Radio** menu on the LCD and click **ENTER**.
 - b) Highlight the **Binding** menu and click **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 clicking **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 exits binding mode.

5. Label the Node with the assigned address number for future reference.
6. Click **BACK** on the DXM to exit binding 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, click **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 at a time to prevent binding the slave radios to the wrong master radio.

1. Enter binding mode on the DXM radio:
 - a) Use the arrow keys select the **ISM Radio** menu on the LCD and click **ENTER**.
 - b) Highlight the **Binding** menu and click **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 clicking **ENTER** on the DXM radio.
4. After entering binding mode on the DXM100, 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. Click **BACK** on the DXM to exit binding 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, click **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.

For a DX80 network, the Gateway controls the site survey and the results display on the LCD. Running Site Survey on a DX80 network does not affect the throughput of the DX80 network.

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 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. Click **ENTER**.
2. Use the Up or Down arrows to select the Node number (DX80 network) or Modbus Slave ID (MultiHop network). Click **ENTER** to run the site survey with that Node or slave.

2.1.3 Set the IP Address

Change the IP Address of the DXM100-B1R1 to connect to a Modbus TCP/IP or Ethernet/IP Host Controller.

Equipment needed:

- DXM100-B1R1 Wireless Controller

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

Entering IP Addresses using the LCD menu system overrides 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.
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 DXM100.

The changes are saved on the DXM100 and the new IP address will be used.

Use this same procedures to set the Subnet Mask (SN) and Default Gateway (GW) to match your network requirements.

2.2 Configuration Instructions

2.2.1 Configuring the DXM100

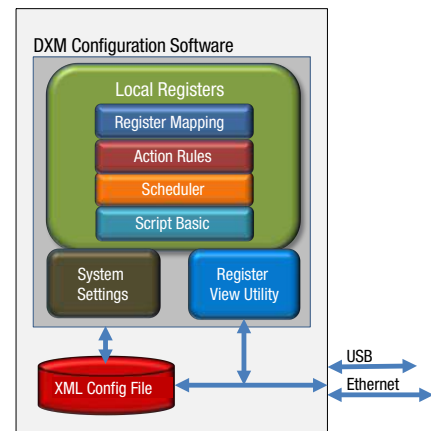
The DXM100 must be configured using the DXM Configuration Tool [software](#).

To configure the DXM100, connect the DXM100's USB or Ethernet port to a computer.

The DXM Configuration Tool allows the user to define parameters for the DXM100, then saves the configuration in an XML file on the PC.

After the configuration file is saved, upload the XML configuration file to the DXM100 for operation.

This quick start guide outlines the basic operations to set up a DXM100 using the configuration software. For a more comprehensive explanation of features, refer the DXM100 Instruction Manual or to the DXM Configuration Tool Instruction Manual.



2.2.2 Configuration Example: Reading Registers on a Modbus Slave Device

The opening page of the DXM Configuration Tool 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 DXM100. The bottom status bar displays the communications status, application status, and the DXM Configuration Tool version.

In this short example, we will configure the DXM100 to read six registers on an external Modbus Slave device and save the data into the local registers.

2.2.2 Step 1: Define the Local Registers

Change the name and parameter settings for each Local Register under the **Local Register Configuration** tab.

You may change them individually or by using the Modify Multiple Registers feature.

This example screen uses the Modify Multiple Registers feature.

Figure 1. Modify Multiple Registers - Configuration Example

1. Click on the **Modify Multiple Registers** tab. 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 *read* to allow the values of the local registers to display on the DXM100's LCD.
4. Click **Change Registers** to change the registers.

2.2.2 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.

Figure 2. Read Rules - Configuration Example

1. Change to the **Register Mapping > Read Rules** tab to define a Modbus read.
2. Click **Add Read Rule**.
3. Click the arrow next to the new rule to expand the information.
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 DXM100.
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 DXM100 local registers. Notice the list of local register names this read rule is using.

2.2.2 Step 3: Define the Time Zone and Set the Time Clock

Figure 3. Settings > General

Use the **Settings > General** tab 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 DXM100 to a computer, click **Sync PC Time with Device** to set the time on the DXM100 to match the time of the computer.

2.2.2 Step 4: Save the Configuration File

To save your configuration file, go to **File > Save As**. Enter a file name and save the file. The file name cannot contain spaces or special characters.

2.2.2 Step 5: Connect the DXM100

1. Connect the DXM100 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 DXM100.

2.2.2 Step 6: Send the Configuration File to the DXM100

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



Important: The program only loads a file to the DXM100. The internal parameter settings are not sent to the device, only the saved configuration file is sent to the DXM100.

After the file is selected, the configuration program begins uploading the file to the DXM100. The DXM configuration program reboots the controller after the program finishes uploading the configuration file. 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 to the DXM100 to reboot.



Important: If the power cycles to the DXM100 while the DXM Configuration Tool is connected, close the USB port from the software and unplug the USB cable. Reconnect the Controller by plugging the USB cable into the Controller, then select **Device > Connection Settings**.

The DXM100 is now running the new configuration. On the DXM100'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.

2.2.2 Tips and Tricks - Register View Screen

Starting Register	ID	Value
1	1	45013456
2	2	9301230
3	3	10
4	4	5
5	5	2345
6	6	0

Starting Register	ID	Value
1	1	0

Figure 4. Register View

The **Register View** screen displays the results of a Modbus read/write utility built into the DXM Configuration Tool. Use this screen to read or write internal local registers or the registers of remote slave devices connected to the DXM100. Use this utility to debug DXM configurations and remote device problems.

3 ISM Radio Board (Modbus Slave ID 1)

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

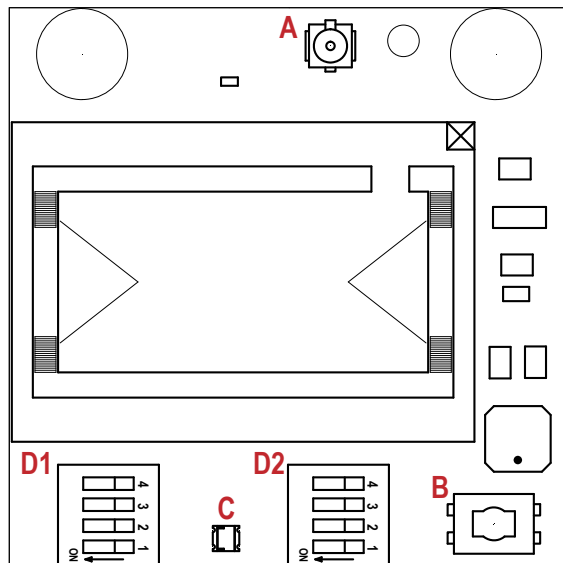
The DX80 MultiHop architecture creates a tree network with a Master radio and one or more Repeater/Slave devices. The MultiHop architecture is suited for networks requiring repeater devices to provide extended range or obstacle avoidance. MultiHop ISM radio devices are defined with R2, R4, and R5 in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

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.

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

The settings outlined below are specific for the DXM100. Not all selections are possible with the DXM100.



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

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 DIP Switch Settings for the MultiHop Radio Board Module

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 Tool (**Settings > General**).



Important: Disabling the serial port disables the ISM radio in the DXM100. Selecting Transparent mode causes radio communications to be slower and denies access to device I/O register data.

Device Settings	D1 Switches				D2 Switches			
	1	2	3	4	1	2	3	4
Serial line baud rate 19200 OR User defined receiver slots	OFF*	OFF*						
Serial line baud rate 38400 OR 32 receiver slots	OFF	ON						
Serial line baud rate 9600 OR 128 receiver slots	ON	OFF						
Serial line baud rate Custom OR 4 receiver slots	ON	ON						
Parity: None			OFF*	OFF*				
Parity: Even			OFF	ON				
Parity: Odd			ON	OFF				
Disable serial (low power mode) and enable the receiver slots select for switches 1-2			ON	ON				
Transmit power 900 MHz radios: 1.00 Watt (30 dBm) 2.4 GHz radios: 0.065 Watts (18 dBm) and 60 ms frame					OFF			
Transmit power 900 MHz radios: 0.25 Watts (24 dBm) 2.4 GHz radios: 0.065 Watts (18 dBm) and 40 ms frame					ON *			
Application mode: Modbus						OFF*		
Application mode: Transparent						ON		
MultiHop radio setting: Repeater							OFF	OFF
MultiHop radio setting: Master							OFF	ON
MultiHop radio setting: Slave							ON	OFF
MultiHop radio setting: DXM LCD Menu Control							ON *	ON *

* 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.

3.1.1 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.

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 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 get Modbus register data from a MultiHop device, configure the DXM100 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.

MultiHop Device	Slave ID	Modbus Registers
DXM Master radio	1	none
Slave device	11	Modbus register 1–16 are inputs, 501–516 are outputs
Repeater device	12	Modbus register 1–16 are inputs, 501–516 are outputs
Slave device	15	Modbus register 1–16 are inputs, 501–516 are outputs

3.3 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.



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

DIP Switch Bank D1	
DIP Switch 1	
OFF *	1 Watt (30 dBm, 900 MHz models only) (default configuration)
ON	250 mW (24 dBm, 900 MHz models only), DX80 compatibility mode

3.4 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 1: Modbus Holding Registers

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

Example: Gateway Modbus Register Table

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

DX80 Device	Slave ID	Modbus Registers
DXM Gateway radio	1	Modbus registers 1–8 are inputs, 9–16 are outputs
Node 1	-	Modbus registers 17–25 are inputs, 26–32 are outputs
Node 2	-	Modbus registers 33–40 are inputs, 41–48 are outputs
Node 3	-	Modbus registers 49–56 are inputs, 57–64 are outputs

3.4.1 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.

Name	Modbus Register Address (Dec.)
Inputs and Outputs, in order by device	2201 through 4784
Discrete Bit Packed (Status, Discrete Inputs, Discrete Outputs)	6601 through 6753
Analog Inputs (1-8) and Analog Outputs (1-8)	6801 through 9098

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.

Inputs (2201–2584)		Outputs (4401–4784)	
Modbus Register Address (Dec)	16-bit Register Value	Modbus Register Address (Dec)	16-bit Register Value
2201–2208	Gateway Inputs 1 through 8	4401–4408	Gateway Outputs 1 through 8
2209–2216	Node 1 Inputs 1 through 8	4409–4416	Node 1 Outputs 1 through 8
2217–2224	Node 2 Inputs 1 through 8	4417–4424	Node 2 Outputs 1 through 8
...
2577–2584	Node 47 Inputs 1 through 8	4777–4784	Node 47 Outputs 1 through 8

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.

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

Register Address	Bit Position															
	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
6601	Node 15	Node 14	Node 13	Node 12	Node 11	Node 10	Node 9	Node 8	Node 7	Node 6	Node 5	Node 4	Node 3	Node 2	Node 1	Gateway
6602	Node 31	Node 30	Node 29	Node 28	Node 27	Node 26	Node 25	Node 24	Node 23	Node 22	Node 21	Node 20	Node 19	Node 18	Node 17	Node 16
6603	Node 47	Node 46	Node 45	Node 44	Node 43	Node 42	Node 41	Node 40	Node 39	Node 38	Node 37	Node 36	Node 35	Node 34	Node 33	Node 32

Bit-Packed Discrete Input 1

Register Address	Bit Position															
	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
6611	Node 15	Node 14	Node 13	Node 12	Node 11	Node 10	Node 9	Node 8	Node 7	Node 6	Node 5	Node 4	Node 3	Node 2	Node 1	Gateway
6612	Node 31	Node 30	Node 29	Node 28	Node 27	Node 26	Node 25	Node 24	Node 23	Node 22	Node 21	Node 20	Node 19	Node 18	Node 17	Node 16
6613	Node 47	Node 46	Node 45	Node 44	Node 43	Node 42	Node 41	Node 40	Node 39	Node 38	Node 37	Node 36	Node 35	Node 34	Node 33	Node 32

Bit-Packed Discrete Output 1

Register Address	Bit Position															
	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
6691	Node 15	Node 14	Node 13	Node 12	Node 11	Node 10	Node 9	Node 8	Node 7	Node 6	Node 5	Node 4	Node 3	Node 2	Node 1	Gateway
6692	Node 31	Node 30	Node 29	Node 28	Node 27	Node 26	Node 25	Node 24	Node 23	Node 22	Node 21	Node 20	Node 19	Node 18	Node 17	Node 16
6693	Node 47	Node 46	Node 45	Node 44	Node 43	Node 42	Node 41	Node 40	Node 39	Node 38	Node 37	Node 36	Node 35	Node 34	Node 33	Node 32

Inputs		Outputs	
Modbus Register Address (Decimal)	Description (Inputs)	Modbus Register Address (Decimal)	Description (Outputs)
6601–6603	Status for all devices		
6611–6613	Input 1 from all devices	6691–6693	Output 1 from all devices
6621–6623	Input 2 from all devices	6701–6703	Output 2 from all devices
6631–6633	Input 3 from all devices	6711–6713	Output 3 from all devices
6641–6643	Input 4 from all devices	6721–6723	Output 4 from all devices
6651–6653	Input 5 from all devices	6731–6733	Output 5 from all devices
6661–6663	Input 6 from all devices	6741–6743	Output 6 from all devices

Inputs		Outputs	
Modbus Register Address (Decimal)	Description (Inputs)	Modbus Register Address (Decimal)	Description (Outputs)
6671-6673	Input 7 from all devices	6751-6753	Output 7 from all devices
6681-6683	Input 8 from all devices		

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.

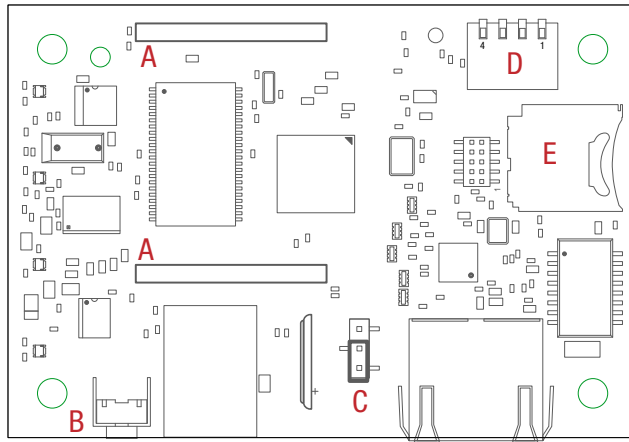
In this format, users can read a 16-bit holding register for all devices or write to a register for all devices using one Modbus message. Using these registers is the most efficient way to read all status registers, read all analog inputs, or write all analog outputs.

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.

Inputs		Outputs	
Modbus Register Address (Decimal)	Description (Inputs)	Modbus Register Address (Decimal)	Description (Outputs)
6801	Input 1 for Gateway	8001	Output 1 for Gateway
6802	Input 1 for Node 1	8002	Output 1 for Node 1
6803	Input 1 for Node 2	8003	Output 1 for Node 2
...
6951	Input 2 for Gateway	8151	Output 2 for Gateway
6952	Input 2 for Node 1	8152	Output 2 for Node 1
6953	Input 2 for Node 2	8153	Output 2 for Node 2
...
7101	Input 3 for Gateway	8301	Output 3 for Gateway
7102	Input 3 for Node 1	8302	Output 3 for Node 1
7103	Input 3 for Node 2	8303	Output 3 for Node 2
...
7851	Input 8 (Status Register) for Gateway	9051	Output 8 for Gateway
7852	Input 8 (Status Register) for Node 1	9052	Output 8 for Node 1
7853	Input 8 (Status Register) for Node 2	9053	Output 8 for Node 2
...

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.

4 SAM4 Processor Board



- A - Cellular modem connection
- B - Force cloud push/Clear password
- C - Boot load jumpers
- D - DIP switches
- E - Micro SD card

Button Operation

The SAM4 processor button has two functions:

- Clearing the access password as explained above.
- Pressing the button for 5 seconds forces a Push to the webserver. This assumes a proper configuration for the webserver.

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 SAM4 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 board U.FL connector. Only install/remove a cellular modem when the power to the device is disconnected.

Force Cloud Push Button

Press and hold this button for two seconds to send an immediate push message from the device (if properly configured).

Clear Password

By default, the DXM100 does not require a password to load a configuration file. If a password is defined, the DXM100 requires that you enter the password before uploading a configuration file.

To change the password, you must already know the current password. If you do not know the current password, clear the password from the DXM100.



CAUTION: Clearing the password erases the current configuration and any program files, log files, or history files currently on the DXM100.

Follow these steps to clear the password requirement from your DXM100.

1. Turn off the power.
2. Set DIP switch 4 to the ON position.
3. Press and hold button 'B'.
4. Apply power to the device.
5. After leaving the device powered on for a few seconds, turn off the power again.

6. Set DIP switch 4 to the OFF position.
7. Reload the configuration file before resuming normal operation.

The password is cleared from the system.

4.1 DIP Switch Settings for the SAM4 Processor Board

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

Settings	DIP Switches			
	1	2	3	4
Disable Ethernet Port	OFF *			
	ON			
Disable LCD Display		OFF *		
		ON		
Not used			OFF *	
Bypass XML				OFF *
				ON

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.

4.2 Ethernet

Before applying power to the DXM100-Bx Wireless Controller, verify the Ethernet cable is connected. If the Ethernet cable is not connected when the device powers up, the DXM100-Bx Wireless Controller will not recognize the connection.

The number of times the processor attempts to connect to the Ethernet network is configured in the DXM Configuration Tool (**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 Tool, Modbus/TCP, and EtherNet/IP. ScriptBasic also has access to Ethernet for custom programming. Use the DXM Configuration Tool to configure the characteristics of the Ethernet connection, fixed IP addresses, DHCP, etc. The LCD menu allows the user to change the IP Address.

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.

4.3 USB

The USB port is used with the DXM Configuration Tool to program the DXM100-Bx 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 Tool **Settings > Cloud Services** screen.

