

Sure Cross® DXM Configuration Software v4

Instruction Manual

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209933

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1 Introduction to Simple Setup Mode

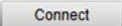
Version 4.8.4 of the DXM Configuration Software introduced a new Simple Setup mode, which is intended to quickly configure networks to push data to the cloud. At this time, Simple Setup mode is supported by DXM700, DXM1000, and DXM1200 models with Performance networks. Selecting Simple Setup mode with any other DXM model connected will prompt the user to connect a supported model.



Configuration Mode: Simple Setup (for Performance n)

Please connect to a DXM to use Simple Setup Mode.

Connect to DXM using: ☒ Serial ☐ TCP/IP

Comm Port: COM3  

Not Connected



Important: Throughout this section, the term "sensors" is used. Please note that Simple Setup mode only works with Banner 1-wire serial sensors used with 1-wire serial Nodes and with Q45 All-in-One Sensor Nodes.

Models Compatible with Simple Setup Mode	Description
DX80N9X1S-P6	DX80 Performance P6 Node, 1-Wire Serial, 900 MHz
DX80N2X1S-P6	DX80 Performance P6 Node, 1-Wire Serial, 2.4 GHz
DX80N9Q45VTP	Wireless Q45VTP 1-Wire Serial Node for Vibration and Temperature Sensors, 900 MHz
DX80N2Q45VTP	Wireless Q45VTP 1-Wire Serial Node for Vibration and Temperature Sensors, 2.4 GHz
DX80N9Q45U	Wireless Q45U Universal 1-Wire Serial Node, 900 MHz
DX80N2Q45U	Wireless Q45U Universal 1-Wire Serial Node, 2.4 GHz
QM42VT1	Vibration and Temperature Sensor; 1-Wire Serial Interface
M12FT4Q	Temperature and Relative Humidity Sensor, 1-Wire Serial Interface
M12FT4Q	Temperature Sensor, 1-Wire Serial Interface
K50UX1CRA	K50 Ultrasonic Sensor with 1-Wire Serial Interface
DX80N9Q45VA	Wireless Q45VA Vibration All-in-One Sensor Node, 900 MHz
DX80N2Q45VA	Wireless Q45VA Vibration All-in-One Sensor Node, 2.4 GHz
DX80N9Q45THA	Wireless Q45THA Temperature and Relative Humidity All-in-One Sensor Node, 900 MHz
DX80N9Q45UAA	Wireless Q45UAA Ultrasonic All-in-One Sensor Node, 1 m Range, 900 MHz
DX80N2Q45UAA	Wireless Q45UAA Ultrasonic All-in-One Sensor Node, 1 m Range, 2.4 GHz
DX80N9Q45UAC	Wireless Q45UAA Ultrasonic All-in-One Sensor Node, 3 m Range, 900 MHz
DX80N2Q45UAC	Wireless Q45UAA Ultrasonic All-in-One Sensor Node, 3 m Range, 2.4 GHz
DX80N9Q45PS50G	Wireless Q45PS All-in-One Pressure Sensor Node, 0-50 psi, 900 MHz

Models Compatible with Simple Setup Mode	Description
DX80N9Q45PS150G	Wireless Q45PS All-in-One Pressure Sensor Node, 0-150 psi, 900 MHz

1.1 Configure for Simple Setup Mode

1. Launch the DXM Configuration Software v4 on your computer.
2. From the **Configuration Mode** drop-down list, select **Simple Setup**.
3. Apply power to your DXM and connect it to your computer.
If you are connecting using USB, connect your DXM to your computer using a USB cable.
The software automatically detects which DXM model is connected.
4. Select your connection: **Serial** or **TCP/IP**.
5. If you selected **Serial**:

The screenshot shows a dialog box titled "Connect to DXM using:". There are two radio buttons: "Serial" (which is selected) and "TCP/IP". Below the radio buttons, there is a label "Comm Port" followed by a dropdown menu showing "COM3" and a "Refresh" button (a circular arrow icon). To the right of the dropdown and refresh button is a "Connect" button.

- a) From the **Comm Port** drop-down list, select your communications port. If the correct port does not appear in the list, click the **Refresh** button.
 - b) Click **Connect**.
- If the connection attempt fails, select a different communications port from the list and try again.
6. If you selected **TCP/IP**:

The screenshot shows a dialog box titled "Connect to DXM using:". There are two radio buttons: "Serial" and "TCP/IP" (which is selected). Below the radio buttons, there is a label "IP Address" followed by a text input field containing "0.0.0.0". To the right of the input field is a checkbox labeled "VPN" which is unchecked. To the right of the checkbox is a "Connect" button.

- a) Verify the DXM is connected to your local network using an Ethernet cable.
 - b) Enter the DXM's IP Address in the **IP Address** field. To find the DXM's IP Address, navigate to the System Info option on the DXM's LCD. Press **Enter**. Navigate to the Ethernet option and press **Enter**. The IP entry should show a valid IP address. If this field reads 0.0.0.0, check the Ethernet cable connection and cycle the DXM's power.
 - c) Click **Connect**.
- After a successful connection, the software automatically advances to the **Load Configuration** screen
7. Select the method by which you'd like to configure your DXM.
Only configuration files created using **Simple Setup Mode** can be used for this step.
 - To start with an existing configuration file saved on your computer, click **Select File to Open** and select your file.
 - To start with the configuration already on the DXM, click **Get Configuration from DXM**.
 - To create a new configuration, click **Next**.

The software screen moves to the **Add Sensors** screen.

1.2 Add Sensors

Add sensors to your wireless network. The DXM reads the sensors data and pushes the data to the DXM's LCD and to the cloud.

Before beginning, verify the sensors in your network are powered up and have been bound to the DXM (see the DXM Wireless Controller Instruction Manual).

1. Go to the **Add Sensors** screen.
2. Select the sensor discovery method from the **Scan for:** drop-down list.
 - All Sensors—Clears the list of discovered sensors, fetches information from all sensors connected to the DXM, and adds these sensors the Discovered Sensors list.
 - Single sensors by Node—To discover a single sensor, select the desired Node ID from the drop-down list. Click **Add Sensor at ID #**. If a sensor is found at the specified Node ID, the sensor is added without clearing the Discovered Sensors list.

Scan for sensors that are bound to the DXM.
After sending this configuration to the DXM, discovered sensors will be read into the DXM's memory, and, if applicable, pushed to a Cloud Services site.

Find Sensors in DX80 Network

Scan for: Node 5

Add Sensor at ID 5

Options for Sensor ID: 1

Include on the DXM's display: ☒

Log to SD card: ☐

Discovered Sensors	
Sensor ID: 1 Temperature / Humidity Sensor	Serial Number: 106610 Part Number: 85309
Have DXM ignore this sensor: <input type="checkbox"/>	
Sensor ID: 3 Vibration / Temperature Sensor	Serial Number: 293133 Part Number: 183149
Have DXM ignore this sensor: <input type="checkbox"/>	
Sensor ID: 5 Ultrasonic Sensor	Serial Number: 246182 Part Number: 193858
Have DXM ignore this sensor: <input type="checkbox"/>	

Each entry in the Discovered Sensors table displays basic sensor information, including ID, sensor type, and part number. Click on a sensor to open that sensor's Options tab to the left of the table. Available options are:

- Include on the DXM's Display—When selected, the sensor data displays in the Registers menu option on the DXM's LCD.
- Log to SD card—When selected, the sensor data is saved to a logfile on the DXM's SD card.

By default, all discovered sensors obey the choices in their Options tab and will have their data pushed to the cloud (see next section). If you would like the DXM to completely ignore a sensor without removing it from the wireless network, select **Have DXM ignore this sensor** for that sensor.

This side panel is used for Alarm rules that allow users to define a **Warn** value and an **Error** value for each data point being sent by the selected sensor. When the value of that data point meets the defined **Warn** or **Error** condition, the DXM pushes sensor data to the cloud if cloud behavior is configured. These pushes occur independently of any regularly-scheduled pushes.

For example, a Temperature-Humidity sensor with Sensor ID 1 might have an **Alarm** rule defined to **Warn** when its Temperature Degrees F is greater than 75 °F. The first time that sensor's Temperature Degrees F data point passes 75 °F, the DXM pushes all its sensor data to the cloud. The next time that data point drops below 75 °F, the **Alarm** rule resets and will trigger a new push the next time the **Warn** condition is met.

1.3 Define the Cloud Services

To push data to the Banner Cloud Data Services (bannerrcds.com) website or another cloud services provider, fill out the settings on the **Cloud Services** screen. If you don't want the DXM to push data to the cloud at all, click **Next**.