4.4 Modbus Registers for the Internal Local Registers (Modbus Slave 199)

The main storage elements for the DXM100 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 DXM100 data and statistics.

4.4.1 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 DXM100, 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.

Registers	Description
1–845	Local Registers (Internal processor memory)
846–849	Local Registers (Reset, Constant, Timer)

4.4.2 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.

Registers	Description
851–900	Local Registers (Data flash, non-volatile)

4.4.3 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.

Registers	Description
1001–1900	Local Registers (Floating point registers, internal processor memory)

4.4.4 Virtual Registers

The DXM100 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 DXM100.

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).

Virtual Registers		
Registers	Definition	
10001	GPS latitude direction (N, S, E, W)	GPS Coordinate Data if the DXM is configured to read an external GPS unit.
10002	GPS latitude	

Virtual Registers		
Registers	Definition	
10003	GPS longitude direction (N, S, E, W)	
10004	GPS longitude	
10011–10012	Resync timer	Engineering use
10013–10014	Resync timer rollover	Engineering use
10015–10016	Reboot cause (Restart Codes above)	Reboot Type
10017–10018	Watchdog reset count	Counter to track how many resets have been caused by the Watchdog
10021	IO Board Battery Voltage (mV)	mV
10022	IO Board - Incoming Supply Voltage (mV)	mV
10023	Cut-off Feature	0—No successful readings 1—Normal range 2—Cut-off engaged
10024	IO Board - Battery Charging Current (mA)	mA
10025–10026	Http Push SSL Acquires	Statistical counts of connections, disconnections and forced disconnects when the DXM100 creates a connection using SSL/TLS (Encrypted connections)
10027–10028	Http Push SSL Releases	
10029–10030	Http Push SSL Forced Releases	
10031–10032	Http Push Attempts	Statistical counts of connections, disconnections and forced disconnects when the DXM controller creates a connection using HTTP non-encrypted
10033–10034	Http Push Successes	
10035–10036	Http Push Failures	
10037–10038	Http Push Last Status	Last DXM100 push status 0 = Initial state, no push attempt as finished yet 1 = Attempt complete 2 = Attempt aborted
10039–10040	Cellular Strength, BER	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
10055–10056	Alarms, smtp, attempts	Email attempts
10057–10058	Alarms, smtp, fails	Email failures
10059–10060	Alarms, sms, attempts	SMS text message attempts
10061–10062	Alarms, sms, fails	SMS text message failures
10100	Number of read maps in default	Read Map statistics
10101	Number of read map successes	
10102	Number of read map timeouts	
10103	Number of read map errors	
10104	Read map success streak	Write Map statistics
10105	Number of write map successes	
10106	Number of write map timeouts	
10107	Number of write map errors	
10108	Write map success streak	API message passing statistics
10109	Number of passthrough successes	

Virtual Registers		
Registers	Definition	
10110	Number of passthrough timeouts	
10111	Number of passthrough errors	
10112	Passthrough success streak	
10113	Number of 43 buffer successes	DX80 Gateway automatic messaging buffer statistics
10114	Number of 43 buffer timeouts	
10115	Number of 43 buffer errors	
10116	43 buffer success streak	
11000	Read map success count	Read/Write maps statistics
12000	Write map success count	
13000	Read map timeout count	
14000	Write map timeout count	
15000	Read map error count	
16000	Write map error count	
17000	Read map success streak	
18000	Write map success streak	
19000	Read map is in default	

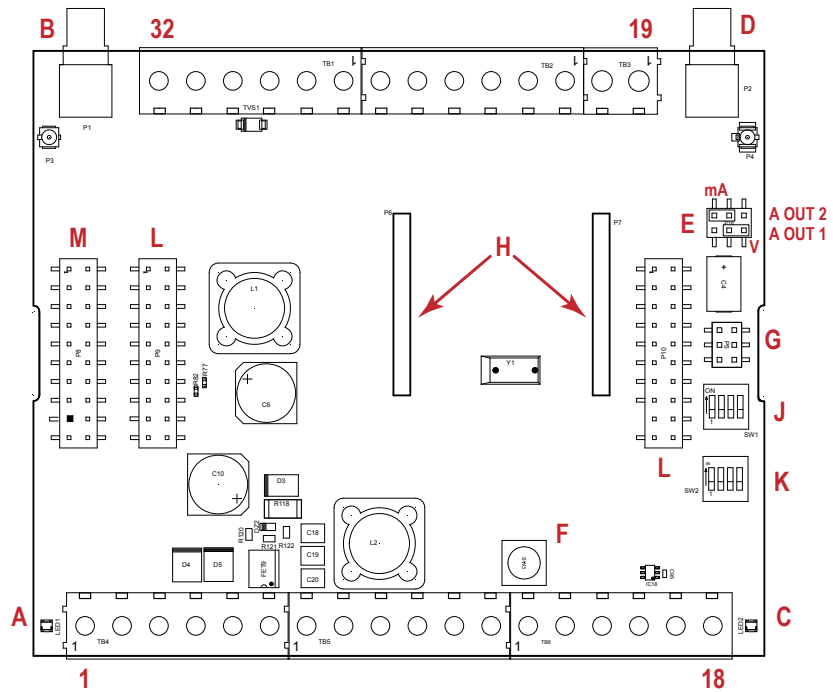
4.4.5 Reset Codes

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

Reset Code	Definition
0	Undefined
1	Unknown
2	General
3	Brownout
4	Watchdog
5	User
6	Software
7	Return from backup mode

5 I/O Base Board for the DXM100-B1 Models

5.1 DXM100-B1 I/O Base Board Connections



1	No connection	12	CT. RS-232 CTS	23	N3. NMOS OUT 3
2	PW. 12 to 30 V dc or solar power in (+)	13	S-. Secondary RS-485 -	24	N2. NMOS OUT 2
3	GD. Ground	14	S+. Secondary RS-485 +	25	N1. NMOS OUT 1
4	B+. Battery in (< 15 V dc)	15	CL. CANL	26	GD. Ground
5	GD. Ground	16	CH. CANH	27	U4. Universal Input 4
6	M-. Primary RS-485 -	17	GD. GND	28	U3. Universal Input 3
7	M+. Primary RS-485 +	18	P3. Courtesy Power 5 V	29	GD. Ground
8	GD. Ground	19	A2. Analog OUT 2	30	P1. Adjustable Courtesy Power (5 V or 16 V)
9	TX. RS-232 Tx	20	A1. Analog OUT 1	31	U2. Universal Input 2
10	RX. RS-232 Rx	21	P2. Adjustable Courtesy Power (5 V or 16 V)	32	U1. Universal Input 1
11	RT. RS-232 RTS	22	N4. NMOS OUT 4		

A	Base board LED	E	Jumpers - Configures Analog Out 1 and 2 for mA or V	J	Modbus Slave ID DIP Switches
B	A1. Cellular antenna	F	Radio Binding Button	K	Modbus Slave ID DIP Switches
C	Radio LED	G	Programming header	L	SAM4 Processor Board Connection
D	A2. ISM Antenna	H	ISM Radio Board Connection	M	Display Connection

5.1.1 DIP Switches for the I/O Board

The DXM100-Bx Wireless Controller I/O board DIP switches are set from the factory to Modbus Slave ID 200. For more information, refer to *Setting the Modbus Slave ID on the I/O Base Board*.

5.1.2 I/O Board Jumpers

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

Jumper	Function	Positions
E	Analog output characteristics for AO2 (pin 19) and AO1 (pin 20)	<p>Defines current (0–20 mA) or voltage (0–10 V) for analog output 1 and 2.</p> <p>By default, current (0–20 mA) is selected using jumpers 1 and 2 and registers 4008 and 4028 contain a value of 2.</p> <p>To select voltage (0–10 V) for output Aout1, set jumper 1 in the voltage position (V) and set Modbus register 4008 on the I/O board (SID 200) to 3.</p> <p>To select voltage (0–10 V) for output Aout2, set jumper 2 in the voltage position (V) and set Modbus register 4028 on the I/O board (SID 200) to 3.</p>

5.2 Applying Power to the DXM100-Bx Wireless Controller

Apply power to the DXM100-Bx 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 DXM100 continuously monitors the health of the power inputs. If a power input fault is detected, the DXM100 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.

Pin	Description
Pin 1	No connection
Pin 2	12 to 30 V dc input (+) or solar panel connection (+)
Pins 3, 5, 8, 17, 26, 29	Main logic ground for the DXM100-Bx Wireless Controller
Pin 4	Solar or backup battery positive input. Battery voltage must be less than 15 V dc. Use only a sealed lead acid (SLA) battery.

5.2.1 Using Courtesy Power or Switch Power

Pin 18 of the DXM100-Bx 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 Tool'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.

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

Enable Register

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

Default setting = ON

Voltage Register

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

Default setting = 5 V

Default Output Register

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

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

Default setting = 0

Modbus Output Register

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

5.2.2 Associating a Switched Power Output to an Input

Use the DXM Configuration Tool to associate a switched power output to a universal input in most situations.

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

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

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

Default Output

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

Cycle power if this register value is changed.

Output Register

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

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

¹ 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.

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

Extended Input Read

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

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

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 the Courtesy 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).
5. Set the **Switched Power Voltage** to 16 volts. Modbus Register 1006 = 1.

5.2.3 Connecting a Battery to the DXM100

When attaching a battery to the DXM100 as a backup battery or as a solar battery, verify the charging algorithm is set properly. The factory default setting for the battery charging algorithm assumes you are using 12 to 30 V dc to recharge the battery.

The charging algorithm is designed to work 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.
- When using a solar panel, connect the solar panel output to pin 2 and connect the ground to pin 3. Connect the 12 V dc SLA battery to pin 4 (+) and pin 5 (-). To change the charging algorithm, refer to [Supplying Power from a Solar Panel](#) on page 31.

The battery charging algorithm defaults to a battery backup configuration. To charge the battery from a solar panel, change the battery charging algorithm.

1. From the DXM100 LCD menu navigate to **Setting Config > I/O Board > Charger**.
2. Select **Solar** for solar panel configurations or **DC** for battery backup configurations.

Modbus Slave ID	Modbus Register	Description
200 *	6071	Battery backup charging algorithm. 0 = Battery is recharged from a solar panel 1 = Battery is recharged from 12 to 30 V dc (default)

* The Modbus Slave ID for the base board is set at the factory and may be changed using the base board DIP switch settings.

5.2.4 Supplying Power from a Solar Panel

To power the DXM100-Bx 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 algorithm 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 algorithm.

To change the charging algorithm from the menu system:

1. From the DXM100 LCD menu, navigate to **System Config > I/O Board > Charger**.
2. Select **Solar** for solar panel configurations.

To change the charging algorithm 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 algorithm.

Modbus Slave ID	Modbus Register	Description
200 *	6071	Battery backup charging algorithm. 0 = Battery is recharged from a solar panel 1 = Battery is recharged from 12 to 30 V dc (default)

The following power operating characteristics are stored in Modbus registers.

Battery voltage

If no battery is present, the value in this register is less than 5 V. If the value in this register is greater than the incoming voltage register, the battery is powering the system.

Battery charging current

The charging algorithm charges the battery when the incoming voltage register value is greater than the battery voltage register value. This registers shows the charging current in milliamps.

Incoming supply voltage

The incoming power can be from a solar panel or from a power supply. The battery is charging when the incoming voltage register value is greater than the battery voltage register value. The battery is powering the system when the incoming voltage register value is less than the battery voltage register value.

On-board thermistor temperature

This register stores the on-board thermistor reading in tenths of degrees C, this is not a calibrated input: divide by 10 to calculate the temperature in degrees C. For calibrated temperature inputs, define one of the universal inputs as a temperature input.

Modbus Slave ID	Modbus Register	Description
200 *	6081	Battery voltage (mV)
	6082	Battery charging current (mA)
	6083	Incoming supply voltage (mV) (solar or power supply)
	6084	On-board thermistor temperature (°C)

* The Slave ID for the base board is set at the factory. This may be changed using the base board DIP switch settings.

5.3 Working with Solar Power

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

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

5.3.1 Setting the DXM100 for Solar Power

By default, the DXM100 is set from the factory to charge a backup battery from a line power source. Use the LCD menu on the front of the DXM100 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.

5.3.2 Solar Components

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

Battery

The DXM solar controller is designed to use a 12 V lead acid battery. The characteristics of a solar system require the battery to be of a certain type. There are basically 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 AGM (absorbed glass mat).

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

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.

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

Average Voltage Readings Relative to Battery Change	
State of Charge (%)	Open Circuit Voltage
100	13.0 or higher
75	12.6
50	12.1
25	11.66
0	11.4 or less

Solar Panel

Banner solar panels come in two common sizes for the DXM100: 5 Watt and 20 Watt. Both panels are designed to work with the DXM100 but provide different charging characteristics. Use the 5 watt panel for light duty operation and use the 20 watt panel when you require greater charging capabilities.

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

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

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

Solar Panel Mounting

To capture the maximum amount of solar radiation throughout the year, mount a fixed solar panel to optimize the sun's energy throughout the year. 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.

5.3.3 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 DXM100 system				
Solar Panel	Battery Capacity ²	Days of Autonomy	DXM mA	DXM Controller
5 watt	10 Ahr	10 days	25 mA	DXM Slave Controller - ISM radio and I/O base board
20 watt	14 Ahr	10 days	30 mA	DXM Controller with ISM radio
20 watt	20 Ahr	10 days	35 mA	DXM Controller with ISM radio and Cellular Modem

5.3.4 Monitoring Solar Operation

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

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

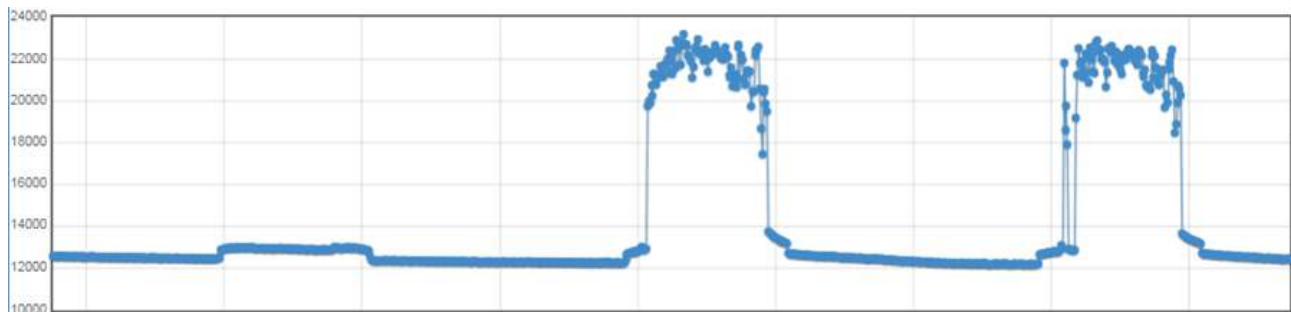


Figure 5. Solar Panel Voltage (mV) -- Cloudy First Day

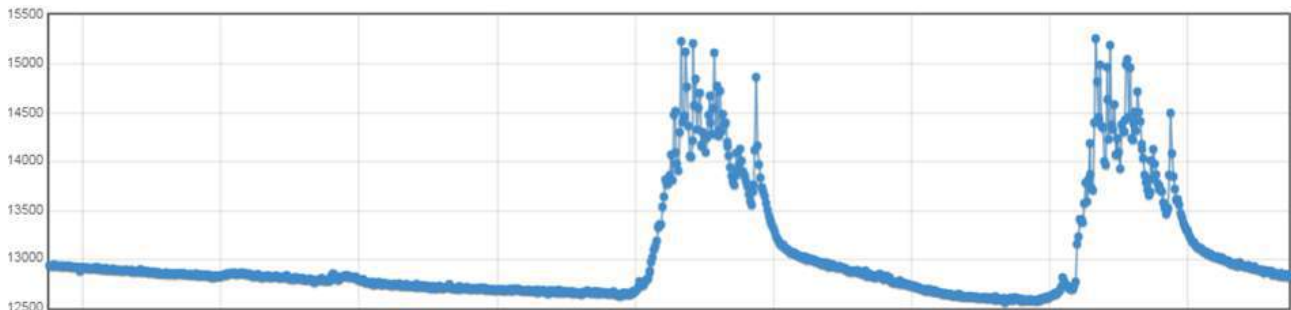


Figure 6. Battery Voltage (mV) - Cloudy First Day

5.4 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).

² 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.

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 DXM100-Bx 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.

Pin	Parameter	Description
Pin 6	Primary RS-485 –	Running Modbus protocol at 19.2k baud, use this bus to connect to other Modbus Slave devices. The DXM100-Bx Wireless Controller is a Modbus Master device on this RS-485 port.
Pin 7	Primary RS-485 +	
Pin 9	RS-232 Tx	Serial RS-232 connection. This bus must use a ground connection between devices to operate correctly. (DXM100-B1 models only; not available on the DXM100-B2 models)
Pin 10	RS-232 Rx	
Pin 13	Secondary RS-485 –	The DXM100-Bx Wireless Controller is a Modbus slave on this bus (see DXM100-B1 I/O Base Board Connections on page 27).
Pin 14	Secondary RS-485 +	
Pin 15	CANL –	DXM100-B1 models only. Not available on the DXM100-B2 models.
Pin 16	CANH +	

5.4.1 Modbus RTU Master/Modbus RTU Slave

The DXM100-Bx Wireless Controller can be a Modbus RTU master device to other slave devices and can be a Modbus slave device to another Modbus RTU master.

The DXM100-Bx Wireless Controller uses the primary RS-485 port as a Modbus RTU master to control external slave devices. The secondary port is the Modbus RTU slave connection.

- As a Modbus RTU master device, the DXM100-Bx Wireless Controller 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 DXM100-Bx Wireless Controller local registers can be read from or written to by another Modbus RTU master device.

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

5.5 Modbus Master Port and Slave Port

There are two RS-485 ports on the DXM100, a Modbus master RS-485 port and a Modbus slave RS-485 port.

The Modbus master RS-485 is controlled by the DXM100, which acts as the Modbus master. All wired devices connected to the master RS-485 port must be slave devices.

The Modbus slave RS-485 port is controlled by another Modbus master device, not the DXM100. The slave port is used by other devices that want to access the DXM100 as a Modbus slave device. All local registers are available to be read or written from this slave port. Set the Modbus Slave ID for the secondary RS-485 port using the LCD display menu: **System > DXM Slave ID**.

5.5.1 Modbus Master and Slave Port Settings

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

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 DXM100, the **Communications Timeout** parameter is the maximum amount of time the DXM100 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 screenshot displays the configuration interface for the DXM100-Bx Wireless Controller, organized into several panels:

- Device Time:** Includes a 'Current device time' display, buttons for 'Get time from device' and 'Synch PC time with device', a 'Device timezone (UTC)' dropdown set to 'UTC (UTC+00:00)', and a checkbox for 'Device observes DST'.
- RS-232 Settings:** Features dropdowns for 'Baud rate' (19200), 'Parity' (None), and 'Stop bits' (1).
- Device Location/GPS:** Contains input fields for 'Default latitude' and 'Default longitude' (both set to 0), a dropdown for 'Acquire using' (Default Lat/Lon), an 'External GPS address' field (0), a time field for 'Acquire GPS data every (hh:mm:ss)' (00:00:00), and a checkbox for 'Send location to cloud'.
- Modbus Master Communications:** Includes dropdowns for 'Serial mode' (RS-485), 'Baud rate' (19200), and 'Parity' (None). It also has time fields for 'Communication timeout (hh:mm:ss.fff)' (00:00:05.000) and 'Maximum polling rate (hh:mm:ss.fff)' (00:00:00.050), and a dropdown for 'Automatic Radio Polling' (None).
- Modbus Slave Communications:** Similar to the master settings, it includes dropdowns for 'Serial mode' (RS-485), 'Baud rate' (19200), and 'Parity' (None), and a checkbox for 'Wireless Modbus backbone'.
- Device Information:** Features a 'Get device information' button and two columns of data: 'Processor information' (Serial number, Model number, Firmware number, Version) and 'IO board information' (Serial number, EEPROM number, Model number, EEPROM version, Firmware number, Firmware version).

The Modbus Slave port settings include:

- **Baud rate** and **parity** (also set on this screen)
- Set the Modbus Slave port ID using the DXM100 LCD
- Set the **Wireless Modbus Backbone** parameter when there is an ISM radio plugged into the SAM4 processor board and the Modbus slave port is using the MultiHop radio as the slave port instead of the terminal block connection.

5.5.2 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 Tool to cycle power to the device.

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

5.6 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 Tool 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 Tool.

Refer to the Modbus Registers section for more descriptions of each Modbus register on the DXM100-Bx Wireless Controller.

5.6.1 Universal Inputs

The universal inputs on the DXM100-Bx 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 Tool 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 DXM100-B1 I/O Base Board](#) on page 40 for universal input register definitions.

Pin	Universal Input	Modbus Register	Description
27	4	4	Program the universal inputs to accept input types NPN, PNP, 10k thermistor, 0 to 10 V, 0 to 20 mA, or potentiometer. The default setting is 8: NPN raw fast. To set the input type, write the following values to the Input Type Modbus registers defined in Modbus I/O Registers for the DXM100-B1 I/O Base Board on page 40. 0 = NPN 1 = PNP 2 = 0 to 20 mA 3 = 0 to 10 V dc 4 = 10k Thermistor 5 = Not used 6 = Not used 7 = Bridge 8 = NPN Raw Fast (default)
28	3	3	
31	2	2	
32	1	1	

Thermistor Input

A thermistor input must use a 10k temperature thermistor between ground and the universal input. The thermistor must be a 10k NTC (Banner model number BWA-THERMISTOR-002) or equivalent. Select the temperature conversion of degrees C (default) or degrees F by writing Modbus registers defined in [Modbus I/O Registers for the DXM100-B1 I/O Base Board](#) on page 40.

Potentiometer Input

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

Bridge Input

The bridge input is not implemented yet.

NPN vs NPN Raw Fast

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

Synchronous Counters

When an input is configured as a counter (inputs set to NPN/PNP), the input counts the input signal transitions. The count value is stored into two 16-bit Modbus registers for a total count of 32-bits (unsigned). To program an input to capture the edge transition counts, follow [Example: Configure Input 1 as a Synchronous Counter](#) on page 38.

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 DXM100 to the PC.
2. Launch the DXM Configuration Tool software.
3. Connect to the DXM100 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.

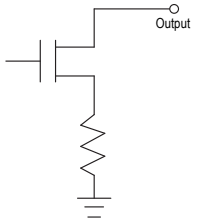
Example: Change Universal Input 2 to a 0 to 10 V dc Input

1. Connect the DXM100 to the PC.
2. Launch the DXM Configuration Tool software.
3. Connect to the DXM100 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 DXM100 to the PC.
2. Launch the DXM Configuration Tool software.
3. Connect to the DXM100 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.

5.6.2 NMOS Outputs

Pin	NMOS Discrete Outputs	Modbus Register	Description	Wiring
22	4	504	Less than 1 A maximum current at 30 V dc ON-State Saturation: Less than 0.7 V at 20 mA ON Condition: Less than 0.7 V OFF Condition: Open	
23	3	503		
24	2	502		
35	1	501		

5.6.3 Analog (DAC) Outputs

The DXM100-B1 and S1 analog outputs may be configured as either 0 to 20 mA outputs (default) or 0 to 10 V outputs.

To change the analog (DAC) output type:

1. Remove power to the device.
2. Remove the DXM cover.
3. Change the hardware jumper position (see the table for the pin number and [DXM100-B1 I/O Base Board Connections](#) on page 27 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).

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

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

Parameter Registers for Analog Outputs (4xxxx)		
OUT 1	OUT 2	Parameters
4001	4021	Maximum Analog Value
4002	4022	Minimum Analog Value
4003	4023	Enable Register Full Scale
4004	4024	Hold Last State Enable
4005	4025	Default Output State
4008	4028	Analog Output Type

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 IO 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 μ A (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.

5.6.4 Modbus I/O Registers for the DXM100-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 DXM100 to read or write the values on the I/O base board.

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

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

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

DXM100-B1 Controller Base Board Output Connection		
Modbus Register	Range	Description
501	0-1	NMOS Output 1
502	0-1	NMOS Output 2
503	0-1	NMOS Output 3
504	0-1	NMOS Output 4
505	0-1	Switched Power 1 (5 V or 16 V)
506	0-1	Switched Power 2 (5 V or 16 V)
507	0-20000	Analog Output 1 default (0-20.000 mA)
	0-10000	Analog Output 1 (0-10.000 V)
508	0-20000	Analog Output 2 default (0-20.000 mA)
	0-10000	Analog Output 2 (0-10.000 V)

Modbus Configuration Registers for the I/O

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

Universal Input Parameters Registers				
Universal Inputs	1	2	3	4
Enable Full Scale Registers	3303	3323	3343	3363

Universal Input Parameters Registers				
Universal Inputs	1	2	3	4
Temperature °C/°F Registers	3304	3324	3344	3364
Input Type Registers	3306	3326	3346	3366
Threshold Registers	3308	3328	3348	3368
Hysteresis Registers	3309	3329	3349	3369
Enable Rising Registers	4908	4928	4948	4968
Enable Falling Registers	4909	4929	4949	4969
High Register for Counter Registers	4910	4930	4950	4970
Low Register for Counter Registers	4911	4931	4951	4971

Modbus Configuration Registers for the 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 μ A (micro Amps) and voltage values are stored as mV (millivolts).

Enable Rising/Falling

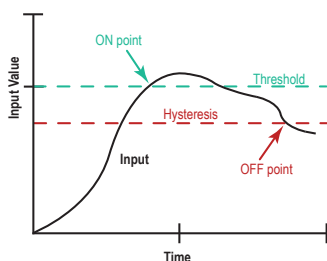
Use these registers to enable the universal input logic to count on a rising transition or a falling transition. Write a one (1) to enable; write a zero (0) to disable.

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.

Modbus Configuration Registers for the Analog Output

The DXM100-B1 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 change 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](#) on page 38.

Modbus Register	Analog Output	Description
4008	Analog Output 1	0 to 20 mA or 0 to 10 V dc output (I/O board jumper selectable)
4028	Analog Output 2	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

Modbus Configuration Registers for Power

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

Modbus Register	Description
6071	Battery backup charging algorithm. 0 = Battery is recharged from a solar panel 1 = Battery is recharged from 12 to 30 V dc . (default)
6081	Battery voltage (mV)
6082	Battery charging current (mA)
6083	Incoming supply voltage (mV) (solar or power supply)
6084	On-board thermistor temperature (°C)

5.7 Restoring Factory Default Settings

To reset 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 base board parameters:

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

To reset only the DXM base board:

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

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

5.8 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 DXM100-Bx 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 DXM100-Bx 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.

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

DIP Switches J		DIP Switch K, Switches 1, 2, 3, 4 (0 is OFF, 1 is ON)									
1	2	0,0,0,0	1,0,0,0	0,1,0,0	1,1,0,0	0,0,1,0	1,0,1,0	0,1,1,0	1,1,1,0	0,0,0,1	1,0,0,1
OFF	OFF	x ⁴	11	12	13	14	15	16	17	18	19
ON	OFF	20	21	22	23	24	25	26	27	28	29
OFF	ON	30	31	32	33	34	35	36	37	38	39
ON	ON	40	41	42	43	44	45	46	47	48	49

DXM100-Bx Wireless Controller Example—To set the DXM100-Bx 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).

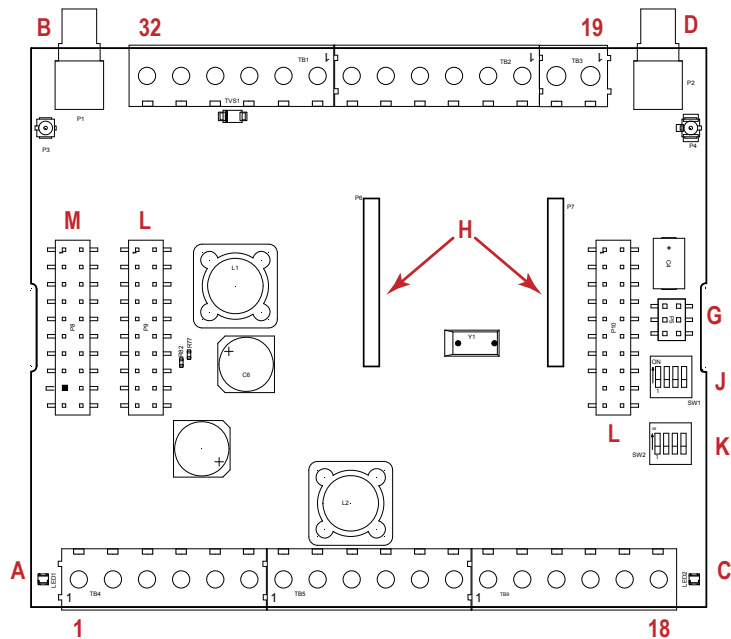
- For the DXM100-Bx Wireless Controller model, all switches on DIP switch K should be in the OFF position to use the Modbus register slave ID.

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

⁴ Uses value in Modbus register 6804.

6 I/O Base Board for the DXM100-B2 Models

6.1 DXM100-B2 and S2 I/O Base Board Connections



1	No connection	12	2B. DLatch 2B	23	N3. NMOS OUT 3
2	PW. 12–30 V dc or solar power in (+)	13	S-. Secondary RS-485 –	24	N2. NMOS OUT 2
3	GD. Ground	14	S+. Secondary RS-485 +	25	N1. NMOS OUT 1
4	B+. Battery in (< 15 V dc)	15	SP. SDI-12 Courtesy Power	26	GD. Ground
5	GD. Ground	16	SD. SDI-12 Data	27	U4. Universal Input 4
6	M-. Primary RS-485 –	17	GD. GND	28	U3. Universal Input 3
7	M+. Primary RS-485 +	18	P3. Courtesy Power 5 V	29	GD. Ground
8	GD. Ground	19	A2. Analog OUT 2 (0–10 V)	30	P1. Adjustable Courtesy Power (5–24 V)
9	1A. DLatch 1A	20	A1. Analog OUT 1 (0–10 V)	31	U2. Universal Input 2
10	1B. DLatch 1B	21	P2. Adjustable Courtesy Power (5–24 V)	32	U1. Universal Input 1
11	2A. DLatch 2A	22	N4. NMOS OUT 4		

A	Base board LED			J	Modbus Slave ID DIP Switches
B	A1. Cellular antenna			K	Modbus Slave ID DIP Switches
C	Radio LED	G	Programming header	L	SAM4 Processor Board Connection
D	A2. ISM Antenna	H	ISM Radio Board Connection	M	Display Connection

6.1.1 DIP Switches for the I/O Board

The DXM100-Bx Wireless Controller I/O board DIP switches are set from the factory to Modbus Slave ID 200. For more information, refer to *Setting the Modbus Slave ID on the I/O Base Board*.

6.2 Applying Power to the DXM100-Bx Wireless Controller

Apply power to the DXM100-Bx 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 DXM100 continuously monitors the health of the power inputs. If a power input fault is detected, the DXM100 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.

Pin	Description
Pin 1	No connection
Pin 2	12 to 30 V dc input (+) or solar panel connection (+)
Pins 3, 5, 8, 17, 26, 29	Main logic ground for the DXM100-Bx Wireless Controller
Pin 4	Solar or backup battery positive input. Battery voltage must be less than 15 V dc. Use only a sealed lead acid (SLA) battery.

6.2.1 Using Courtesy Power or Switch Power

Pin 18 of the DXM100-Bx 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 Tool'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.

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

Enable Register

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

Default setting = ON

Voltage Register

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

Default setting = 5 V

Default Output Register

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

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

Default setting = 0

Modbus Output Register

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

6.2.2 Associating a Switched Power Output to an Input

Use the DXM Configuration Tool to associate a switched power output to a universal input in most situations.

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

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

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

Default Output

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

Cycle power if this register value is changed.

Output Register

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

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

Switched Power Enable

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

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

Voltage

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

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

For 5 V, set the Modbus register to 204.

For 7 V, set the Modbus register to 125.

For 10 V, set the Modbus register to 69.

For 15 V, set the Modbus register to 32.

For 20 V, set the Modbus register to 12.

For 24 V, set the Modbus register to 3.

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

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

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

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

Extended Input Read

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

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

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 the Courtesy 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 \times 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).
5. Set the **Switched Power Voltage** to 16 volts. Modbus Register 1006 = 1.

6.2.3 Connecting a Battery to the DXM100

When attaching a battery to the DXM100 as a backup battery or as a solar battery, verify the charging algorithm is set properly. The factory default setting for the battery charging algorithm assumes you are using 12 to 30 V dc to recharge the battery.

The charging algorithm is designed to work 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.
- When using a solar panel, connect the solar panel output to pin 2 and connect the ground to pin 3. Connect the 12 V dc SLA battery to pin 4 (+) and pin 5 (-). To change the charging algorithm, refer to [Supplying Power from a Solar Panel](#) on page 31.

The battery charging algorithm defaults to a battery backup configuration. To charge the battery from a solar panel, change the battery charging algorithm.

1. From the DXM100 LCD menu navigate to **Setting Config > I/O Board > Charger**.
2. Select **Solar** for solar panel configurations or **DC** for battery backup configurations.

Modbus Slave ID	Modbus Register	Description
200 *	6071	Battery backup charging algorithm. 0 = Battery is recharged from a solar panel 1 = Battery is recharged from 12 to 30 V dc (default)

* The Modbus Slave ID for the base board is set at the factory and may be changed using the base board DIP switch settings.

6.2.4 Supplying Power from a Solar Panel

To power the DXM100-Bx 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 algorithm 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 algorithm.

To change the charging algorithm from the menu system:

1. From the DXM100 LCD menu, navigate to **System Config > I/O Board > Charger**.
2. Select **Solar** for solar panel configurations.

To change the charging algorithm 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 algorithm.

Modbus Slave ID	Modbus Register	Description
200 *	6071	Battery backup charging algorithm. 0 = Battery is recharged from a solar panel 1 = Battery is recharged from 12 to 30 V dc (default)

The following power operating characteristics are stored in Modbus registers.

Battery voltage

If no battery is present, the value in this register is less than 5 V. If the value in this register is greater than the incoming voltage register, the battery is powering the system.

Battery charging current

The charging algorithm charges the battery when the incoming voltage register value is greater than the battery voltage register value. This registers shows the charging current in milliamps.

Incoming supply voltage

The incoming power can be from a solar panel or from a power supply. The battery is charging when the incoming voltage register value is greater than the battery voltage register value. The battery is powering the system when the incoming voltage register value is less than the battery voltage register value.

On-board thermistor temperature

This register stores the on-board thermistor reading in tenths of degrees C, this is not a calibrated input: divide by 10 to calculate the temperature in degrees C. For calibrated temperature inputs, define one of the universal inputs as a temperature input.

Modbus Slave ID	Modbus Register	Description
200 *	6081	Battery voltage (mV)
	6082	Battery charging current (mA)
	6083	Incoming supply voltage (mV) (solar or power supply)
	6084	On-board thermistor temperature (°C)

* The Slave ID for the base board is set at the factory. This may be changed using the base board DIP switch settings.

6.3 Working with Solar Power

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

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

6.3.1 Setting the DXM100 for Solar Power

By default, the DXM100 is set from the factory to charge a backup battery from a line power source. Use the LCD menu on the front of the DXM100 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.