1. Enter the DXM Gateway ID.

The ID uniquely identifies your DXM when it pushes data to the cloud. If you are using Banner Cloud Data Services, this value is provided to you when you set up a Gateway on bannercds.com.

2. From the **Connect to internet using** drop-down list, select the connection method (Ethernet or Cell).
3. From the **Push to cloud every:** drop-down list, select the push frequency.
4. Enter the **Custom service name/IP (optional):** field if you're pushing to a third-party cloud service provider.
5. Select either **DHCP** or **Static IP** from the drop-down list.

By default, DHCP automatically assigns an IP address to the DXM. If you'd like to assign a specific IP address to the DXM, select **Static IP** and fill out the address fields.

1.4 Send the Configuration to the DXM

Use the **Send to DXM** screen to configure the DXM.

To apply your configuration to the DXM, click **Send Configuration to DXM**. The DXM may take up to a minute to reboot after it's been configured. After the clock in the top-right of the DXM's LCD begins operating again, the DXM is configured and ready for use.

To save this configuration to your computer for later use, click **Save Configuration File** and navigate to the desired location in the save dialog. The configuration will be saved as an XML file.

1.5 Read the Sensor Data

After the DXM has been configured and successfully rebooted, use the **Read Data** screen to verify the DXM is behaving as expected. Click **Read Sensor Data** to retrieve sensor data from the DXM.

If a sensor shows 0 for its values after reading sensor data, it's possible that the DXM has not yet retrieved data from that sensor. Try again in a few minutes and all sensors should display valid data.

Finished reading sensor data!

Sensor Data on DXM		
Sensor ID: 1 Temperature / Humidity Sensor	Name	Value
	Humidity	2268
	Temperature Degrees C	-0.05
	Temperature Degrees F	-0.05
Sensor ID: 3 Vibration / Temperature Sensor	Name	Value
	Z RMS Velocity inches	0.0048
	Z RMS Velocity mm	0.01
	Internal Degrees F	72.75
	Internal Degrees C	22.65
	X RMS Velocity inches	0.0065
Sensor ID: 5 Ultrasonic Sensor	Name	Value
	Ultrasonic Distance mm	65535
	Temperature Degrees C	23.55
	Temperature Degrees F	74.35
	Ultrasonic Distance inches	655.35

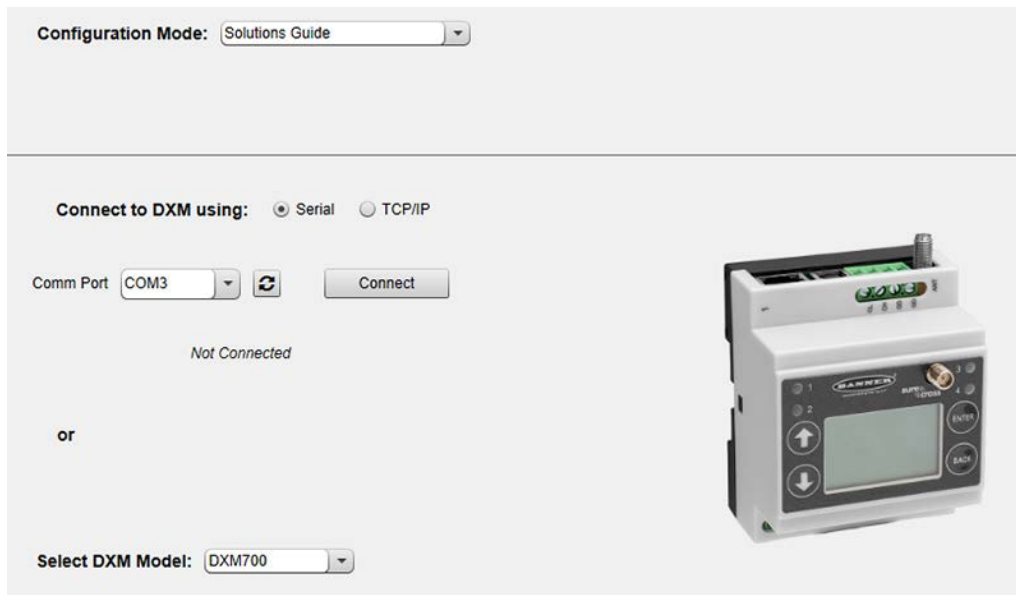
1.6 Simple Setup Summary

The **Summary** screen summarizes the configuration changes made to your XML file.

Advanced users may use this screen to understand the underlying configuration in the style of **Traditional Setup Mode**.

2 Introduction to Solutions Guide Setup Mode

Version 4.9.3 of the DXM Configuration Software introduces a new Solutions Guide setup mode, which allows users to quickly customize the application-specific Solutions Guides available on the Banner Engineering website. A subset of the Solutions Guides available for DXM700, DXM1000, DXM1200, DXM1500, and DXM-R90x devices are currently supported.



Throughout the configuration instructions, you may click **Next** to move to the next configuration screen or click **Previous** to return to the previous screen.

2.1 Configure for Solutions Guide Mode

Solutions Guide mode can be used to configure a connected DXM Controller (online configuration) or to generate a configuration file without connecting a DXM Controller (offline configuration).

1. Launch the DXM Configuration Software v4 on your computer.
2. From the **Configuration Mode** drop-down list, select **Solutions Guide**.
3. To perform an online configuration:
 - a) Apply power to your DXM.
 - b) Select your connection type: **Serial** or **TCP/IP**.
 - c) If you selected **Serial**, connect your DXM to your computer using a USB cable. From the **Comm Port** drop-down list, select your communications port. If the correct port does not appear in the list, click the **Refresh** button.
 - d) If you selected **TCP/IP**, verify the DXM is connected to your local network using an Ethernet cable. Enter the DXM's IP Address in the **IP Address** field. To find the DXM's IP Address, navigate to the **System Info** menu on the DXM's LCD and press **Enter**. Navigate to the **Ethernet** option and press **Enter**. The IP entry should show a valid IP address. If this field reads 0.0.0.0, check the Ethernet cable connection and cycle the DXM's power.
 - e) Click **Connect**.

On a successful connection, the **Select DXM Model** drop-down list's selection displays the connected DXM model. The software advances to the next screen.
4. To perform offline configuration:
 - a) Use the **DXM Model** drop-down list to select the model you'd like to create a configuration file.
 - b) Click **Next**.

2.2 Select the Solution Guide

Use the **Select Guide** screen to choose which type of Solutions Guide you'd like to customize.

The following Solutions Guides are currently supported.

- Vibration v2
 - Temperature/Relative Humidity °C
 - Temperature/Relative Humidity °F
 - Pressure v1
1. To start with a default Solutions Guide configuration:
 - a) Select the desired guide type from the **Solutions Guide Type** drop-down list.
 - b) Click **Next**.
 2. To start with an existing configuration file:
 - a) Click **Select File to Open**.
 - b) Navigate to the desired file. If the selected configuration file can successfully be loaded in Solutions Guide mode, the software will advance to the next screen. If the selected file is not compatible with Solutions Guide mode, an error message displays.

2.3 Select the Sensors

Select which sensors from the Solutions Guide to use.

The DXM reads data from connected sensors and pushes that data to the [BannerCDS](#) website or a third-party cloud services provider.

The list of **Available Sensors** shows the **Sensor Name** and the **Push to Cloud** parameters for each sensor defined by the selected Solutions Guide.

1. To rename a sensor, enter the desired name in the **Sensor Name** field.

This is the name used to tag all associated data when it is pushed to the cloud.

2. By default, only the first sensor is set to push data to the cloud. To configure a sensor to push data to the cloud, select **Push to Cloud**.
 - Select **Add All to Cloud Push** to select **Push to Cloud** for all the sensors.
 - Select **Remove All from Cloud Push** to deselect for all sensors.
3. By default, vibration sensors will push raw current measurements to the cloud alongside their other data. If a vibration sensor is set to push to the cloud but its current is not relevant for your application, you can reduce data use by deselecting **Include Measured Current**.
 - Select **Add All Current Measurements** to select **Include Measured Current** for all the sensors.
 - Select **Remove All Current Measurements** to deselect for all sensors.
4. If you are performing the online configuration, you can bind Nodes to the connected DXM's network from within the software instead of from the DXM's menu system. To bind a Node from within the software:
 - a) Click **Bind Node** next to the listed sensor in the **Available Sensors** list.
 - b) A popup window prompts you to enter binding mode on the Node before proceeding. How your specific Sensor Node or Node enters binding mode varies depending on the Node type.

After binding completes, this Node's data is with the chosen sensor when its data is pushed to the cloud.
5. After you have finished modifying the sensor settings, click **Next**.