6.3.2 Solar Components

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

Battery

The DXM solar controller is designed to use a 12 V lead acid battery. The characteristics of a solar system require the battery to be of a certain type. There are basically 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 AGM (absorbed glass mat).

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

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.

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

Average Voltage Readings Relative to Battery Change	
State of Charge (%)	Open Circuit Voltage
100	13.0 or higher
75	12.6
50	12.1
25	11.66
0	11.4 or less

Solar Panel

Banner solar panels come in two common sizes for the DXM100: 5 Watt and 20 Watt. Both panels are designed to work with the DXM100 but provide different charging characteristics. Use the 5 watt panel for light duty operation and use the 20 watt panel when you require greater charging capabilities.

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

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

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

Solar Panel Mounting

To capture the maximum amount of solar radiation throughout the year, mount a fixed solar panel to optimize the sun's energy throughout the year. 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.

6.3.3 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 DXM100 system				
Solar Panel	Battery Capacity ⁶	Days of Autonomy	DXM mA	DXM Controller
5 watt	10 Ahr	10 days	25 mA	DXM Slave Controller - ISM radio and I/O base board
20 watt	14 Ahr	10 days	30 mA	DXM Controller with ISM radio

⁶ 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.

Solar panel and battery combinations for a DXM100 system				
Solar Panel	Battery Capacity ⁶	Days of Autonomy	DXM mA	DXM Controller
20 watt	20 Ahr	10 days	35 mA	DXM Controller with ISM radio and Cellular Modem

6.3.4 Monitoring Solar Operation

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

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



Figure 7. Solar Panel Voltage (mV) -- Cloudy First Day

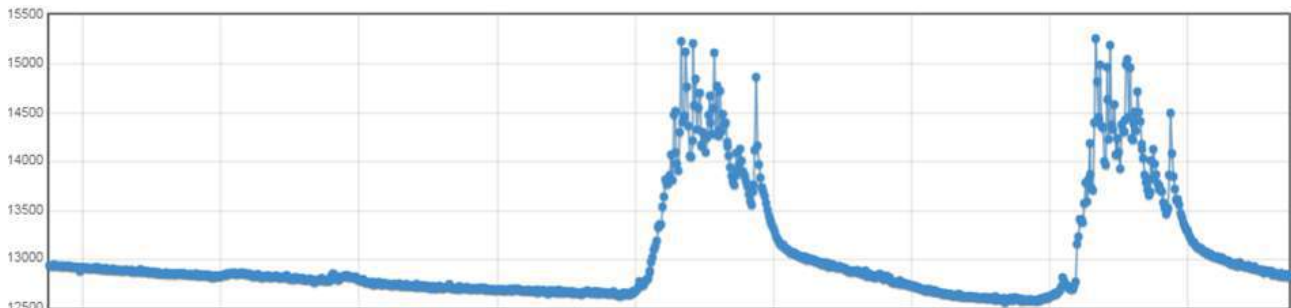


Figure 8. Battery Voltage (mV) - Cloudy First Day

6.4 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 DXM100-Bx 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.

Pin	Parameter	Description
Pin 6	Primary RS-485 –	Running Modbus protocol at 19.2k baud, use this bus to connect to other Modbus Slave devices. The DXM100-Bx Wireless Controller is a Modbus Master device on this RS-485 port.
Pin 7	Primary RS-485 +	
Pin 9	RS-232 Tx	Serial RS-232 connection. This bus must use a ground connection between devices to operate correctly. (DXM100-B1 models only; not available on the DXM100-B2 models)

⁶ 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.

Pin	Parameter	Description
Pin 10	RS-232 Rx	
Pin 13	Secondary RS-485 –	The DXM100-Bx Wireless Controller is a Modbus slave on this bus (see DXM100-B1 I/O Base Board Connections on page 27).
Pin 14	Secondary RS-485 +	
Pin 15	CANL –	
Pin 16	CANH +	

6.4.1 Modbus RTU Master/Modbus RTU Slave

The DXM100-Bx Wireless Controller can be a Modbus RTU master device to other slave devices and can be a Modbus slave device to another Modbus RTU master.

The DXM100-Bx Wireless Controller uses the primary RS-485 port as a Modbus RTU master to control external slave devices. The secondary port is the Modbus RTU slave connection.

- As a Modbus RTU master device, the DXM100-Bx Wireless Controller 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 DXM100-Bx Wireless Controller local registers can be read from or written to by another Modbus RTU master device.

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

6.5 Modbus Master Port and Slave Port

There are two RS-485 ports on the DXM100, a Modbus master RS-485 port and a Modbus slave RS-485 port.

The Modbus master RS-485 is controlled by the DXM100, which acts as the Modbus master. All wired devices connected to the master RS-485 port must be slave devices.

The Modbus slave RS-485 port is controlled by another Modbus master device, not the DXM100. The slave port is used by other devices that want to access the DXM100 as a Modbus slave device. All local registers are available to be read or written from this slave port. Set the Modbus Slave ID for the secondary RS-485 port using the LCD display menu: **System > DXM Slave ID**.

6.5.1 Modbus Master and Slave Port Settings

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

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 DXM100, the **Communications Timeout** parameter is the maximum amount of time the DXM100 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 screenshot displays the configuration interface for the DXM100-Bx Wireless Controller, organized into several panels:

- Device Time:** Includes a 'Current device time' display, buttons for 'Get time from device' and 'Synch PC time with device', a 'Device timezone (UTC)' dropdown menu (set to 'UTC (UTC+00:00)'), and a checkbox for 'Device observes DST'.
- RS-232 Settings:** Features dropdown menus for 'Baud rate' (19200), 'Parity' (None), and 'Stop bits' (1).
- Device Location/GPS:** Contains input fields for 'Default latitude' and 'Default longitude' (both set to 0), a dropdown for 'Acquire using' (Default Lat/Lon), an input for 'External GPS address' (0), a time interval for 'Acquire GPS data every (hh:mm:ss)' (00:00:00), and a checkbox for 'Send location to cloud'.
- Modbus Master Communications:** Includes dropdowns for 'Serial mode' (RS-485), 'Baud rate' (19200), and 'Parity' (None). It also has time input fields for 'Communication timeout (hh:mm:ss.fff)' (00:00:05.000) and 'Maximum polling rate (hh:mm:ss.fff)' (00:00:00.050), and a dropdown for 'Automatic Radio Polling' (None).
- Modbus Slave Communications:** Similar to the master settings, it includes dropdowns for 'Serial mode' (RS-485), 'Baud rate' (19200), and 'Parity' (None), and a checkbox for 'Wireless Modbus backbone'.
- Device Information:** Features a 'Get device information' button and two columns of data: 'Processor information' (Serial number, Model number, Firmware number, Version) and 'IO board information' (Serial number, EEPROM number, Model number, EEPROM version, Firmware number, Firmware version).

The Modbus Slave port settings include:

- **Baud rate** and **parity** (also set on this screen)
- Set the Modbus Slave port ID using the DXM100 LCD
- Set the **Wireless Modbus Backbone** parameter when there is an ISM radio plugged into the SAM4 processor board and the Modbus slave port is using the MultiHop radio as the slave port instead of the terminal block connection.

6.5.2 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 Tool to cycle power to the device.

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

6.6 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 Tool 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 Tool.

Refer to the Modbus Registers section for more descriptions of each Modbus register on the DXM100-Bx Wireless Controller.

6.6.1 Universal Inputs

The universal inputs on the DXM100-Bx 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 Tool 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 DXM100-B1 I/O Base Board](#) on page 40 for universal input register definitions.

Pin	Universal Input	Modbus Register	Description
27	4	4	Program the universal inputs to accept input types NPN, PNP, 10k thermistor, 0 to 10 V, 0 to 20 mA, or potentiometer. The default setting is 8: NPN raw fast. To set the input type, write the following values to the Input Type Modbus registers defined in Modbus I/O Registers for the DXM100-B1 I/O Base Board on page 40. 0 = NPN 1 = PNP 2 = 0 to 20 mA 3 = 0 to 10 V dc 4 = 10k Thermistor 5 = Not used 6 = Not used 7 = Bridge 8 = NPN Raw Fast (default)
28	3	3	
31	2	2	
32	1	1	

Thermistor Input

A thermistor input must use a 10k temperature thermistor between ground and the universal input. The thermistor must be a 10k NTC (Banner model number BWA-THERMISTOR-002) or equivalent. Select the temperature conversion of degrees C (default) or degrees F by writing Modbus registers defined in [Modbus I/O Registers for the DXM100-B1 I/O Base Board](#) on page 40.

Potentiometer Input

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

Bridge Input

The bridge input is not implemented yet.

NPN vs NPN Raw Fast

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

Synchronous Counters

When an input is configured as a counter (inputs set to NPN/PNP), the input counts the input signal transitions. The count value is stored into two 16-bit Modbus registers for a total count of 32-bits (unsigned). To program an input to capture the edge transition counts, follow [Example: Configure Input 1 as a Synchronous Counter](#) on page 38.

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 DXM100 to the PC.
2. Launch the DXM Configuration Tool software.
3. Connect to the DXM100 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.

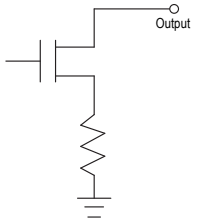
Example: Change Universal Input 2 to a 0 to 10 V dc Input

1. Connect the DXM100 to the PC.
2. Launch the DXM Configuration Tool software.
3. Connect to the DXM100 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 DXM100 to the PC.
2. Launch the DXM Configuration Tool software.
3. Connect to the DXM100 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.

6.6.2 NMOS Outputs

Pin	NMOS Discrete Outputs	Modbus Register	Description	Wiring
22	4	504	Less than 1 A maximum current at 30 V dc ON-State Saturation: Less than 0.7 V at 20 mA ON Condition: Less than 0.7 V OFF Condition: Open	
23	3	503		
24	2	502		
35	1	501		

6.6.3 Analog (DAC) Outputs

The DXM100-B2 and S2 analog outputs are 0 to 10 V dc outputs and cannot be changed.

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

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

Parameter Registers for Analog Outputs (4xxxx)		
OUT 1	OUT 2	Parameters
4001	4021	Maximum Analog Value
4002	4022	Minimum Analog Value
4003	4023	Enable Register Full Scale
4004	4024	Hold Last State Enable
4005	4025	Default Output State

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 IO 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.

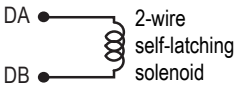
Enable Register Full Scale. Set to 1 to enable a linear range from 0 to 65535 for specified input range. For a 4 to 20 mA output, a value of 0 represents 4 mA and 65535 represents 20 mA. Set this parameter to 0 to store readings in unit-specific data. For example, the register data representing a 15.53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

6.6.4 DC Latching Outputs

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

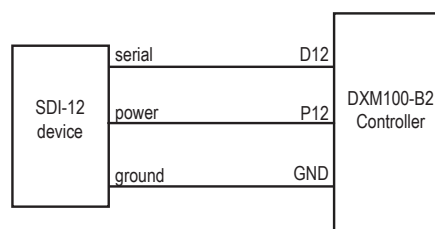
The DXM Configuration Tool allows the user to adjust parameters that govern the operation of the DC latch outputs. Most applications will not require any changes for correct operation. DXM Configuration Tool parameters include:

- **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 40ms

6.6.5 SDI-12 Interface

The SDI-12 interface on the DXM100-B2 Wireless Controllers can support up to five devices with twelve 32-bit register values each. The DXM100-B2 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!".

The DXM100-B2 controller is configured by writing non-volatile Modbus registers with configuration parameters. Read or write the device configuration parameters using standard Modbus commands.



Basic SDI-12 Interface Parameters

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

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

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

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

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

Supported M! Commands		Supported C! Commands	
SDI-12 Command	Register Value	SDI-12 Command	Register Value
xM!	0 or 10	xC!	1 or 20
xM1!	11	xC1!	21
xM2!	12	xC2!	22
xM3!	13	xC3!	23
xM4!	14	xC4!	24
xM5!	15	xC5!	25
xM6!	16	xC6!	26
xM7!	17	xC7!	27
xM8!	18	xC8!	28
xM9!	19	xC9!	29

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

Device/CMD Configuration	Registers (Default Value)		
	Enable	Device Address	Device Command
SDI-12 Device/CMD 1	1751 (1)	11001 (48) ⁷	11002 (10)
SDI-12 Device/CMD 2	1701 (0)	11201 (49)	11202 (10)
SDI-12 Device/CMD 3	1651 (0)	11401 (50)	11402 (10)
SDI-12 Device/CMD 4	1601 (0)	11601 (51)	11602 (10)
SDI-12 Device/CMD 5	1551 (0)	11801 (52)	11802 (10)

SDI-12 Device Result Registers

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

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

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

⁷ The default device addresses 48 through 52 are in ASCII.

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

SDI-12 Device Settings

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

- **Sample Rate.** Formed using two 16-bit parameters, a HI word and a LOW word. The sample rate is how often the SDI-12 device is powered up, then interrogated for data. The value in the registers is the number of 0.010 second counts. For example, the default value is 22,500, which calculates to a sample rate of 22500×0.010 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 50×0.010 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.

Device / Cmd Configuration	Registers (Default Value)							
	Enable	Device Address	Switch Power Enable	Device Command	Sample HI	Sample Low	Warmup Time	Voltage
SDI-12 Device/CMD 1	1751 (1)	11001 (48) ⁸	1754 (1)	11002 (10)	1752 (0)	1753 (22500)	1755 (50)	1756 (148)
SDI-12 Device/CMD 2	1701 (0)	11201 (49)	1704 (0)	11202 (10)	1702 (0)	1703 (22500)	1705 (50)	1706 (148)
SDI-12 Device/CMD 3	1651 (0)	11401 (50)	1654 (0)	11402 (10)	1652 (0)	1653 (22500)	1655 (50)	1656 (148)
SDI-12 Device/CMD 4	1601 (0)	11601 (51)	1604 (0)	11602 (10)	1602 (0)	1603 (22500)	1605 (50)	1606 (148)
SDI-12 Device/CMD 5	1551 (0)	11801 (52)	1554 (0)	11802 (10)	1552 (0)	1553 (22500)	1555 (50)	1556 (148)

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

MFG	Models	Technical Note
Acclima	SEN-SDI (TDT SDI-12 Soil Moisture Sensor)	SDI-12 and the Acclima TDT SDI-12 Soil Moisture Probe
Adcon Telemetry	HydraProbell	
AquaCheck	Sub-surface Probe	SDI-12 and the AquaCheck Sub-Surface Soil Moisture Probe
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

⁸ The default device addresses 48 through 52 are in ASCII.

MFG	Models	Technical Note
Sentek	EnviroSCAN	<i>SDI-12 and the Sentek EnviroScan Soil Moisture Probe</i>

6.6.6 Modbus I/O Registers for the DXM100-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 DXM100 to read or write the values on the I/O base board.

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

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

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

DXM100-B2 Controller Base Board Output Connection		
Modbus Register	Range	Description
501	0-1	NMOS Output 1
502	0-1	NMOS Output 2
503	0-1	NMOS Output 3
504	0-1	NMOS Output 4
505	0-1	Switched Power 1 (5 V to 24 V)
506	0-1	Switched Power 2 (5 V to 24 V)
507	0-1	DC Latching Output 1
508	0-1	DC Latching Output 2
509	0-10000	Analog Output 1 (0-10.000 V)
510	0-10000	Analog Output 2 (0-10.000 V)

Modbus Configuration Registers for the I/O

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

Universal Input Parameters Registers				
Universal Inputs	1	2	3	4
Enable Full Scale Registers	3303	3323	3343	3363

Universal Input Parameters Registers				
Universal Inputs	1	2	3	4
Temperature °C/°F Registers	3304	3324	3344	3364
Input Type Registers	3306	3326	3346	3366
Threshold Registers	3308	3328	3348	3368
Hysteresis Registers	3309	3329	3349	3369
Enable Rising Registers	4908	4928	4948	4968
Enable Falling Registers	4909	4929	4949	4969
High Register for Counter Registers	4910	4930	4950	4970
Low Register for Counter Registers	4911	4931	4951	4971

Modbus Configuration Registers for the 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 μ A (micro Amps) and voltage values are stored as mV (millivolts).

Enable Rising/Falling

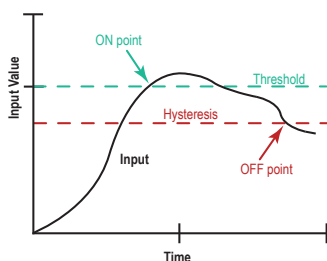
Use these registers to enable the universal input logic to count on a rising transition or a falling transition. Write a one (1) to enable; write a zero (0) to disable.

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.

Modbus Configuration Registers for Power

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

Modbus Register	Description
6071	Battery backup charging algorithm. 0 = Battery is recharged from a solar panel 1 = Battery is recharged from 12 to 30 V dc . (default)
6081	Battery voltage (mV)
6082	Battery charging current (mA)
6083	Incoming supply voltage (mV) (solar or power supply)
6084	On-board thermistor temperature (°C)

6.7 Restoring Factory Default Settings

To reset 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 base board parameters:

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

To reset only the DXM base board:

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

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

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

Only DXM100-S1 and -S1R2 Slave models require that the Modbus Slave ID be adjusted on the I/O base board. The DXM100-Bx 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 DXM100-Bx 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.

Settings	Location J DIP Switches			
	1	2	3	4
Modbus Slave ID set to 11 through 19	OFF	OFF		
Modbus Slave ID set to 20 through 29	ON	OFF		

Settings	Location J DIP Switches			
	1	2	3	4
Modbus Slave ID set to 30 through 39	OFF	ON		
Modbus Slave ID set to 40 through 49	ON	ON		
Not Used			-	
Modbus Slave Configuration (DX100-S1 and -S1R2 models only) ⁹				ON
Standard Communication Mode				OFF

DIP Switches J		DIP Switch K, Switches 1, 2, 3, 4 (0 is OFF, 1 is ON)									
1	2	0,0,0,0	1,0,0,0	0,1,0,0	1,1,0,0	0,0,1,0	1,0,1,0	0,1,1,0	1,1,1,0	0,0,0,1	1,0,0,1
OFF	OFF	x ¹⁰	11	12	13	14	15	16	17	18	19
ON	OFF	20	21	22	23	24	25	26	27	28	29
OFF	ON	30	31	32	33	34	35	36	37	38	39
ON	ON	40	41	42	43	44	45	46	47	48	49

DXM100-Bx Wireless Controller Example—To set the DXM100-Bx 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 DXM100-Bx Wireless Controller model, all switches on DIP switch K should be in the OFF position to use the Modbus register slave ID.

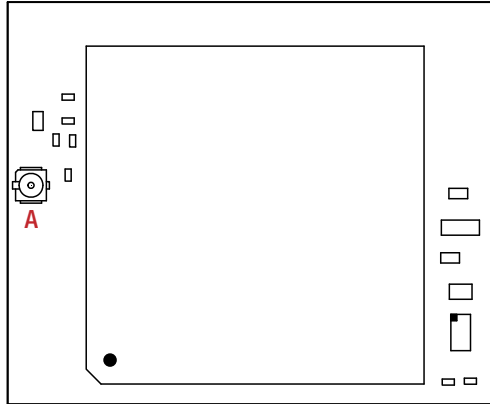
⁹ Must be in the ON position for the -S1 and -S1R2 model)

¹⁰ Uses value in Modbus register 6804.

7 Cellular Modem Boards

7.1 Cellular Modem Board for CDMA

The optional CDMA cellular modem is installed on the SAM4 processor board on the two 12-pin sockets.



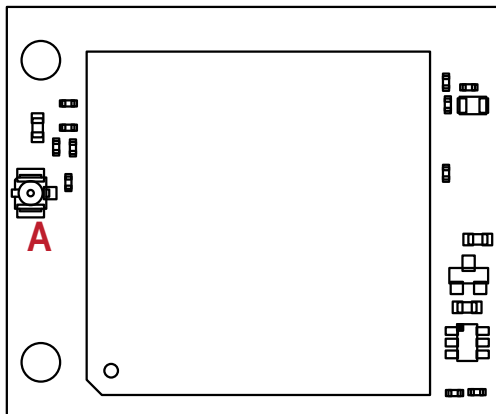
The U.FL connector should be to the left, with the antenna cable going to the left antenna U.FL connector.

A - U.FL antenna connection

After June 1, 2018, CDMA cellular modems cannot be provisioned on the wireless network. Purchase LTE cellular modems after this date.

7.2 Cellular Modem Board for GSM and LTE

The optional GSM or LTE cellular modem is an optional accessory that is installed on the SAM4 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.

7.3 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.

There are four LED indicators that give the run/fault status for the DXM100. To view the processor board, open the housing top cover. Refer to [SAM4 Processor Board](#) on page 22 for LED locations. The four processor board 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.
- LED 4—ScriptBasic program failed to load.

7.4 Using the DXM Cellular Modem

The DXM cellular modem provides a remote network connectivity solution for the DXM100.

To use the cellular modem:

1. Configure the DXM100 to use the cellular network as the external network connection.
2. Verify the cellular modem is installed and the correct antenna is connected to the cellular antenna port.
3. Activate the cellular service.

7.4.1 Activating a Cellular Modem

Activating the DXM100 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.

Cellular Kit Model Number	Kit Description	Notes
SXI-GSM-001	3G GSM worldwide cellular modem using Telit HE910-D modem kit. The kit includes cellular modem, antenna, and antenna cable.	Requires a GSM cellular wireless plan attached to the SIM card, IMEI (International Mobile Equipment Identity) number.
SXI-LTE-001	Verizon LTE cellular modem using Telit LE910 modem kit. (Verizon part number SENSX002). The kit includes cellular modem, SIM card, antenna, and antenna cable.	Cellular plans can be purchased through https://bannercds.com . Requires a LTE Verizon cellular wireless plan attached to the SIM card, IMEI (International Mobile Equipment Identity) number.

For additional information, refer to the Banner Connected Data Solutions support center. The support center includes video tutorials, product documentation, technical notes, and links to download configuration software.

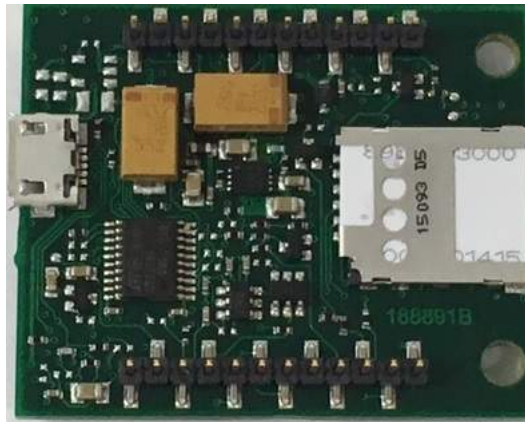
Purchase and Install the Cellular Modem

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

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

Cell Modem Kit	Cell Service
SXI-GSM-001	3G GSM (HSPA+ networks; GSM/EGPRS fallback)
SXI-LTE-001	Verizon 4G LTE

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.



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 DXM100's SMA connector located next to the antenna cable.



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.

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

Activate a Verizon 4G LTE Cellular Plan

Activate a cellular plan for your DXM100 using the Banner Connected Data Solutions website.

1. Go to <https://bannercds.com> to purchase DXM100 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.

Configure the DXM Controller for a Cellular Modem

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

1. Go to the **Settings > Cloud Services** screen.
2. Set the **Network Interface** to **Cell**
All push data, SMS messages, or email alerts will be sent using the cellular modem.
3. Under the **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 DXM100 cellular capability. The wireless carrier will provide the APN parameters. Not all parameters may be required.
 - For CDMA, select CE910 2G CDMA. Requires a wireless data plan put in place based on the MEID number of the cellular module. Once activated, the DXM100 must be provisioned on the wireless network by using the LCD display menu **System Config > Provision Cell**. The APN parameters are not required for this cellular modem.
4. To send data to the webserver, set the **Cloud Push** settings and the Webserver settings.

When the DXM100 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.

7.5 Accessing the DXM Using SMS

The DXM100 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 Tool 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 DXM100 cause the DXM to respond. See the examples below for SMS responses. Responses may take 20 seconds or more, depending upon the network.

A DXM100 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.

7.5.1 HTTP Push

Push triggers a http push to a webserver. The DXM100 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>`

DXM100 acknowledgment text message: `Register push requested`

7.5.2 Reboot

Reboot triggers the DXM100 to reboot. The processor reloads the XML configuration file and zeroes all local register data. This does not affect the other components of the DXM100 (ISM radio, I/O board, cellular modem). The DXM100 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>`

DXM100 acknowledgment text message: `rebooting...`

7.5.3 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>`

DXM100 acknowledgment text message: `Register 1 is 0`

7.5.4 Set Register

srN,X sets a register value, where `N` is the register number and `X` is the value. The DXM100 responds with a SMS message indicating the register was set.

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

`sr1,10 <send>`

DXM100 acknowledgment text message: `Register 1 has been set to 10`

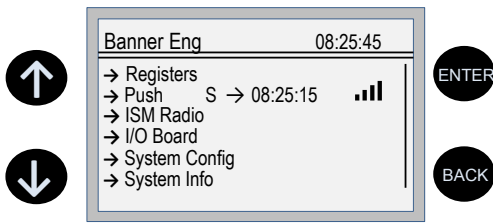
7.5.5 Configuring the DXM100 for SMS Controlling

Configure the DXM100 for SMS messaging capability using the DXM Configuration Tool.

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 DXM100.
3. Save the configuration file (**File > Save**).
4. Load the XML file to the DXM100.
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 DXM100 from an approved phone number.

8 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.

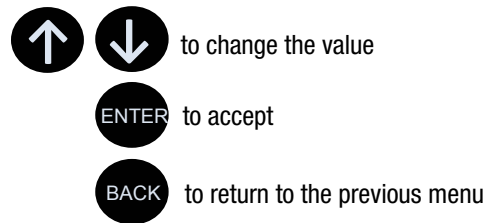
The DXM100 can be configured to require a passcode be entered before the LCD and Menu system will operate. The passcode configuration is defined in the DXM Configuration Tool.

8.1 Registers

The **Registers** submenu displays the processor's local registers that can be configured using the DXM Configuration Tool.

To configure these local registers, launch the DXM Configuration Tool. 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.

Registers → List of Local Register Values and the Register Name

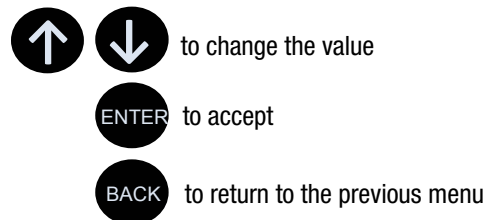


Read allows the register to be displayed, and Write or Read/Write allows the register value to be changed using the LCD. The Units and Scaling parameters are optional and affect the LCD.

8.2 Push

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

Push → Trigger Data Push Status Time (hh:mm:ss) → Trigger Data Push



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.

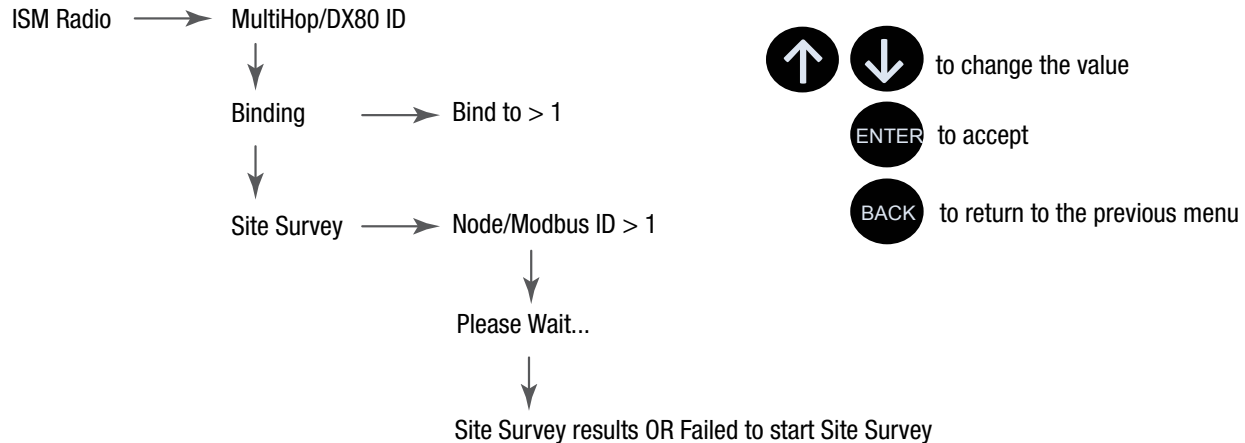
- The **Trigger Push** submenu forces an immediate push to the web server.
- The status and time fields indicate success or failure of the last attempted push and time of the last attempted push.

8.3 ISM Radio

The **ISM Radio** menu allows the user to view the Modbus ID of the internal ISM radio, invoke binding, or run a site survey. To change the ISM Radio Modbus ID refer to the **System** menu.

The top level menu includes a read-only **ISM Radio** menu selection. This menu displays the type of radio in the DXM100 (MultiHop or DX80 Star) and the Modbus ID of the radio.

This menu only allows the user to view this data. Binding or Site Survey with the internal radio is also run from this menu selection. This top-level **ISM Radio** menu is different from the **System > ISM Radio** submenu.



8.3.1 Binding

All ISM radio devices must be bound to the internal Gateway/master device before the DXM100 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).

To bind:

1. Enter the **Binding** menu.
2. For devices without rotary dials, select the wireless device number.
3. Enter binding mode. The gateway/master radio enters binding mode.
4. Triple-click the wireless Node/slave device to put it into binding mode. The LEDs indicate when binding on the wireless device is completed.

For more information of the binding of a particular device review the individual datasheet.

8.3.2 Site Survey

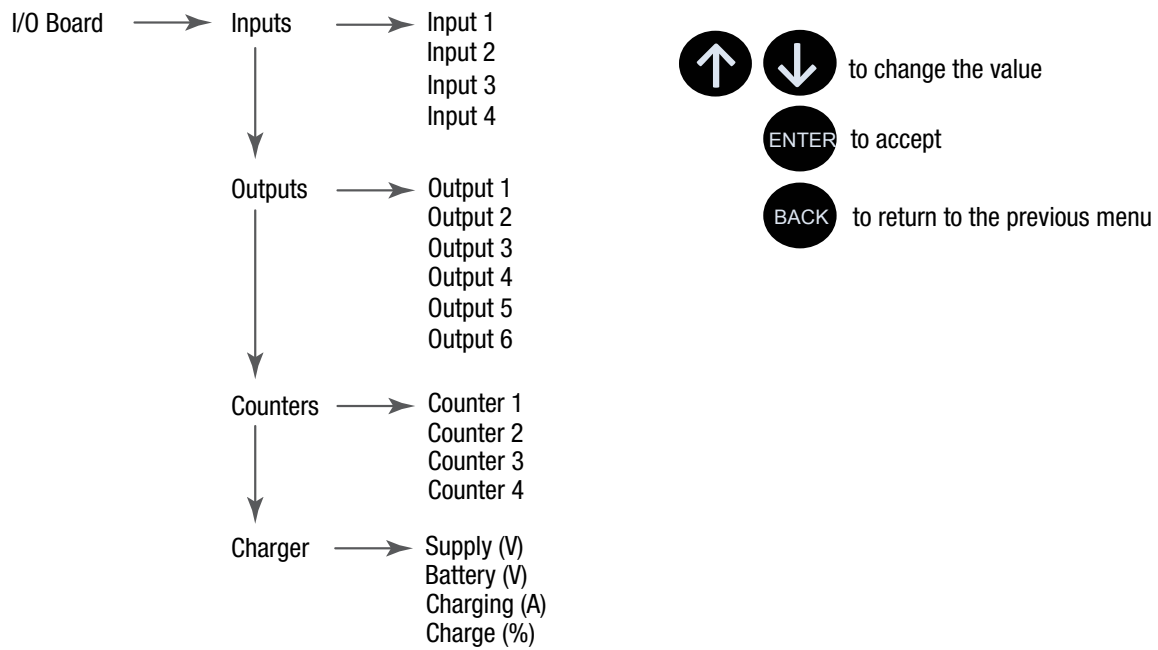
After creating a wireless network using the binding process, run a site survey on each device to see the link quality.

1. Enter the **Site Survey** menu.
2. Select the Node or Slave ID for the end device.
3. Click **Enter** to run a site survey.

The Site Survey results display as green, yellow, red, and missed packets. Green indicates the highest signal strength, then yellow, and red. Missed packets failed to be received. The DX80 system can run a site survey analysis while the network is operational. A MultiHop device runs with its parent device and does not allow other traffic when a site survey is running.

8.4 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

The DXM100 base has four universal 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

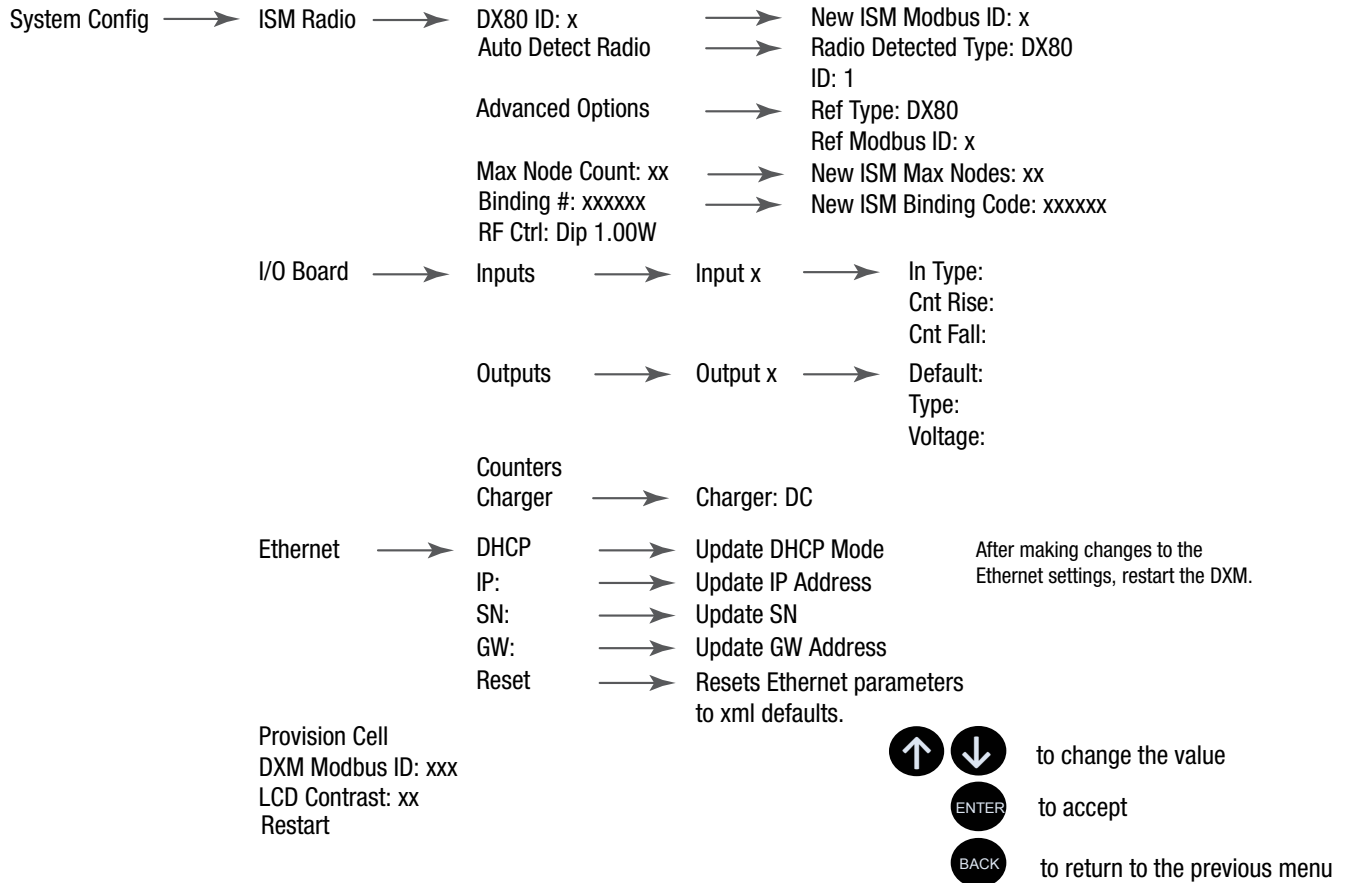
Counters on the DXM base board are associated to inputs but the count value is stored in different register. Adjust or view the count registers using the LCD menu.