2.4 Configure the Cloud Services

Use the **Cloud Services** screen to define what data is pushed to the cloud data services provider. If you don't want the DXM to push data to the cloud at all, click **Next** to move on to the next screen.

The screenshot shows the 'Cloud Services' configuration screen. At the top, there's a 'DXM Gateway ID is:' label with a dropdown menu set to 'GUID' and a text box containing '00000000-0000-0000-0000-000000000000'. Below this is 'Custom server name / IP (optional):' with a text box 'push.bannercds.com'. Next is 'Page / Topic (optional):' with a text box '/push.aspx'. Then 'Connect to internet using:' with a dropdown menu set to 'Ethernet'. At the bottom, there's a 'Static IP' dropdown menu. Below it are three rows: 'IP address:' with '192.168.10.1' (currently 0.0.0.0), 'Subnet:' with '255.255.255.0' (currently 0.0.0.0), and 'Gateway address:' with '0.0.0.0' (currently 0.0.0.0).

1. Enter the **DXM Gateway ID**.
The ID uniquely identifies your DXM when it pushes data to the cloud. If you are using the Banner Cloud Data Services (www.bannercds.com), this value was provided to you when you set up a DXM on the BannerCDS website.
2. From the **Connect to Internet using** drop-down list, select the DXM's connection method (Ethernet or Cell).
3. Update the **Custom service name / IP (optional)** field if you are pushing data to a third-party cloud service provider.
4. Update the **Page / Topic (optional)** target page if you are pushing data to a third-party cloud service or topic if you're pushing to the AWS IoT service.
5. Select either **DHCP** or **Static IP** from the drop-down list.
 - Select **DHCP** to automatically assign an IP address to the DXM.
 - Select **Static IP** and fill out the address fields to assign a specific IP address to the DXM.

2.5 Send the Configuration to the DXM

Use the **Send to DXM** screen to configure the DXM.

To apply your configuration to the DXM, click **Send Configuration to DXM**. The DXM may take up to a minute to reboot after it's been configured. After the clock in the top-right of the DXM's LCD begins operating again, the DXM is configured and ready for use.

To save this configuration to your computer for later use, click **Save Configuration File** and navigate to the desired location in the save dialog. The configuration will be saved as an XML file.

3 Introduction to Traditional Setup Mode

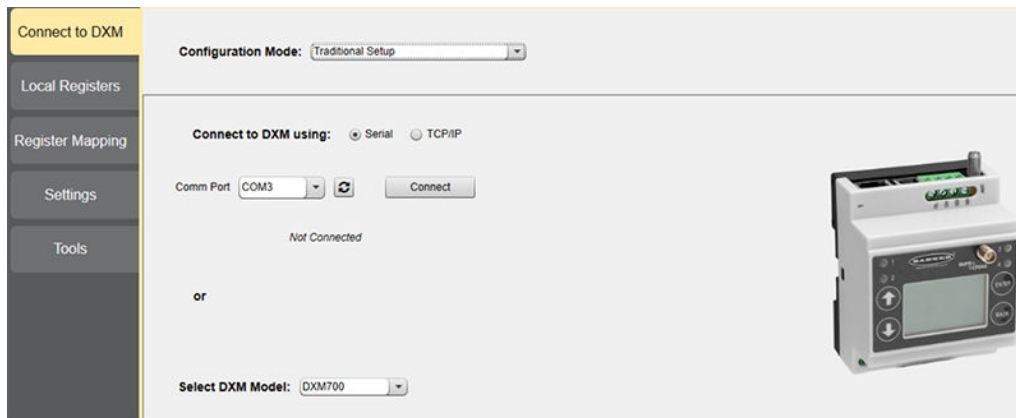
This section will walk you through the traditional method of setting up the DXM Configuration Software and communicating with a connected DXM device. Version 4 of the configuration software supports multiple DXM device models, each of which incorporates different features.

As of DXM Configuration Software v4.10.28, the Simple Setup procedure is only available with the [DXM700](#), [DXM1000](#), [DXM1200](#), and [DXM1500](#) models.

As soon as a DXM model is connected to your computer, the software automatically detects the correct model and loads the appropriate screens. You may also manually select which model of DXM you are configuring if you intend to create a configuration file without connecting a device. This ensures that the interface and the configuration file use the correct features.

Not all screens are available for all models. To change to another model of DXM, go to the **Connect to DXM** screen and use the drop-down list to select another model. If the active configuration is incompatible with the selected model, you will be prompted to either proceed and wipe out the active configuration or cancel the model change and preserve the configuration.

Figure 1. Traditional Setup opening screen



Connect via USB or Ethernet. If connecting via Ethernet, set network parameters through the DXM LCD menu in the **System Cfg > Ethernet** menu. Network parameters can also be set within the configuration software. Setting parameters on the LCD menu overrides the parameters stored in the configuration file. To use the network parameters in the configuration file, reset the network parameters on the DXM LCD menu.

Since the DXM-R90x connects only via TCP, its **Connect to DXM** screen differs from the other DXM models. When the **Select DXM Model** drop-down is set to DXM-R90x, a new network discovery table is displayed. Click **Scan Network for DXMs** to detect DXM devices on the host computer's network. Discovered DXMs are listed in the network discovery table. Double-click any row entry to connect to that DXM. If the DXM's IP address is already known, the standard TCP connection option is available below the network discovery table.

Banner recommends disconnecting the COMM port through the **Device** menu before turning off power or disconnecting the USB cable. Use **Device > Reboot** to restart the DXM if needed; the tool automatically disconnects the COMM port, then reconnect it again.



Tip: If connection attempts are failing (Application Status Icon in the footer of the tool is Red), close the configuration software and disconnect the USB cable from the computer. Reconnect the cable, launch the software, and attempt connecting again.

If you cannot connect to your DXM Controller, refer to [Troubleshooting](#) on p. 82 for more information.



Important: Any model of DXM may connect to the configuration software regardless of which device model is selected in the tool. Compatibility is checked before configuration files are uploaded to the device.

3.1 DXM Configuration Software

Configure the DXM using the DXM Configuration Software. The configuration software can be used stand-alone or connected to the controller using USB or Ethernet. The tool creates an XML file defined for the DXM and can be used at the website level for configuration.

The configuration software restricts the naming of registers and rules to characters a-z, A-Z, 0-9, # \$ _ () space. A register name cannot end in a space. If an unacceptable name has been entered, a red ! displays.

Use the configuration software either while connected to a DXM or as a standalone configuration software.

The top-level menus are similar to other Windows programs: **File**, **Traffic**, **DXM**, and **Help**.

- Use the **File** menu to manage the loading and saving of the XML configuration file created by the DXM Configuration Software.
- Use the **Traffic** menu to view data traffic on the serial bus or via UDP.
- Use the **DXM** menu to send and retrieve XML configuration files to or from a connected DXM.
- A new **Help** menu has also been added, which launches a copy of the DXM Configuration Software instruction manual in the user's default PDF viewer.

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

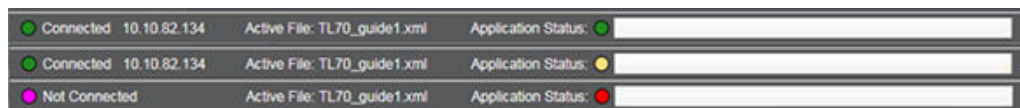
3.2 Save and Upload the Configuration File

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

Changes to the XML file are not automatically saved. Save your configuration file before exiting the tool and before sending the XML file to the device to avoid losing data. If you select **DXM > Send XML Configuration to DXM** before saving the configuration file, the software will prompt you to choose between saving the file or continuing without saving the file.

1. Save the XML configuration file to your hard drive by going to the **File > Save As** menu.
2. Go to the **DXM > Send XML Configuration to DXM** menu.

Figure 2. Status indicator bar



- If the Application Status indicator is red, close and restart the DXM Configuration Tool, unplug and re-plug in the USB or Ethernet cable and reconnect the DXM to the software.
- If the Application Status indicator is green, the file upload is complete.
- If the Application Status indicator is yellow, the file transfer is in progress.

The device reboots and begins running the new configuration.

3.3 Configuration File Cross Compatibility

Version 4 of the configuration software supports multiple DXM device models, each of which supports different features. As such, not all XML configuration files are cross-compatible.

For example, because the DXM700 supports a larger range of local registers than does the DXM100 or DXM150, the file in question may use registers that would be invalid for the DXM100 and DXM150 models. If this is the case, the configuration file is not converted and a warning message displayed.

Version 4.1.7 adds support for the DXM100-A1[¶] model. Version 4.8.4 adds support for the DXM1000 and DXM1200 models. Version 4.10.27 adds support for the DXM1500 and DXM-R90x1 models.