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.

8.5 System Config

Use the **System Config** menu to set DXM100 system parameters.



The **System Config** submenus are:

- ISM Radio
- I/O Board
- Ethernet
- Provision Cell
- DXM Modbus ID
- LCD Contrast
- Restart

8.5.1 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 DXM100 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 DXM100. The reference Modbus ID is what the DXM100 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 DXM100 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 DXM100 uses this reference to determine how to communicate to the internal radio. If set incorrectly, the DXM100 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.
- **Reference Modbus ID** defines the Modbus ID the DXM100 uses when communicating with the internal radio. If this is set incorrectly, the DXM100 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.

8.5.2 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 DXM100 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
Sinking	Discrete input, low active, 0 = ON, 1 = OFF
Sourcing	Discrete input, high active, 1 = ON, 0 = OFF
Current	Analog input, 0–20 mA
Voltage	Analog input, 0–10 V dc
Thermistor 2*	Thermistor input, 10k - J (r-t curve), beta(K) 3890
Thermistor 1*	Thermistor input, 10k - G (r-t curve), beta(K) 3575

Counter	Description
In Type	Sinking or sourcing
Cnt Rise	Increment the count when the input transitions from 0 -> 1
Cnt Fall	Increment the count when the input transitions from 1 -> 0

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

Output Parameters	Description
Default	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.
Type	Select the output type: NMOS Sinking, Switch Power (Swch Pwr), Analog.
Voltage	Outputs defined as switched power can adjust the voltage: 5 V or 16 V

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](#) on page 31.

Charger Parameters	Description
DC	Used when 12–24 V dc power supplies connected to the DXM100 power pins and the attached batteries are used as backup batteries. This limits the current during the battery charging process. (factory default setting)

Charger Parameters	Description
Solar	Select Solar when a solar panel is connected to the power pins of the DXM100. Solar panels are current limited by their design and therefore can charge the battery without managing the input power.

8.5.3 Ethernet

Use the **Ethernet** submenu to sets the IP Address, Gateway Address, and Subnet mask of the DXM100'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 Tool.

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 DXM100 after changing the Ethernet parameters.

The Ethernet cable should be attached before powering up the DXM100.

8.5.4 Provision Cell

If the DXM100 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](#) on page 65.

8.5.5 DXM Modbus ID

Use the secondary Modbus RS-485 port when the DXM100 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**.

8.5.6 LCD Contrast

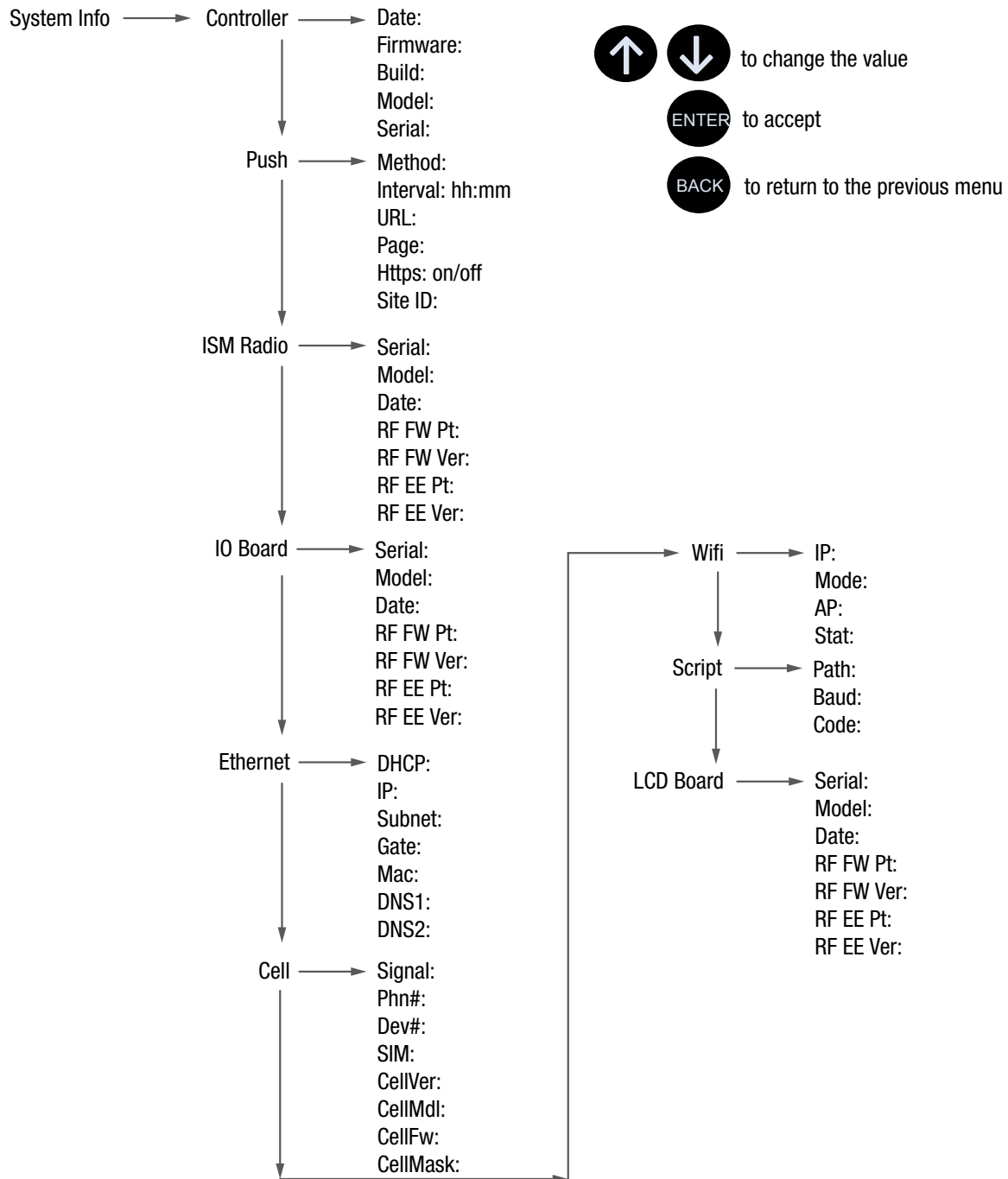
Use the **LCD Contrast** option to adjust the LCD contrast. Adjust the starting number lower to decrease the display contrast. The factory default is 28. Do not set a number less than 15 or the display may not be bright enough to see to change back.

8.5.7 Reset

Use the **Restart** menu to force the main processor to restart. This does not affect the other boards in the system (I/O board, ISM radio board, or cellular modem).

8.6 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.

Script

Displays the name of the ScriptBasic file running.

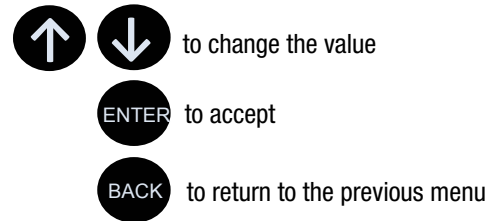
LCD Board

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

8.7 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



The display lock feature uses the DXM Configuration Tool to set a passcode within the DXM100. A valid passcode is 1 to 9 digits long and uses numbers 0 through 9. For example 1234 or 209384754.

8.8 Using the Display LEDs

Turn on the DXM100 LEDs by writing to the LEDs' Modbus registers.

The DXM display uses Modbus slave ID 201 and has four individual registers for each of the four LEDs on the display.

Turn on an LED by writing a 1 value to the register. Turn off the LED by writing a 0 to the register.

Do not write to any other Modbus registers. They are used by the LCD display for menu data.

Display Modbus Register	Display LED
1102: bit 0	LED 1 (Green)
1103: bit 0	LED 2 (Red)
1104: bit 0	LED 3 (Yellow)
1105: bit 0	LED 4 (Red)

DXM100 Display Example

This example shows setting up the DXM100 using the DXM Configuration Tool to read four universal inputs and write the state values to the display LEDs.

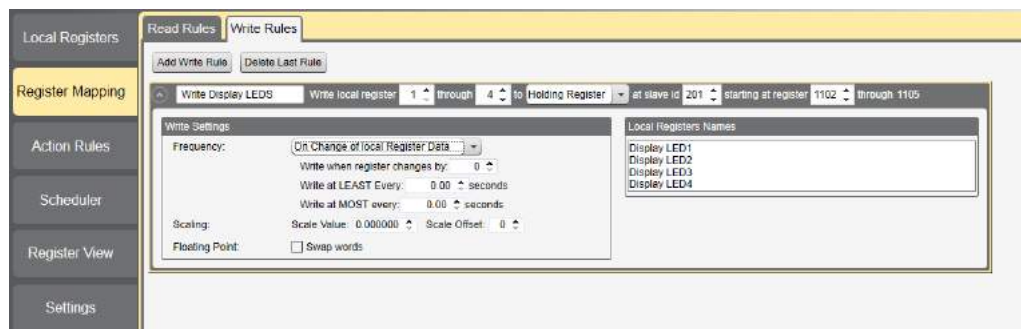
1. Using the DXM Configuration Tool, go to the **Local Registers > Local Register Configuration** screen.
2. Define the local registers by assigning names to the first four registers and setting the LCD permissions parameter to read/write. The LCD permissions show the register contents on the LCD menu 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 DXM100 using a USB cable and select **Device > Connection Settings** from the menu bar.
7. Upload the XML configuration file to the DXM100 by selecting **Device > Upload Configuration to Device** from the menu bar.

After a configuration file is uploaded, the DXM100 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 DXM100 now turns on an LED on the display.

On the DXM100's LCD menu, the arrow on the left side of the register line indicates this local register can be written to. Try changing the configuration to delete the Read Rule then turn on/off the LEDs by changing the register value through the LCD display.

8.9 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.

Modbus Register	I/O Connection	Modbus Register	I/O Connection
1102 : bit 0	LED 1	1104 : bit 0	LED 3
1103 : bit 0	LED 2	1105 : bit 0	LED 4

9 Working with Modbus Devices

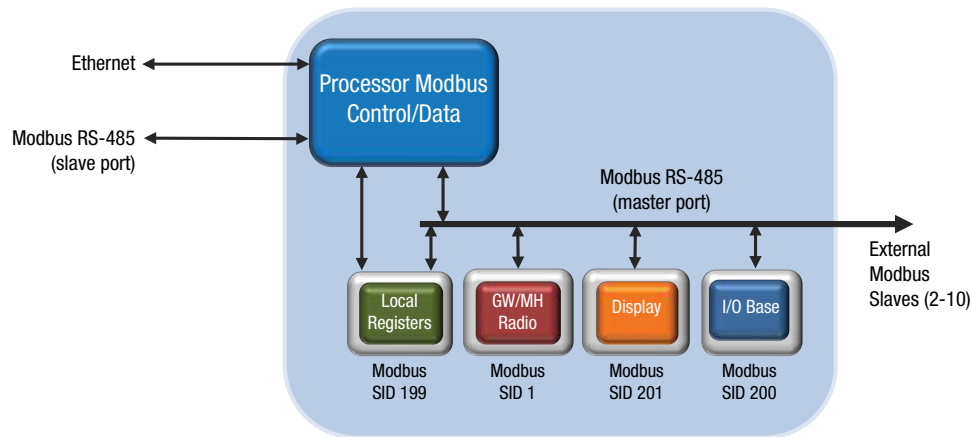
9.1 Overview

The DXM100 has two physical RS-485 connections using Modbus RTU protocol.

The master Modbus RS-485 port is for the DXM100 to act as a Modbus master device to control internal and external Modbus slave devices.

The Modbus master RS-485 port is labeled M+ and M- on the DXM100. The Modbus slave port is used when another Modbus master device wants to communicate with the DXM100 when the DXM100 is a Modbus slave device.

The Modbus slave RS-485 port is labeled S+ and S1 on the DXM100.



The DXM100 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 DXM100 local registers. To operate as a Modbus slave device, the DXM100 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 DXM100 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 Tool.

The DXM100 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 DXM100.

DXM Internal Modbus Slave IDs (factory default)	
Modbus Slave ID	Device
1	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.
199	Local Registers—Internal storage registers of the DXM100
200	I/O Base Board—All data and parameters for each input or output of the DXM100.
201	LCD Display—The user has access to the LED indicators on the DXM100.

9.2 Assigning Modbus Slave IDs

Assign the DXM Modbus Slave ID only if a Modbus master device is reading or writing the DXM100 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 DXM100 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 Tool under the **Settings > General** tab.

DXM Master Configuration—When the DXM100 operates as a Modbus master device, use the DXM Configuration Tool to configure read or write operations of the DXM Modbus network. The DXM100 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 DXM100. Assign slave IDs of 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 DXM100. 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.

9.3 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 DXM100 are also Modbus slaves, ISM radio, I/O base board, LCD, and internal Local registers.

9.4 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 DXM100 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 DXM100 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 through 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).

Modbus Slave ID	Description
1	Allocated for the internal ISM radio device, either a DX80 Gateway or MultiHop Master
2–10	Slave addresses available for direct connected Modbus slave devices to the master RS485 port (M+ , M-)
11–60	Allocated for wireless MultiHop radio network devices. If there is not an internal MultiHop in the DXM100, these slave addresses are available to use for directly connected devices.
61–198	Available to user for direct connected Modbus slave devices or the expansion of the wireless network slave IDs to go past 50 wireless devices.
199	Allocated for internal Local Register
200	Allocated for the I/O base board, will be different for special DXM slave only models.
201	Allocated for the LCD display board, the user can read/write LEDs.

9.5 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 DXM100, if there are no MultiHop wireless devices. If a MultiHop network a part of the DXM100, special considerations need to be made to set the timeout parameter.

Wireless communications are inherently lossy networks, and controllers operating these networks must be configured 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 DXM100, the **Communications Timeout** parameter is the maximum amount of time the DXM100 should wait after a request is sent until the response message is received from the Modbus slave device. Use the DXM Configuration Tool to set the timeout parameter on the **Settings > General** screen.

The default setting for the timeout parameter is 5 seconds.

9.5.1 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.

9.5.2 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 DXM100 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 DXM100 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 = $(9 \times 1.3 \text{ sec}) + (8 \text{ retry wait} \times 1.3 \text{ sec}) = 22 \text{ seconds}$

Slave to Master Send time = $(9 \times 0.04 \text{ sec}) + (8 \text{ retry wait} \times 0.04 \text{ sec}) = 1 \text{ second}$

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 = $(9 \times 0.04 \text{ sec}) + (8 \text{ retry wait} \times 0.04 \text{ sec}) = 1 \text{ second}$

Repeater to Master Send time = $(9 \times 0.04 \text{ sec}) + (8 \text{ retry wait} \times 0.04 \text{ sec}) = 1 \text{ second}$

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.

9.5.3 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 = $(9 \times 0.04 \text{ sec}) + (8 \text{ retry wait} \times 0.04 \text{ sec}) = 1 \text{ second}$

Slave to Master Send time = $(9 \times 0.04 \text{ sec}) + (8 \text{ retry wait} \times 0.04 \text{ sec}) = 1 \text{ second}$

Total Send/Receive time = 2 seconds

Minimum Timeout period = 2 seconds

9.5.4 Adjusting the Receive Slots and Retry Count Parameters

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

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

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

9.5.5 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 DXM100 does not use the wireless network to access the data, which allows for much faster messaging and much lower timeout values.

For a DXM100 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.

9.6 Modbus TCP Client

The DXM100 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 Tool to define and configure Modbus TCP client communications with other Modbus TCP servers.

10 Configuration Instructions

10.1 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 DXM100. Reboot the DXM100 to activate a new schedule.

If power is cycled to the DXM100 in the middle of a schedule, the DXM100 looks at all events scheduled that day and processes the last event before the current time.

Right-click on most fields to access a context-sensitive menu. The most common options in the menus are **Cut**, **Copy**, **Paste**, **Delete**, and **Insert** to make data entry easier.

10.1.1 Create a Weekly Event

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

The screenshot displays the 'Weekly Events' configuration interface. At the top, there are buttons for 'Add Weekly Event' and 'Delete Last Event'. Below this, two event configuration panels are shown, labeled 'Weekly event 1' and 'Weekly event 2'. Each panel includes a 'Register' dropdown (set to '20'), an 'Active days' selector (showing M, T, W, Th, F, S, Su), and 'Start' and 'End' time fields. The 'Schedule Definition' section for each event has a 'Start Value' field (set to 1 for event 1, 0 for event 2), a 'Start at' dropdown (set to 'Specific Time'), and a '24 hour format' checkbox. The 'End Value' field is set to 0, and the 'End at' dropdown is also set to 'Specific Time'. To the right of each event panel is a 'Holidays' section with 'Active Holidays' and 'Available Holidays' lists, and 'Add' and 'Remove' buttons.