DXM100-A1 configuration files are always convertible into DXM100, DXM150, DXM700, DXM1000, DXM1200, and DXM1500 files. However, depending on which features are configured, the reverse is not always true. The following features are available to standard DXM100 models but are not supported by the DXM100-A1:

- Ethernet connectivity—Typically displayed on the **Settings > Ethernet** and **Settings > Cloud Services** screens
- Modbus TCP and CAN (**Register Mapping** screen)
- Slave Port Settings (**Settings > System** screen)
- ScriptBasic Network Options and ScriptBasic RS-232 Settings (**Settings > Scripting** screen)

After selecting a DXM device model on application start-up, you can load any configuration file created for that device model or for any other model. Validation is performed to ensure that an incompatible file cannot be loaded into the tool or written to a connected device. Changing the device model selection on the Model Select screen converts the active configuration if it passes cross-compatibility validation.



Important: Loading a cross-compatible file and saving it overwrites that file's original device model setting, reformatting it for the currently-selected device model.

[¶] Model DXM100-A1 was previous named DXM100-AG1 and may appear as -AG1 in some software and documentation. The -AG1 model is the same as the -A1 model.

3.4 Software Screens

The following sections explain the function of each screen.

3.4.1 Local Registers

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

Since a Modbus register is only 16-bits, all transactions with Modbus devices use the lower 2-bytes (16-bits) of the Local Registers.

The Local Register characteristics are defined on the **Local Registers** screen of the DXM Configuration Software.

Description of Local Registers	Local Registers	
	DXM100, DXM100-A1, and DXM150	DXM700, DXM1000, DXM1200, DXM1500, DXM-R90x1
32-bit unsigned integer-based registers	1–845	1–845 and 5001–7000
Special function registers that can be reset registers	846–850	846–850
Non-volatile registers with limited write capability for permanent data storage. Refer to the DXM Instruction Manual for more information	851–900	851–900 and 7001–8000
32-bit IEEE 754 floating point registers. Floating point values require two Local Registers to store a value. Floating point Local Registers are referenced on the odd numbered register addresses, 1001, 1003, 1005. When using Action Rules/ Read Rules always reference the odd numbered register addresses.	1001–1900	1001–5000

Local Register Parameters

The following parameters may appear on multiple register configuration screens.

Select the register to define.

Register Overview

Name

Set a name for the register. This parameter is only used for the display on the DXM LCD and for the BannerCDS cloud services website. As soon as you name a register, the register appears in the **Local Registers in Use** list.

Register group

Register Groups can be used to easily sort related registers on the Local Registers In Use table. Enter a tag to create a register group.

Units

Select the units information for the Local Register data. This parameter field is only used for display on the DXM LCD and for the Banner Cloud Data Services cloud services website. Select the Custom field to create user defined units.

Value Options

Value type

Defines the behavior of the register's value. Use the drop-down list of select:

None—Register has a value of 0 by default and can be modified by any source that has permission to set register values.

Constant—Forces the local register to be set to the specified value. Use to compare values when using action rules. Constant values cannot be overwritten by any source that would normally have permissions to modify register values.

Counter—The value increments with the specified frequency (every 100 ms or every 1 second). Write to the Local Register to start the timer at a specific value.

Scaling

The scaling parameter changes the viewing of Local Register data. Scaling is performed in two steps: applying a scale (one of five functions: add, subtract, multiple, divide, or modulo (remainder in division)), then adding an offset value. The step order can be changed to add offset first and then apply the scale by selecting the "Apply offset before scale value" checkbox.

Sign type

Supported for integer register ranges only. Set to unchanged, default, or set (Unsigned, Signed 32-bit, or Signed 16-bit).

Select **Unsigned** data format to show Local Register data as a positive integer.

Select **Signed 32-bit** format to treat the data as a two's complement value, displaying value as positive or negative.

Select **Signed 16-bit** format for specialized applications, such as ensuring compatibility with certain Banner Engineering Solutions Guides.

Storage/HTTP Connectivity

LCD permissions

Defines whether the Local Register contents will display on the DXM's Registers menu. Use the drop-down list to select from the following options:

None—The Local Register will not display on the DXM.

Read—The Local Register will display on the DXM.

Read/Write—The DXM can read and write the Local Register value from the LCD.

SD card logging

Defines the onboard micro SD card storage of this local register. Up to three different log files can be stored on the micro SD card, each with different logging definitions. Select from the following options:

None—No logging selected

Log 1—Save this Local Register data to the Data Log 1.

Log 2—Save this Local Register data to the Data Log 2.

Log 3—Save this Local Register data to the Data Log 3.

Cloud settings

Defines the register's interaction with the Banner Cloud Data Services website (<https://bannercds.com>). Use the drop-down list to select from:

None—The web server cannot access this register.

Read—The web server can read the value of this register.

Write—The web server can write a new value to this register.

Read/Write—The web server can both read and write the value of this register.

Push at Boot Time—Push register value to the web server whenever the DXM boots up.

Push at UTC 00:00—Push register value to the web server at midnight UTC.

Protocol conversion

Defines this Local Register as either an input or output for EtherNet/IP™. (Modbus TCP has access to all Local Registers and does not need to be defined.)

None—This register is not exposed to the host PLC over EtherNet/IP.

EIP Originator > DXM—For EtherNet/IP, data from the host PLC is written to the DXM Local Register.

EIP DXM > Originator—For EtherNet/IP, data from the DXM Local Register is sent to the host PLC.

AWS IoT Core

Push to AWS IoT Core

Denotes whether the register will be included in AWS publishes (see **Settings > AWS IoT Core** for the configuration).

AWS IoT Core push group

This register will be published along with any other registers that share the same AWS push group.

Define push groups on the AWS IoT Core settings screen. Push groups can each have unique destinations and publish rates.

Apply Scale/Offset for AWS IoT Core

Indicates whether calculations defined in the Scaling parameter (if any) should be applied when publishing this register's value to AWS IoT Core. Values are uploaded as integers; floating point values are truncated to the integer during the upload process.

AWS IoT Core is only supported for DXM700, DXM1000, and DXM1200 models. The four related parameters (Apply Scale/Offset, push group, Publish when value changes, and Push to AWS IoT Core) are only visible when one of these models is selected.

To modify AWS parameters for multiple registers at once, use the **Batch AWS IoT Core Configuration** screen. This screen is visible only when a supported DXM model is selected.

Publish when value changes

If checked, this register will be published whenever its value changes in addition to normally-scheduled AWS IoT Core publishes.

Local Registers in Use

Use the **Local Registers in Use** screen to view a list of defined registers or to make changes to registers and show where the register is used in the defined configuration.

Figure 3. Local Registers in Use screen

ID	Register Name	Register Group	Units	Signed	Constant or Timer	Cloud Permissions	LCD Permissions	Protocol Conversion	Log Files	Cyclic Push	Read Rules	Write Rules	Threshold Rules
1	Humidity 1		RH	No		Read/Write	Read/Write	None	None	None	Modbus RTU None		New threshold rule
2	Humidity 2		RH	No		Read/Write	Read/Write	None	None	None	Modbus RTU None		
3	None		None	No		Read/Write	Read/Write	None	None	None	Modbus RTU None		
4	Humidity 1 Copy 1		RH	No		Read/Write	Read/Write	None	None	None	Modbus RTU None		
5	Humidity 1 Copy 2		RH	No		Read/Write	Read/Write	None	None	None	Modbus RTU None		
6	None		None	No		Read/Write	Read/Write	None	None	None	Modbus RTU None		
7	None		None	No		Read/Write	Read/Write	None	None	None			
8	Temp 1		None	No		Read/Write	Read/Write	None	None	None			

The lower section of this screen shows the Register Panel, a one-stop tool for configuring local register behavior. This panel includes the **Edit Register**, **Modify Multiple Registers**, and **Batch AWS IoT Core Configuration** tabs.

The **Edit Register** tab presents all parameters for a single register. See [Edit Registers Using the Local Registers in Use Screen](#) on p. 49.

The **Modify Multiple Registers** tab allows contiguous groups of registers to be modified in a single operation. See [Modify Multiple Registers](#) on p. 50.

Use the **Batch AWS IoT Core Configuration** tab to configure your AWS IoT Core functions for contiguous groups of registers.

The Register Panel appears automatically any time a local register-related tab is selected. Click and drag the gray bar along the panel's top margin to resize it. The Register Panel is set to its maximum height by default.

To quickly modify a register seen on the **Local Registers in Use** table, click on any cell in the register's row. That register will be loaded into the **Register Panel**, and the table will be automatically updated as you make changes.

Action Rules

Action rules allow for simple logic functions and simple manipulation of local register data. The processing of an action rule is autonomous from other local register functions.