1. Click **Add New Rule**.
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.

10.1.2 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.

10.1.3 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.

10.2 Authentication Setup

The DXM100 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.

10.2.1 Set the DXM100 to use Authentication

The DXM100 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.

Setup requires both the webserver and the DXM100 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 DXM100.

1. From within the DXM Configuration Tool, go to **Settings > Cloud Services**.

2. Define the username and password in the **Webserver 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 Tool.

3. Click on **Send Authentication**.

The controller must be connected to the PC for this operation to succeed.

The data transmits directly to the DXM100's non-volatile memory. If successful, a pop-up window appears, asking to reboot the device.

4. Select **Yes** to reboot the device.

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.

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 Tool. The username and password do not need to be a defined user within the Banner Connected Data Solutions website.

10.2.2 DXM100 Configuration Authentication

The DXM100 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 Tool.

With the DXM100 connected to the PC, click **Get Device Status**. The DXM100 status displays next to the button.

Use the DXM Configuration Tool 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 DXM100 must be connected to the PC to change the administration password.

The DXM100 can be unlocked without knowing the administration password, but doing this erases the configuration program, logging files, and any ScriptBasic program on the device.

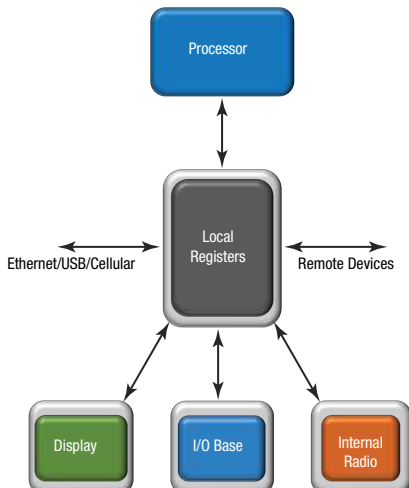
To unlock the hardware without knowing the administration password:

1. Turn off the power to the DXM100.
2. Open the controller top to access the button and DIP switches of the SAM4 processor board.
3. Turn on DIP switch 4 (next to the SD card holder).
4. Press and hold the reset button (next to the USB jack) while applying power to the DXM100.
5. Release the reset button.
6. After five seconds, turn off the power.
7. Turn off DIP Switch 4.
8. Install the DXM cover and apply power.

The device no longer has an administration password set.

10.3 Register Flow and Configuration

The DXM100 register data flow goes through the Local Registers, which are data storage elements that reside within the processor. Using the DXM Configuration Tool, 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.



10.3.1 Basic Approach to Configuration

When programming an application in the DXM100, first plan the overall data structure of the Local Registers. The Local Registers are the main storage elements in the DXM100. Everything goes into or out of the Local Registers.

1. In the DXM Configuration Tool, 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 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 Tool. 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.

10.3.2 Troubleshooting a Configuration

The built-in Register View utility is found in the DXM Configuration Tool on the **Register View** screen.

When a configuration is running on the DXM100, this utility can read or write Local Registers to help understand application operation. The utility can also access data from remote devices, making it easier to troubleshoot a configuration.

Local Registers can also be configured to show register data on the LCD menu to view Local Register data without having the controller connected to a PC. On the **Local Registers** tab, set the read permissions on each register to be display on the LCD.

10.3.3 Saving and Loading Configuration Files

The DXM Configuration Tool 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 DXM100. The DXM Configuration Tool uploads the configuration file saved on the PC to the DXM100; it will not send the configuration loaded in the tool.

10.3.4 Uploading or Downloading Configuration Files

The DXM100 requires a XML configuration file to become operational. To upload or download configuration files, connect a computer to the DXM100 using the USB port or Ethernet port. Then use the **Upload Configuration to Device** or **Download Configuration from Device** under the **Device** menu.

10.4 Setting Up EtherNet/IP™

The DXM100 is defined from the factory to send/receive register data from the Gateway and the first 16 Nodes with an EtherNet/IP™¹¹ host. To expand the number devices going to Ethernet/IP the user must change the Maximum Node count parameter in the DX80 Gateway from 16 to 32. Use the DX80 Configuration Tool to set this parameter.

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 Tool 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.

10.4.1 Configuring the Host PLC

On the host PLC, install the DXM100 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 DXM100. The host system sees the DXM100 as a generic device with the product name of Banner DXM (ProdType: 43 - Generic Device, ProdName: Banner DXM).

¹¹ EtherNet/IP is a trademark of Rockwell Automation.

10.4.2 Configuring the DXM100

Use the DXM Configuration Tool to define each local register to be **EIP Originator -> DXM** or as a **EIP DXM -> Originator**.

- Define a DXM local register as **EIP Originator -> DXM** when the host PLC (Originator) will send data to the DXM100 local register (DXM).
- Define a DXM local register as **EIP DXM -> Originator** when that register data will be sent from the DXM100 (DXM) to the host PLC (Originator).

Data from an EIP controller in assembly instance 112 is data destined for the DXM100 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 DXM100 local registers is sent to the EIP controller using assembly instance 100. Each local register in the DXM100 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 in assembly instance 100 is zero.

The following screen shot shows the DXM Configuration Tool defining 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 DXM100 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 Tool as **EIP Originator -> DXM** registers.

EIP Assembly Instance 112			DXM Local Registers	
Adrs	Data		Adrs	Data
00	11	➔	01	11 22
01	22			
02	33		05	33 44
03	44			
04	55		10	55 66
05	66			

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.

EIP Assembly Instance 112			DXM Local Registers	
Adrs	Data		Adrs	Data
00	77		10	77 88
01	88			
02	99		11	99 10
03	10			
04	11		19	11 12
05	12			

10.5 Setting up Email and Text Messaging

The DXM100 can be configured to send email or SMS messages based on threshold conditions. 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.

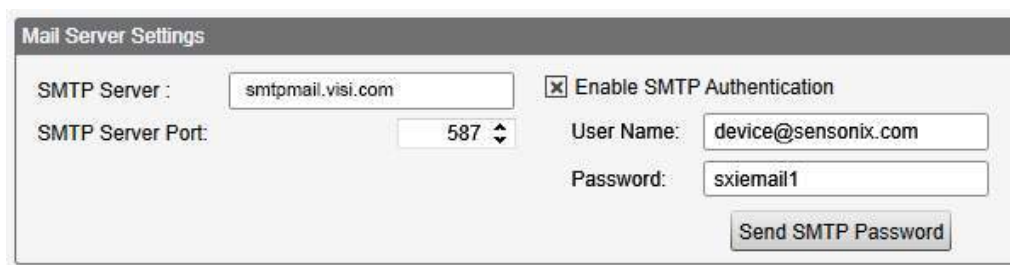
Follow these instructions and use the DXM Configuration Tool to program the controller for email and/or SMS.

1. Set the time on the DXM100.
2. Define the **Network Interface** settings by selecting either Ethernet or Cell on the **Cloud Services** screen.
3. If you selected Ethernet, configure your Ethernet connection by setting the IP settings on the **Network** screen.
4. Set the email and message parameters on the **Mail and Messaging** 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.

10.5.1 Mail Server Authentication

Complete the mail server settings to have the DXM100 send email alert messages or to email the log files.

The SMTP password is stored in the DXM100, not the XML configuration file. Use the **Settings > Mail and Messaging** screen to complete this configuration.



Mail Server Settings

SMTP Server : ☒ Enable SMTP Authentication

SMTP Server Port: User Name:

Password:

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 DXM100. The DXM100 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.

10.5.2 Define the Network Interface Settings

On the **Cloud Services** screen, define the network connection settings by selecting Ethernet or Cell from the **Network Interface** drop-down list. This determines how the DXM100 sends data.

When selecting Ethernet, provide the network parameters on the **Network** screen. If you don't require pushing data to a web server, set the **Cloud Push** interval to zero.

<div> Network Interface Push interface Ethernet Ethernet retries per push interval 5 Cell Configuration Cell module CE910 2G CDW <input type="checkbox"/> Enable Server Mode APN <input type="text"/> APN Username <input type="text"/> APN Password <input type="text"/> </div> <div> Cloud Push Cloud push interval None Sample count 1 Push port 80 <input type="checkbox"/> Print push debug messages to serial console </div> <div> Web Server Authentication <input type="checkbox"/> Require Authentication Username <input type="text"/> Password <input type="text"/> <input type="button" value="Send Authentication"/> </div>	<div> Web Server Server name/IP push.sensonix.net Page /push.aspx Host header <input type="text"/> Site ID is GUID <input type="button" value="Clear"/> 00000000-0000-0000-0000-000000000000 <input type="text"/> <div> <input type="button" value="Custom HTTP Headers"/> </div> <div> Initial Push Options <input type="checkbox"/> Include XML GUID on first push </div> </div> <div> HTTPS <input type="checkbox"/> Use HTTPS Certificate CN *.sensonix.net </div>
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10.5.3 Configure your Ethernet Connection

To send email based on a threshold rule or to email log files, first define the network and email servers. In the DXM Configuration Tool, go to **Settings > Network**.

1. To define the Ethernet IP address, give the DXM100 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 DXM100 uses a public service to resolve Domain names, but if the network connection does not have Internet access, the DNS settings may be required.

Current Device IP IP Address: 0.0.0.0 Subnet: 0.0.0.0 Gateway address: 0.0.0.0 Device MAC: 00:00:00:00:00:00 <input type="button" value="Get Settings from Device"/>		Cell Firewall Cell firewall IP address: 0.0.0.0 Cell firewall netmask: 255.255.255.0																		
IP Address DHCP: <input type="button" value="v"/> IP address: 0.0.0.0 Subnet: 255.255.255.0 Gateway address: 0.0.0.0		Network Parameters <input type="checkbox"/> Enable UDP console Ethernet Connection Acquisition Connection retry: 5 Connection retry wait: 00:00:10.000 Max delay between retries: 00:01:00.000 Cellular Connection Acquisition Connection retry: 5 Connection retry wait: 00:00:10.000 Activity timeout: 00:00:10 Watchdog timeout: 00:00:10.000																		
DNS Primary DNS IP address: 0.0.0.0 Secondary DNS IP address: 0.0.0.0 Primary cell DNS IP address: 0.0.0.0 Secondary cell DNS IP address: 0.0.0.0		Cell Software Firewall <input checked="" type="checkbox"/> Open software firewall *If there are no valid entries for a section, the firewall is left open for that category of messages. <table border="1"> <tr> <td>Phone Number</td> <td>Add</td> <td>Remove</td> </tr> <tr> <td>Open to all SMSs</td> <td></td> <td></td> </tr> <tr> <td>IP Address</td> <td>Add</td> <td>Remove</td> </tr> <tr> <td>Open to all IPs</td> <td></td> <td></td> </tr> <tr> <td>Email Address</td> <td>Add</td> <td>Remove</td> </tr> <tr> <td>Open to all Emails</td> <td></td> <td></td> </tr> </table>	Phone Number	Add	Remove	Open to all SMSs			IP Address	Add	Remove	Open to all IPs			Email Address	Add	Remove	Open to all Emails		
Phone Number	Add	Remove																		
Open to all SMSs																				
IP Address	Add	Remove																		
Open to all IPs																				
Email Address	Add	Remove																		
Open to all Emails																				

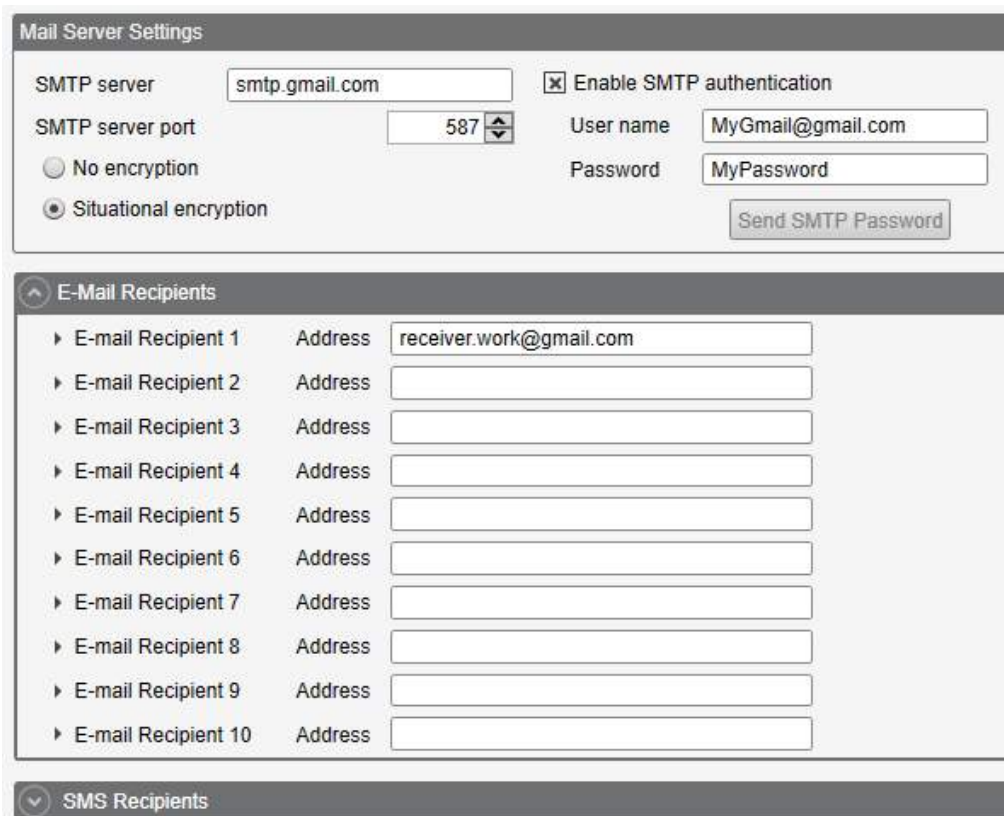
10.5.4 Configure your Cellular Connection

A cellular connection does not require any configuration other than being selected as the network connection under the **Cloud Services** screen.

10.5.5 Set the Email and Messaging Parameters

From the **Settings > Mail and Messaging** 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 DXM100. After the password is entered, click on **Send SMTP Password** to send it to the DXM100. The password is stored in non-volatile memory, so reboot the DXM100 to recognize the new password.



Mail Server Settings

SMTP server: ☒ Enable SMTP authentication

SMTP server port: User name:

☐ No encryption Password:

☒ Situational encryption

E-Mail Recipients

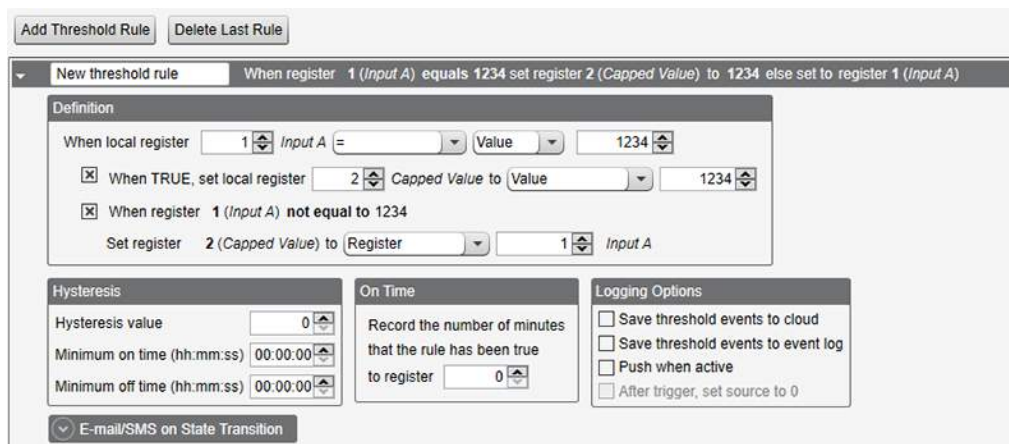
- E-mail Recipient 1 Address:
- E-mail Recipient 2 Address:
- E-mail Recipient 3 Address:
- E-mail Recipient 4 Address:
- E-mail Recipient 5 Address:
- E-mail Recipient 6 Address:
- E-mail Recipient 7 Address:
- E-mail Recipient 8 Address:
- E-mail Recipient 9 Address:
- E-mail Recipient 10 Address:

SMS Recipients

At the bottom of the screen, define the recipient to receive emails and enter the phone numbers for SMS messages. These recipients for email or SMS messages can be selected in the threshold definition for sending alert messages.

10.5.6 Define Threshold Rules for Email

To define a threshold, go to **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.



New threshold rule When register 1 (Input A) equals 1234 set register 2 (Capped Value) to 1234 else set to register 1 (Input A)

Definition

When local register 1 Input A = Value 1234

☒ When TRUE, set local register 2 Capped Value to Value 1234

☒ When register 1 (Input A) not equal to 1234

Set register 2 (Capped Value) to Register 1 Input A

Hysteresis

Hysteresis value:

Minimum on time (hh:mm:ss):

Minimum off time (hh:mm:ss):

On Time

Record the number of minutes that the rule has been true to register

Logging Options

☐ Save threshold events to cloud

☐ Save threshold events to event log

☐ Push when active

☐ After trigger, set source to 0

☒ E-mail/SMS on State Transition

10.5.7 Define Log File Parameters for Emailing Log Files

The DXM100 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 **Network** screen. Set the DXM100 time, under **Settings > General**, so that all data is properly time stamped.

Select the registers to log on the **Local Registers > Register Configuration** screen. 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).
3. Define the email address.

The screenshot shows the 'Data Log 1' configuration window. It is divided into two main sections. The left section, 'Format and log trigger', contains options for enabling logging, timestamping, and setting the file name and log rate. The right section, 'E-mail and file save settings', contains options for email delivery, including file size limits, recipient email, and subject line.

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 Tool to read back the log files. Under **Settings > Logging**, click **Refresh List**, highlight the file to download, then click **Save Selected**.