- Threshold rules create event-driven conditions, such as events to the cloud, local logs, or an email address
- Register Copy rules copy the contents of one register to another
- Math/Logic rules deal with 32-bit register logic with results from 0 to 4,294,967,295
- Control Logic rules are binary rules, with the results being either 0 or 1
- Trending rules find average, minimum, and maximum values
- Tracker rules monitor a Local Register value and store the result of a function in another register

Read rules are executed first, beginning with the first rule defined. The read rules execute in the order they were entered into the DXM Configuration Software. After all read rules execute, the write rules are processed, in order. After the write rules are processed, the system begins again with the read rules.

Processing the read/write rules takes a long time to complete, not because they take a lot of processing power, but because each rule has a lengthy overall communication time relative to the processor execution cycle time. So, in parallel, action rules are solved. Each action rule is processed in order, similar to the read/write rules. The groups of action rules are solved in this specific order:

1. Calculate (Math), continually processed
2. Copy rules, processed only when a change of state is detected on the source register
3. Threshold rules, continually processed
4. Control Logic, continually processed
5. Trending, continually processed
6. Trackers, continually processed



Important: Define all action rules to use integer-based Local Registers or floating point Local Registers. Do not mix the two Local Register types within an Action Rule. To move integer-based Local Registers 1–850 to floating point Local Registers, use the Register Copy rules.

All Action Rules screens have up/down arrows near the top of the screen that scroll through the rules. All Action Rules also have **Clone Selected Rule** or **Delete Selected Rule** buttons to quickly copy/paste or delete the selected rule.

Threshold Rules

A **Threshold Rule** triggers event messages sent to the cloud (event-driven push), triggers events to be stored to the local event log and creates a standard push message to the cloud with all defined registers being sent.

A Threshold rule creates a simple IF-THEN-ELSE comparison for a register to determine its value and set another register to indicate if the rule is true or false (you must select a true option to also set a false option). The definition section of the threshold rule sets the comparison and values. The definitions of the threshold rules can further be defined by the optional parameters, Hysteresis, On Time, E-mail/SMS and Logging options.

If selected, the false option (else condition) is applied. This creates an IF-THEN-ELSE structure. To remove the ELSE condition un-check the false option or set the result register to itself.



Important: Read Rules can scale incoming Modbus register values to make Threshold rules easier to understand. If Read Rule scaling is not used, the values stored in Local Registers are the raw Modbus values from the slave device. Display scaling and offset are not applied for these comparisons.

The Threshold rule is written as a sentence. Select the Local Register, operator, and value from the drop-down lists. Then define the value of the Local Register when the statement is true and not true.

Value/Register—When Value is selected, provide a fixed number in the following entry box. When Register is selected, provide a Local Register address in the following entry box. The contents of the Local Register will be used in the Threshold rule. When Same as Source is selected (else statement), the contents of the Local Register defined in the If comparison is used as the result.

Hysteresis—Optional parameter that is enabled only when values are non-zero. How hysteresis is applied depends on the comparison. For a test that becomes true 'if greater than,' the test will not return to false until the Local Register is less than the test value by a margin of at least this hysteresis value. If a test becomes true 'if less than,' it will not return to false until

the Local Register is greater than the test value by a margin of at least this hysteresis value. Minimum On Time and Minimum Off Time are time-based parameters that govern how long a statement must be true or false to activate the output register.

On Time—Stores in a Local Register how long (in minutes) the Threshold rule has been true. The On Time value is shown in the Local Register in minutes but maintains the internal counter in seconds. This results in the accuracy of seconds, not rounding of the value stored in the Local Register.

Logging Options—Threshold rules create events. These events can cause certain actions to occur, such as:

- Save threshold events to cloud—An immediate push with the threshold register states is sent to the webserver when this rule becomes active.
- Save threshold events to event log—Go to **Settings > Logging** to set up the event log.
- Push when active—Pushes the data to the cloud when the threshold rule becomes active. All local registers with the Cloud Reporting parameter ON will push to the cloud. (**Local Registers > Local Register Configuration**)
- After trigger, set source to 0—After a Push is sent as a result of the Threshold rule, the source Local Register is set to zero to indicate the Push data packet was sent.

E-Mail/SMS—When a Threshold rule becomes active or inactive, the controller can send an E-Mail or SMS message. Select which recipient should be notified when this rule is changes state. SMS messages can only be sent when cellular is selected as the network interface. (**Settings > Cloud Services**). Note that email or SMS message recipients can only be selected if they have already been defined on the **Settings > Notifications** screen.

Register Copy Rules

Use the **Register Copy** screen to copy a local register into another local register or range of registers.



Important: To move integer-based Local Registers 1–850 to floating point Local Registers, use the **Register Copy** rules. **Register Copy** automatically converts the integer value to a floating point value.



Important: Creating multiple copy rules using the same starting register will not be consistent. Instead create a daisy-chaining of registers. For example, copy register 1 to register 2, then copy register 2 to register 5, then copy register 5 to register 10.

Name	Copy Register	To Register	Through Register	Affecting the following registers
Analog IN	1 Humidity 1	4	5	Humidity 1 Copy 1 Humidity 1 Copy 2

Add Copy Rule—Click to create a new copy rule.

Name—Name your rule.

Copy Register—The starting register of the data source range of registers.

To Register—The starting register of the data target range of registers

Through Register—The ending register of the data target range of registers.

Math and Logic Rules

Math/Logic rules deal with 32-bit register logic with results from 0 to 4,294,967,295. In contrast, **Control Logic** rules are binary rules, with the results being either 0 or 1.

Name	Operation	Local Register	And/Through	Local Register	Affecting the following registers	Store the result to	Local Register
New math rule	Average	8	Through	11	Temp 1 Temp 2 Temp 3 Temp 4	12	Average Temp

Some operations are valid for ranges of registers. Select **And** or **Thru** to select two registers or multiple registers in a range. **Average**, **Sum**, and **Logic Operations** are valid for ranges of multiple registers. The Local Registers are unsigned 32-bit integers. All math and logic functions can operate on all 32-bits. The Local Register operations are:

- **Add**—Adds two local registers and stores the result in a Local Register.
- **Average**—Averages the values of multiple registers and stores the result.
- **Divide**—Divides local register 1 by local register 2 and stores the result. Dividing by zero results in a zero.

- **Logic NOT**—Performs a bit-wise one's complement on a Local Register and stores the result.
- **Logic OR, AND, NOR, NAND, XOR**—Performs bit-wise logic function on multiple registers and stores the result. Bit-wise logic functions operate on all 32-bits of the Local Registers. To perform logic function on a simple 0 or 1 in registers, use the Control Logic rules.
- **Multiply**—Multiplies one local register by another and stores the result.
- **Sum**—Adds multiple contiguous local registers and stores the result in a Local Register.
- **Subtract**—Subtracts Local Register 2 from Local Register 1 and stores the result. For negative numbers, the results are in two's complement form.

Control Logic Rules

Control Logic rules are binary rules, with the results being either 0 or 1. In contrast, the Math Logic rules deal with 32-bit register logic with results from 0 to 4,294,967,295.

Some Control Logic rules create memory elements using the DXM Local Registers as inputs and outputs. A value of zero in a Local Register is defined as 0 in the Control Logic rule, a non-zero value in a Local Register is defined as a 1 value. Control Logic rules are evaluated when an input value changes state. Memory elements include S/R Flip/Flop, D Flip/Flop, T Flip/Flop and J-K Flip/Flop

Control logic also works for floating point registers and virtual registers. In the case of floating point values, anything over 0.5 is considered logical 1.

Control Logic			
Function	In 1	In 2	Q out
AND	0	0	0
	1	0	0
	0	1	0
	1	1	1
OR	0	0	0
	1	0	1
	0	1	1
	1	1	1
XOR	0	0	0
	1	0	1
	0	1	1
	1	1	0

Control Logic			
Function	In 1	In 2	Q out
NOT	0	-	1
	1	-	0
NAND	0	0	1
	1	0	1
	0	1	1
	1	1	0
NOR	0	0	1
	1	0	0
	0	1	0
	1	1	0



Note: * Output Qn is an inverted output from the Q output and represents optional inputs or outputs. Leave the optional inputs or outputs connected to 0 when not used.

J-K Flip-Flop

If J and K are different, the output Q takes the value of J. The **Enable**, **Clock**, and **Qn** connections are not required for operation.

J-K Flip-Flop					
*Enable	J	K	* Clock	Q	Qn *
0	X	X	X	No change	No change
1	X	X	0 or 1 or ↓	No change	No change
1	0	0	↑	No change	No change
1	1	0	↑	1	0
1	0	1	↑	0	1

J-K Flip-Flop					
*Enable	J	K	* Clock	Q	Qn *
1	1	1	↑	No change	No change

If an input is zero it is false (0), and if a value is non-zero (anything but zero) it is considered true (1). All but one requires two inputs; the NOT rule only has one input. Some of the Control Logic rules provide basic non-memory logic functions: AND, OR, XOR, NOT, NAND and NOR. These basic logic functions are based on zero and non-zero values and result in a 0 or 1.

Optionally, the rules can have a **Clock** input and an **Enable** input. The **Clock** input determines the time (0-1 rising edge) the rule is evaluated. The **Enable** input enables or disables the logic function.

- AND—Output is high (1) only if both inputs are non-zero
- OR—Output is high (1) if either input is non-zero
- XOR—Output is high (1) if either, but not both, inputs are non-zero
- NOT—Input is inverted to the output
- NAND—Output is low (0) if both inputs are high (> 0)
- NOR—Output is high (1) if both inputs are zero (0)

Set-Reset (S/R) Flip-Flop

The Set/Reset Flip-Flop, or S/R Latch, is the most basic memory device. The S input sets the output to 1, and the R input sets the output to 0. Selecting **Insert input** turns the inputs to low active, so a 0 on the S input set the Q output to 1. The truth table below is defined without the invert flag.

Set/Reset (S/R) Flip-Flop			
S	R	Q	Qn *
1	0	1	0
0	0	No change	No change
0	1	0	1
1	1	Invalid ²	

Delay (D) Flip-Flop

The Delay (D) Flip-Flop takes the D input to the outputs at the next rising edge of the clock. All other states of clock have no effect on the outputs. The **Enable** input is optional. A **Clock** input and a **D** input changing at the same time results in an undetermined state.

Invert Inputs—Typically a input value of "1" will be evaluated as true (active), selecting "Invert inputs" will result in a "0" value to be considered true(active).

FlipFlop is R dominated—xxx

Table references:

- X = doesn't matter what the value is.
- <up arrow>, <down arrow> = signify a rising or falling edge of the clock input.
- * = optional input or output

Delay (D) Flip-Flop				
*Enable	D	Clock	Q	Qn *
0	X	X	No change	No change
1	X	0 or 1 or ↓	No change	No change
1	0	↑	0	1
1	1	↑	1	0

Toggle (T) Flip-Flop

The Toggle (T) Flip-Flop toggles the state of the output if the input is 1. The **Enable** input is optional. A **Clock** input and a **T** input changing at the same time results in an undetermined state.

² The Set input and Reset input active at the same time is an illegal condition and should not be used.

Toggle (T) Flip-Flop				
*Enable	T	Clock	Q	Qn *
0	X	X	No change	No change
1	X	0 or 1 or ↓	No change	No change
1	0	↑	0	1
1	1	↑	(toggle)	(toggle)

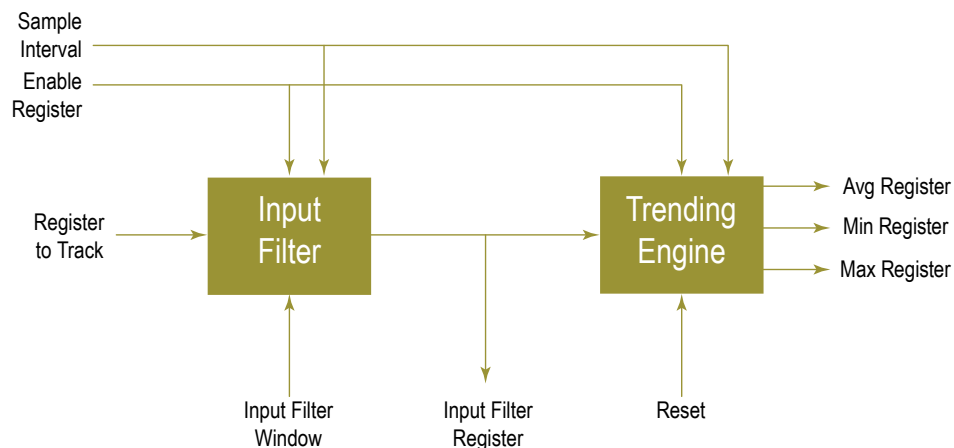
Trending and Filtering Rules

Use **Trending** rules to find the average, minimum, and maximum values for a specific register at a user-specified time interval. The Trend function collects data when the device boots up and accumulates the average, minimum, and maximum values for a register.

Local Registers locations to define include: Register to Track, Filter Register, Average Value Register, Minimum Value Register, Maximum Value Register, and Enable Register. When not using the Local Register definitions, leave them set to zero.



The filter and tracking is applied according to this flowchart.



The Trending rule has an optional filter input, and the filter output is the input to the Trending operation. The filter result is used before applying the Trending rule when you define the **Filter** parameter. The other Trending parameters are listed. The Average, Minimum, and Maximum register fields are optional and can be left set to zero when using the Filter output register.

Register to Track—Local Register to provide the input to the filter and Trending rule.

Sample Interval—Defines the time interval of the samples to collect from the Local Register.

Filter—Defines the specific filter algorithm to apply to the front-end of the Trending rule.

Cumulative Average—Sums the samples and divides by the number of samples.

Exponential Moving Average—A moving average filter that applies weighting factors that decrease exponentially. The weighting for each older sample decreases exponentially, never reaching zero.

Lulu Smoother—Takes the minimum and maximum values of mini sequences of sample points. The mini sequence length is defined by the filter window parameter.

Median Average—Takes a least three sample points, sorts the sample points numerically, and selects the middle value as the result. A new sample point into the filter removes the oldest sample point.

Recursive Filter —Created from a percentage of the current sample plus a percentage of past samples. The number of samples is determined by the **Filter Window** parameter.

Simple Moving Average—Takes the number of samples defined by the **Filter Window** parameter and averages the samples for the result. When a new sample is taken, it becomes the latest sample point, and the oldest sample point is taken out of the filter averaging.

Weighted Moving Average—A moving average filter that applies a weighting factor to the data based on when the data was captured. More recent data has a higher weighted factor.

Filter Window—Defines the number of samples for a filter algorithm. For example, if the sample interval is 5 minutes and the Filter Window is 100, this will create a 100 point moving average over a 500 minute time period.

Filter Register—The Local Register that stores the output of the first stage filter. This is not required to connect the filter front-end to the Trending rule processing.

Average Value Register—The Local Register number to store the average value of the Trending rule. The average is calculated from the beginning of power-up or from the Reset Trending time. (Hourly, Daily) Defining this Local Register is optional and can be left at zero.

Minimum Value Register—The Local Register number to store the Minimum value of the Trending rule. The Minimum is captured from the beginning of power-up or from the Reset Trending time. (Hourly, Daily) Defining this Local Register is optional and can be left at zero.

Maximum Value Register—The Local Register number to store the Maximum value of the Trending rule. The Maximum is captured from the beginning of power-up or from the Reset Trending time. (Hourly, Daily) Defining this Local Register is optional and can be left at zero.

Reset Trend Data—Use to reset the Trend data accumulation. (Hourly, Daily, or not at all)

Enable Register—The Enable Register is an optional register and can be left set to zero. The Enable Register defines the address of a Local Register that can be used to turn on and off the trending function. Set the value of the Local Register defined to a 1 to turn on trending; set the value to zero to turn off trending. When disabled, the current data is held until the rule is enabled again.

Tracker Rules

Tracker rules monitor a Local Register and store the result of a function in another Local Register.

The possible functions are:

- Count the number of register transitions from 0 to non-zero value (rising edge). The speed at which it can count depends on how much work the DXM is performing. Typical tracker rates should be around 1 to 2 times per second.
- Track time in milliseconds the Local Register is in the non-zero state
- Track time in milliseconds the Local Register is in the zero state

Name	Register to Track	Transition to Track	Result Register
New tracker	1 Humidity 1	Rising edge	2 Humidity 2

3.4.2 Register Mapping

Use the **Register Mapping** screens to configure read rules and write rules for Modbus RTU, Modbus TCP, and CAN/J1939.

Read and write rules allow the user to program the ability to read or write information from internal or external Modbus slaves to/from the local registers. On the DXM, use the read/write rules to access the Modbus registers of the LCD display, I/O base board, and the internal ISM radio.

The **Register Mapping** screens handle all direct register mapping. DXM Configuration Software allows the user to create Write/Read rules that in turn create Modbus messages to external devices. How the user enters rules affects how a Modbus message is formed. If the user creates three individual read or write rules, those rules create three individual Modbus messages that will be sent out the RS-485 master port. If the user creates one read or write rule that spans multiple registers, the result is one Modbus message.