10.6 Ethernet and Cellular Push Retries

The DXM100 can be configured to send register data packets to a webserver. When the Ethernet or cell communications path is not operating, the DXM100 retries the send procedure. The communications retry process is outlined below for each configuration.

Regardless of the communications connection (Ethernet or cellular), a failed attempt results in the register data packet being saved on the local micro SD card¹². 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.

10.6.1 Ethernet Push Retries

With an Ethernet-based network connection, the DXM100 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 DXM100 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.

¹² Enable HTTP logging to save data on the SD card; this is the factory default. See SETTINGS -> LOGGING in the DXM Configuration Tool.

10.6.2 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 DXM100 archives the register data packets after 10 failed attempts.

10.6.3 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.

10.6.4 Email and Text Message Push Retries

There are no retries for emails or SMS messages that fail to be sent from the DXM100.

10.7 DXM Modbus Registers

The DXM100-Bx Wireless Controller may have up to four internal Modbus slave devices:

DXM Internal Modbus Slave IDs (factory default)	
Modbus Slave ID	Device
1	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.
199	Local Registers — Internal storage registers of the DXM100
200	I/O Base Board — All data and parameters for each input or output of the DXM100.
201	LCD Display — The user has access to the LED indicators on the DXM100.

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.

11 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.

11.1 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 Tool is stored in EEPROM. The small section of non-volatile local registers is also stored in EEPROM.

11.2 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

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**.

Data Log files

Users may create up to four data log files using the DXM Configuration Tool. 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 DXM100 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. For more information on the communications retry mechanism, refer to the technical note on system retries. (*DXM Ethernet and Cellular Push Retries.docx*).

ScriptBasic Created 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.

System Voltage Monitor File

The CmVMon.txt file (**C**ellular **m**illi-**V**olt **M**onitor) 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.

CM	2015-09-22 18:52:43	VMon	Power entered normal range 24487
CM	2015-10-13 20:49:47	VMon	Power entered normal range 24004
CM	2015-10-16 15:00:20	VMon	Power entered normal range 24014
CM	2015-10-19 19:12:26	VMon	Power entered normal range 12845

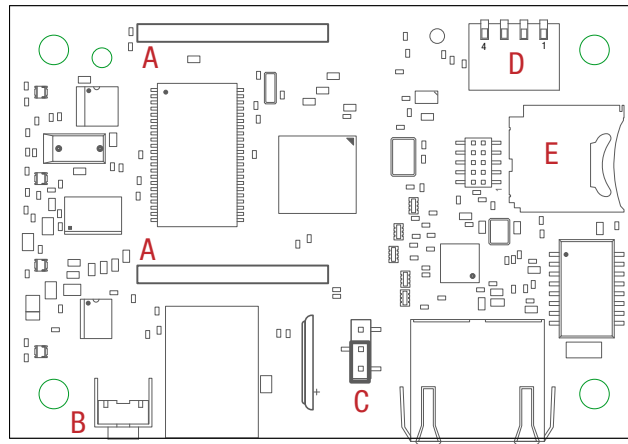
12 Updating the DXM Processor Firmware

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

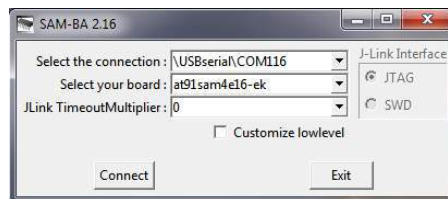
12.1 Update Your DXM Processor Firmware (Prior to Version 2.0)

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.

1. Download the SAM-BA software from <http://www.microchip.com/developmenttools/productdetails.aspx?partno=atmel+sam-ba+in-system+programmer>.
2. Install the SAM-BA program.
3. Set the SAM4 processor board jumper (jumper C, shown below in the "boot load off" position).

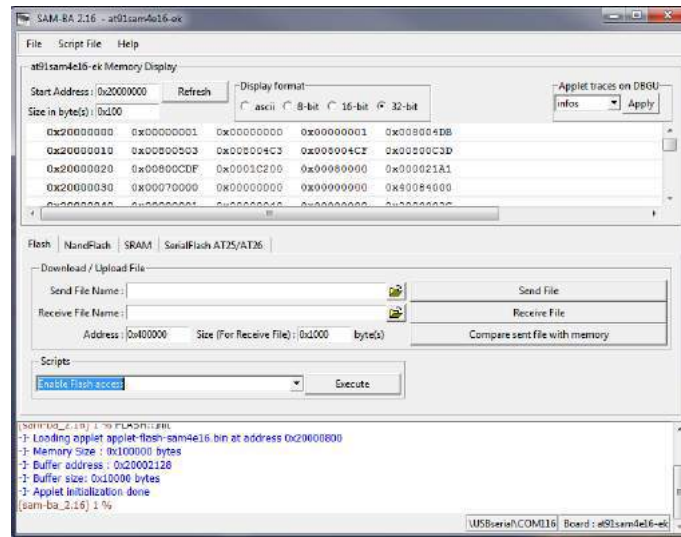


- a) Disconnect the DXM Controller from its power supply.
 - b) Open the hardware cover.
 - c) Using your fingers or tweezers, move the jumper to the "boot load on" position (jumper on the top two pins).
 - d) Connect the DXM back to its power supply.
 - e) After about 20 seconds, move the jumper back to its original position.
 - f) Replace the hardware cover.
4. Launch the SAM-BA program. Select the COM port and correct board. Click **CONNECT**.

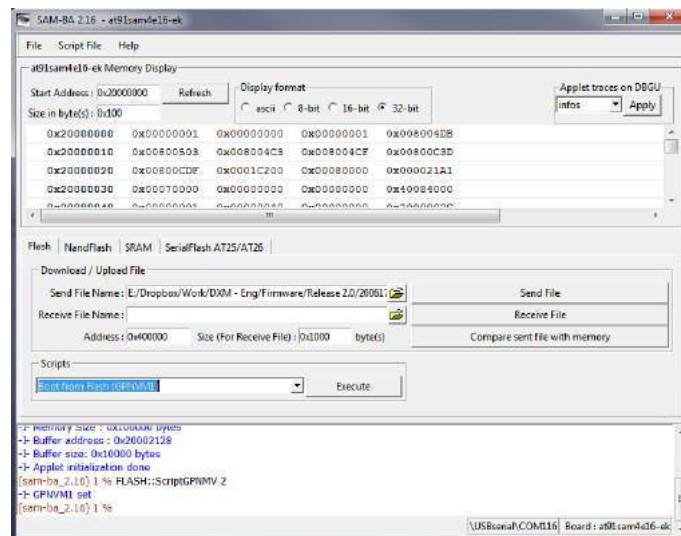


The SAM-BA program attempts to automatically detect the COM port and the correct device.

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



- In the **SCRIPTS** pull-down menu, select **BOOT FROM FLASH (GPNVM1)**. Click **EXECUTE**. Click **EXECUTE** again if the message indicates it failed.
- 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 load process takes a few seconds.

- After the load is complete, the program asks if you want to lock the flash region. Click **NO**.
- Close the SAM-BA bootloader program.
- Cycle the power to the DXM Controller.
The new code should now be running and the LEDs should be on.

12.2 Updating Your DXM100 Processor Firmware (Version 2 or Later)

DXM100s with processor firmware version 2.0 or later have a built-in boot loader program to update the firmware. Use the DXM Configuration Tool 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 DXM100. The DXM Configuration Tool 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		
Reprogramming Step	Approximate time required	Description
Loading new firmware file (*.HEX)	DXM Configuration Tool: 2 minutes over Ethernet or 15 minutes over USB Banner Connected Data Solutions: 2 minutes over Ethernet or 5 minutes over Cellular	Send the new firmware image to the DXM100. After the new image is on the device, the controller resets. LED3 is red during the loading process.
Verify the contents of the new firmware file	1 minute	When the DXM100 finds a file that should be installed, LED4 (amber) flashes at about a 1 second rate while the contents of the file are validated.
New firmware file is valid		After validation successfully completes, LED4 is on (amber).
New firmware file is being loaded	2 minutes; do not remove power to the DXM100 during the programming process.	LED3 (red) blinks approximately once per second. LED3 continues to blink during the application programming process.
Finished		After programming has completed, the DXM100 resets and begins running the new firmware

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.

12.2.1 Update Your DXM Processor Firmware Using the DXM Configuration Tool

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

- Using the DXM Configuration Tool version 3 or later, connect to the DXM100 via USB¹³ or Ethernet.
File loads to the DXM100 will take about 15 minutes using USB or approximately 2 minutes using Ethernet.
- On the DXM Configuration Tool, 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.



- Under **Settings > Reprogram**, click **Select upgrade file** to select the firmware file to program.

After the file load is completed, the DXM100 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**.

12.2.2 Update Your Processor Firmware Using the Banner Connected Data Solutions Website

To update your processor firmware (version 2.0 or later) using the DXM100 website, follow these instructions.

To use the website to update the firmware file, first configure the DXM100 to push data to the website.

¹³ While the file download is in process over a USB connection, do not use other applications on the PC. After the DXM100 reboots for a firmware update, the USB port may be unresponsive. Clear the connection by disconnecting the USB cable and restarting the DXM Configuration Tool software.

1. Go to **Dashboard** > **Sites** and click **+** to verify the current firmware part number and version on the DXM100.

[illegible]

Data collected from the DXM100 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 DXM100 retrieves the new firmware file. The new firmware file must be the same part number of firmware that is currently in the DXM100.

12.2.3 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 DXM100).

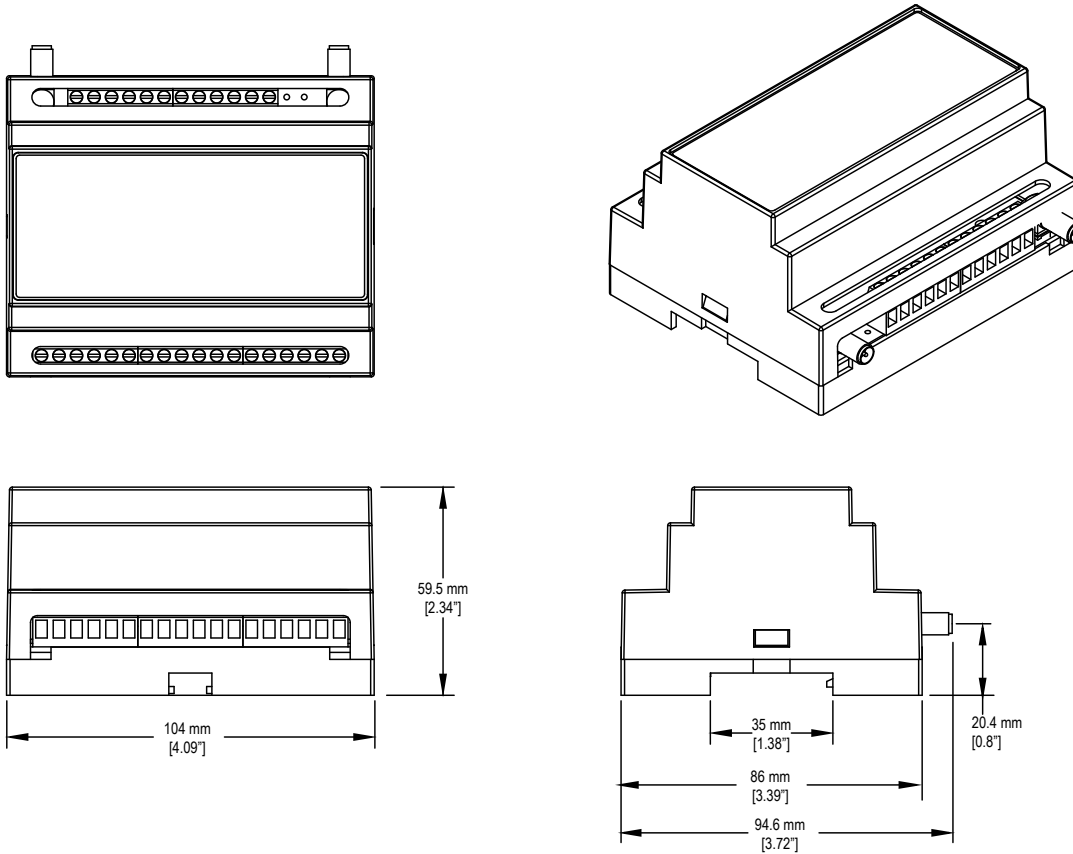
1. Disconnect the DXM100 from its power supply.
2. Remove the micro SD card from the DXM100.



- a) Open the cover housing to the DXM100.
 - 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 DXM100 by sliding the card into the holder.
 6. Reconnect the DXM100 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.

13 DXM100 Dimensions



All measurements are listed in millimeters, unless noted otherwise.

14 Accessories

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

Cordsets

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

Static and Surge Suppressor

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

Short-Range Omni Antennas

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

Medium-Range Omni Antennas

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

Enclosures and DIN Rail Kits

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

Misc Accessories

BWA-CG.5-3X5.6-10—Cable Gland Pack: 1/2-inch NPT, Cordgrip for 3 holes of 2.8 to 5.6 mm diam, 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-2MRFRS6—LMR200, RP-SMA Male to RP-SMA Female Bulkhead, 6 m
BWC-4MNFN6—LMR400 N-Type Male to N-Type Female, 6 m

Long-Range Omni Antennas

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

Long-Range Yagi Antennas

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

Power Supplies

[PSD-24-4](#)—DC Power Supply, Desktop style, 3.9 A, 24 V dc, Class 2, 4-pin M12/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)

15 Additional Information

15.1 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 Configuration Quick Start, p/n [191247](#)
- DXM Configuration Tool software (p/n [b_4447978](#))
- DXM Configuration Tool Instruction Manual, p/n [158447](#)
- DXM EDS [Configuration file](#) for Allen-Bradley PLCs
- EIP Configuration File for DXM 1xx-BxR1 and R3 models (p/n [194730](#))
- Activating a Cellular Modem (p/n [b_4419353](#))
- Additional technical notes and videos

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

15.2 DXM100 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 DXM100, 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.

15.2.1 Firmware Updates

The DXM100 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 DXM100. 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.

15.2.2 Website Information

The Banner website is the main method of disseminating DXM100 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

15.2.3 Feature Requests

Our customer is our most valuable resource to improve our DXM100. If you have suggestions for improvements to the DXM100 or configuration tools, please contact Banner Engineering Corp.

15.2.4 Potential DXM Issues

Potential issues with the DXM100 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.

15.2.5 DXM Security

The DXM100 was designed to collect local wireless sensor data, local sensor data, provide simple control, and send the data to the cloud.

The DXM100 does not run a Linux or Windows based operating system but an embedded RTOS environment. As a proprietary operating system, the security aspects are easier to manage and minimize.

Security updates are released through the Banner website and New Product Release Announcements (NPRA).

15.3 Contact Us

Corporate Headquarters

Address:

Banner Engineering Corporate
9714 Tenth Avenue North
Minneapolis, Minnesota 55441, USA

Phone: +1 763 544 3164**Website:** www.bannerengineering.com

Europe

Address:

Banner Engineering EMEA
Park Lane, Culliganlaan 2F, bus 3
1831 Diegem, Belgium

Phone: +32 (0)2 456 0780**Website:** www.bannerengineering.com**Email:** mail@bannerengineering.com

Turkey

Address:

Banner Engineering Elk. San. Ve Tic. Ltd. Şti.
Şerifali Mah. Münevver Sok. Ekomed Plaza No:10 Kat:4
Ümraniye / İstanbul, Türkiye

Phone: +90 216 688 8282**Website:** www.bannerengineering.com**Email:** turkey@bannerengineering.com.tr

India

Address:

Banner Engineering India Pune Head Quarters
Office No. 1001, 10th Floor Sai Capital, Opp. ICC Senapati Bapat Road
Pune 411016, India

Phone: +91 (0) 206 640 5624**Website:** www.bannerengineering.com**Email:** salesindia@bannerengineering.com

Mexico

Address:

Banner Engineering de Mexico Monterrey Head Office
Edificio VAO Av. David Alfaro Siqueiros No.103 Col. Valle Oriente C.P.66269
San Pedro Garza Garcia, Nuevo Leon, Mexico

Phone: +52 81 8363 2714 or 01 800 BANNERE (toll free)**Website:** www.bannerengineering.com**Email:** mexico@bannerengineering.com

Brazil

Address:

Banner do Brasil
Rua Barão de Teffé nº 1000, sala 54
Campos Elíseos, Jundiaí - SP, CEP.: 13208-761, Brasil

Phone: +55 11 2709 9880**Website:** www.bannerengineering.com**Email:** brasil@bannerengineering.com

China

Address:

Banner Engineering Shanghai Rep Office
Xinlian Scientific Research Building Level 12, Building 2
1535 Hongmei Road, Shanghai 200233, China

Phone: +86 212 422 6888**Website:** www.bannerengineering.com**Email:** sensors@bannerengineering.com.cn

Japan

Address:

Banner Engineering Japan
Cent-Urban Building 305 3-23-15 Nishi-Nakajima Yodogawa-Ku
Osaka 532-0011, Japan

Phone: +81 (0)6 6309 0411

Website: www.bannerengineering.com

Email: mail@bannerengineering.co.jp

Taiwan

Address:

Banner Engineering Taiwan
8F-2, No. 308 Section 1, Neihs Road
Taipei 114, Taiwan

Phone: +886 (0)2 8751 9966

Website: www.bannerengineering.com

Email: info@bannerengineering.com.tw

15.4 Warnings

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

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

15.5 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.

Index

A

authentication 84, 85

C

cell modem

activate 3G GSM 66

activate Verizon 4G LTE 66

configure DXM 67

install 65

purchase 65

create

holiday event 84

one-time event 83

weekly event 83

D

DXM

configure for cell 67

H

holiday event 84

O

one-time event 83

S

scheduler 83, 84

W

webserver authentication 84, 85

weekly event 83