Click on the arrow of the read or write rules to show all the parameters for that rule.

RTU

Use the **Register Mapping > RTU** screen to define **RTU Read** and **RTU Write** rules. The **Read Rules** or **Write Rules** interact with the Local Registers to exchange data with external Modbus devices.

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

When DXM-R90x is the selected DXM model, an additional **RTU Configuration** screen is displayed before **RTU Read** and **RTU Write**. This screen allows each of the DXM-R90x's five UART buses to be configured separately with distinct baud, parity, timeout, and message delay settings.

Define an RTU Read Rule

Follow these steps to create a new read rule.

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 4. Read Rules - Configuration Example

1. From the **Register Mapping > RTU > RTU Read** screen, click **Add Read Rule**.
2. Click the arrow next to the name to display the parameters.
3. Name your rule.
4. Select the slave ID.
5. Select how many registers to read, and the beginning register.
6. Define the register type, how often to read the register, and any other appropriate parameters.
7. If necessary, select the error condition. For this example, if the read function fails after three attempts, the read rule writes 12345 to the DXM local registers. Notice the list of local register names this read rule is using.

Read Rules

Each read rule defines a Modbus slave ID and register range to read and then store in the Local Registers. The Local Register names shown are the registers that are being used by the read rule.

When DXM-R90x is the selected DXM model, each RTU rule created on the **RTU Read** and **RTU Write** screens contains a **Port** drop-down field that specifies which of the DXM-R90x's five UART buses the rule should use.



Important: Setting Read Rules or Write Rules to fast rates may cause other processes, ScriptBasic, LCD display, USB port accesses or API calls to be delayed or rejected.

The user defines parameters that can be applied to each read rule.

Remote Type—Select the register type from the drop-down list.

Read Holding register—16-bit register access, Modbus function 3; all Banner wireless devices use Holding Registers

Read Coil—Single bit access, Modbus function 1

Input Register—16-bit register access to read holding registers, Modbus function 4

Read Discrete Input—Single bit access, Modbus function 2

Frequency—Defines the cyclical rate at which the register is read. The maximum cyclic poll rate is controlled by the maximum polling rate set in the **Settings > General** screen, the **Modbus Master Communications** section. Changing that value causes the tool to adjust all polling rates. For example, setting the maximum rate to 1 second causes the tool to adjust all rules with a frequency of less than 1 second up to 1 second.

Offset and Scaling—Scale and Offset are applied to the Modbus data before writing to the Local Registers. The Scale value is multiplied followed by adding of the offset value. Dividing can be accomplished by using scale values less than 1. Subtracting the offset value can be accomplished by using a negative offset value. The result is held in the Local Register.

Apply Offset before Scale Value—The execution order for scaling values is changed to first add the offset value then multiply scale value. The result is held in the Local Register.

Error Conditions—Applies a default value to the Local Register after a user-defined number of Modbus register read fails.

Floating Point - Swap Words—A floating point value is a 32-bit value requiring two consecutive Modbus register reads or writes. The DXM expects the most significant part of the floating point value to be first (lowest address) followed by the least significant part. If a Modbus slave device sends the least significant part first, select **Swap Words** to align the words correctly.

On Register—The On Register is the address of a Local Register used to enable the Read rule. If the On Register is zero, it is not used. If the On Register is specified, the data value of the Local Register controls the executions of the Read rule. When the value of the Local Register is zero, the Read Rule is idle. When the value of the Local Register is non-zero, it will continuously execute the Read Rule as fast as it can. This speed is governed the number of Read/Write rules defined and by the Modbus Master Communications parameter Maximum Polling Rate (default 50 ms). This parameter is located on the **Settings > General** screen. The Frequency interval is not followed when using the **On Register** feature.

Slave IDs

DXM ISM Gateway radio: 1

DXM I/O Board: 200

DXM LCD: 201

MultiHop Remote Slave radios: 11 through 60

Write Rules

The write rules write Local Register data to the defined Modbus slave ID and registers. The Local Register names shown are the registers used by the write rule.



Important: Setting Read Rules or Write Rules to fast rates may cause other processes, ScriptBasic, LCD display, USB port accesses or API calls to be delayed or rejected.

The user-defined parameters that can be applied to each Write rule are:

Remote Type—Defines the type of Modbus functions to use

Write Holding register, Modbus function 16; all Banner wireless devices use Holding Registers

Write Multiple Coil, Modbus function 15

Write Single Holding register, Modbus function 6

Frequency—Defines how often to write the Local Register to the Modbus slave device in one of two ways:

Cyclical—Causes a Modbus write based on a timing interval, as fast as possible or a specified time interval.

On Change of Local Register Data—Allows the user to specify a certain criteria when to write to a Modbus slave device. For example, if the Local Register changes by a user-specified amount, the write occurs. If the user wants to write the Local Register to the Modbus slave at a minimum interval, use the **write AT LEAST** time setting. Use the **write AT MOST** time interval to minimize the write cycles for Local Registers that change frequently.

The maximum cyclic poll rate is controlled by the maximum polling rate set in the **Settings > General** screen, the **Modbus Master Communications** section. Changing that value causes the tool to adjust all polling rates. For example, setting the maximum rate to 1 second causes the tool to adjust all rules with a frequency of less than 1 second up to 1 second.

Offset and Scaling—Scale and Offset are applied to the Local Register data as it is being sent in the Modbus write command. Local Register data is not changed in the process. The Scale value is multiplied followed by adding of the offset value. Dividing can be accomplished by using scale values less than 1. Subtracting the offset value can be accomplished by using a negative offset value. The result is held in the Local Register. **Apply Offset before Scale Value**—The execution order for scaling values is changed to first add the offset value then multiply scale value. The result is held in the Local Register.

Floating Point - Swap Words—A floating point value is a 32-bit value requiring two consecutive Modbus register reads or writes. The DXM expects the most significant part of the floating point value to be first (lowest address) followed by the least significant part. If a Modbus slave device sends the least significant part first, select **Swap Words** to align the words correctly.

Modbus TCP and Configuration

Use the **Register Mapping > Modbus TCP** screen to define Ethernet communication rules for the DXM to access remote register data from Modbus TCP servers. First define devices under the **TCP Configuration** tab, then define the Read/Write rules for the devices.

At the top of the window is an **Enable Modbus TCP** check box. Select this box to globally enable Modbus over TCP. The Start up delay defines the amount of time between the DXM power on and the execution of the Modbus TCP Read/Write rules.

The **Modbus TCP** screen defines

To use Modbus TCP, follow these steps:

1. Select **Enable Modbus TCP**.
2. Enable a **Socket** connection.
3. Configure the settings (IP Address, Port, Poll rate, and Time out).
4. Create and enable a rule.
5. Link the rule to an enabled Socket.

Modbus/TCP Parameters

The Modbus TCP interface parameters are:

Enable Modbus TCP

Globally enables or disables Modbus TCP

Start up Delay

Defines the time delay between boot up and the execution of the rules

Modbus TCP Timeout

Denotes the amount of time to wait before closing an inactive TCP connection

Ethernet Socket Parameters

The individual Ethernet socket parameters are:

Enable

Must be selected to open the socket connection to the Modbus TCP server

IP Address

Defines the IP address of the Modbus TCP server. The format is xxx.xxx.xxx.xxx

Port

Defines the port to be used for the Modbus TPC protocol. The default is 502.

Poll Rate

Defined how often to execute the write and read rules defined for this socket connection

Time out

How long the processor waits for an acknowledgement from the Modbus server before going on to the next rule

If Modbus TCP is disabled, this section is not copied into the final XML configuration file. If the Modbus TCP rules do not point to an enabled device, the rules are not written into the final XML configuration file.

CAN / J1939

CAN/J1939 is a wired communications protocol standard maintained by the Society of Automotive Engineers (SAE). Commonly used in off-road and heavy equipment, J1939 is a higher level protocol that is built upon the Controller Area Network (CAN) physical layer developed and originally published by Robert Bosch GmbH in 1991.

All J1939 messages are sent using the 29 bit message identifier, also known as the extended frame format, described in CAN 2.0B.

Typical J1939 data frames consist of the 29 bit identifier, 8 byte payload, a 15 bit CRC, and 20 additional bits used as flags, delimiters, or simply reserved for future use. Therefore a typical CAN packet is approximately $29 + 8 \times 8 + 15 + 20 = 128$ bits long. At the standard rate of 250 kbits/sec, a J1939 packet is a little over 500 μ s long. Actual duration may vary because the protocol defines that "bit stuffing" shall occur any time there are 5 bits in a row of identical polarity.

There is no centralized network coordination function in a J1939 network. Every node (known as an Electronic Control Unit, or EC) in a J1939 network "claims" a unique address for itself during network commissioning (after power-up). All ECs on the bus can be producers, consumers, or both producers and consumers of data. When an EC has data that it wants to write to the bus, it begins transmitting while simultaneously monitoring the channel for collisions. Collisions can be detected immediately because each bit is sent using a dominant/recessive scheme and any EC that sees a dominant bit on the channel when it transmitted recessive bit will know to immediately cease the transmission. This is known as non-destructive bus arbitration.

Note that a minimum of two nodes must be used to initialize communication on a CAN bus. Since a transmitted message must be acknowledged in the ACK bit by a receiver, the transmitting controller sends out an error flag if the message is not properly ACKed.

Messages in J1939 are organized by a field in the 29-bit header known as the Parameter Group Number or PGN. The PGN may be thought of as an index into a large data table. The J1939 standard defines what the data means in every such table entry, but also leaves many PGNs to be defined in a proprietary manner.

For example, the PGN 65262 is defined to contain Engine Temperature. Within the 8 bytes sent with this PGN, the J1939 specification also defines that byte 1 is for Engine Coolant Temperature, byte 2 contains Engine Fuel Temperature 1, bytes 3-4 encode Engine Oil Temperature 1, bytes 5-6 encode Engine Turbocharger Oil Temperature, byte 7 represents Engine Intercooler Temperature, and byte 8 is for Engine Intercooler Thermostat Opening.

Theory of Operation

The Banner DXM functions as a protocol converter between its internal local register space and J1939 PGNs.

Users must configure the DXM to select the J1939 PGNs to be monitored, which is known as creating a J1939 Read Rule. Similarly, the DXM can be configured to transmit messages if desired, which is known as creating a J1939 Write Rule. Read Rule and Write Rules map out the link between local registers and PGNs.

Data contained in DXM local registers may be accessed using the scripting engine in the DXM.

At startup, the DXM attempts to claim a unique J1939 address on the CAN bus it is connected to. It does so by sending its desired address to the PGN 0xEE00 and waiting for a reply. The DXM broadcasts the contents of its NAME field, which is specified in the DXM Configuration Software using the J1939 Name fields. All sub-fields are currently user selectable except the Manufacturer ID.

The DXM allows two separate methods for specifying the address to claim on a J1939 network. Either one may be used; the choice of the method can be determined by whichever one is more convenient. In the first method, a list of acceptable addresses is specified. The DXM attempts to claim the first (leftmost) address, and if denied, will proceed to the next and the next. In the second method, a range of acceptable addresses is specified and the DXM attempts to claim the lowest, then increment that choice by 1 until it is able to claim one or reaches the end of the list.

No further J1939 functions (transmitting or receiving) begin until the DXM claims its address. In the DXM Configuration Software, go to the **Register Mapping > J1939** screen and click **Read device J1939 address and name** to view the current DXM device address. If it returns -1, it was unsuccessful in claiming an address.

After the DXM has claimed an address, it passively listens to all J1939 traffic. Any messages that contain PGNs for which there is a matching read rule are decoded and the data is copied into the desired local registers. Any PGNs in the J1939 Write Rules area are transmitted onto the bus at the interval chosen. Each time a J1939 message is about to be transmitted, the DXM populates the J1939 data fields with the contents of the specified local registers, then writes the message onto the bus.

The acceptance criteria for J1939 Read Rules are:

1. The CAN protocol version must pass. This should always be the case in a J1939 network, but may have to be revisited if this device is used for other CAN bus applications.
2. The 16 bits that make up the arriving PGN are examined. Specifically the PGN is considered to be the concatenation of the 8 bit PDU Format and the 8 bit PDU specific fields.
 - a. If the PGN $\geq 0xF000$, then the message destination is global and the PGN is left unaltered as it is handed to the next layer of the internal stack. The implication of this is that read rules for PGNs in this range should have the PGN in the rule set to exactly what the device documentation says.
 - b. If the PGN $< 0xF000$, then it is a peer-to-peer message and the PGN is considered to be the 8-bit PDU format bits followed by 8 bits of 0. Put another way, PGN = (PGN & 0xFF00), where & represents a bitwise logical AND operation.
 - a. Read rules for PGNs in this range should have the PGN in the rule set to mask off the lower 8 bits to zero.
 - b. In this case, the lower 8 bits (PDU specific bits) are the destination address. Destination address = PGN & 0x00FF.
 - c. If the address claimed by the DXM does not match the message's intended destination address, the message is discarded. To prevent messages from being discarded this way, select **Accept peer to peer messages sent to any address** in the DXM Configuration Software.

Start Up Guide for the DXM

Verify your DXM is powered up and connected to a computer that has the DXM Configuration Software installed.

The screenshot shows the 'J1939 Configuration' window with the 'J1939 Rules' tab selected. The 'J1939 Name' section contains a table with columns: Arbitrary address capable, Industry group, Vehicle system instance, Vehicle system, Function, Function instance, ECU instance, and Identity number. The 'J1939 Address and Comms' section has radio buttons for 'Addresses to acquire' and 'Find an address in the range'. Below these are fields for 'Start address' and 'End address', a 'BIP' percentage field, and a checkbox for 'Accept peer to Peer messages sent to any address'. A 'Read device J1939 address and name' button is present, along with 'Current J1939 address' and 'DXM J1939 name' fields. The 'J1939 Statistics' section at the bottom has two columns of statistics, each with a 'Get' button and a 'Clear' button.

J1939 Name							
Arbitrary address capable	Industry group	Vehicle system instance	Vehicle system	Function	Function instance	ECU instance	Identity number
<input checked="" type="checkbox"/>	0	0	0	0	0	0	0

J1939 Address and Comms

☐ Addresses to acquire

☒ Find an address in the range: Start address 0 End address 0

BIP 25 % ☐ Accept peer to Peer messages sent to any address

Read device J1939 address and name

Current J1939 address -1

DXM J1939 name 0000000000000000

J1939 Statistics

Get traffic and filtering totals		Get name and address claim totals	
Number of transmits	0	Name claims	0
Read rules satisfied	0	Address claims	0
Messages passed through stack	0	Address fails	0
Messages passed through CAN peripheral	0	Address overrides	0

1. On the DXM: Make the wired connection to the bus. Using the labels on the housing decal, CH (pin 16) is for CANH and CL (pin 15) is for CANL.
2. On your computer: Launch the DXM Configuration Software and navigate to the **Register Mapping > J1939** screen.

3. Configure the **J1939 Name** for the DXM.

All sub-fields of the NAME area are user-configurable except the Manufacturer Code, which is permanently set to 758 (decimal) as granted to Banner Engineering by SAE.

4. Specify the preferred addresses for the DXM to claim using one of two methods:

- Create an explicit list of addresses in the **ID1** through **ID8** fields. The DXM attempts to claim the address under **ID1** first. If that address is already taken, it attempts to claim the address under **ID2** and continues until it claims an address.
- List the **Start address** and the **End address**. The DXM attempts to claim the **Start address** first and increment sequentially until it successfully claims or reaches the **End address**.

5. **BIP** may be left at 25%. This field is the "babbling idiot protection" and establishes is the maximum fraction of the J1939 channel bandwidth that the internal stack allows the DXM to consume with data transmissions. It is a safeguard to protect the user from specifying too many or too frequent J1939 transmissions that could cause bus collisions and performance issues.

6. Select **Accept Peer to Peer messages sent to any Address** to allow the DXM to listen in on peer-to-peer messages that aren't directed to its own bus address.

Even though most messages on the J1939 bus are sent to a broadcast address, some peer-to-peer messaging is possible.

Create a J1939 Read Rule

Create a J1939 read rule to configure the J1939 to monitor for desired Parameter Group Numbers (PGNs) and capture their data.

These instruction assume the DXM is powered up and connected to a computer running the DXM Configuration Software.

Name	Source Address	Local register	PGN	Local register byte width
None	0	1	GPS Integer Reg0000	Two, 2

1. From the **Register Mapping > J1939** screen, click **Add J1939 Read**.

2. Enter a name for the rule.

This name does not affect the actual behavior of the system.

3. Enter a **Source Address**.

- If the bus address of the EC sending the PGN is known, enter that address as the **Source Address**.
- To accept messages from any source, enter the wildcard value of 255 as the **Source Address**.

Every J1939 message includes a **Source Address**, which is the bus address of the device that sent the message. The DXM filters incoming messages based on this address.

4. Enter a **Local Register**.

The **Local Register** is the base address in local register memory space that the data should be sent to. When creating multiple read rules, choose to base addresses spaced so that the same local register does not get written to by multiple read rules.

5. Enter a **PGN**.

This is the parameter group number (PGN) of the J1939 message that this rule captures.

- If PGN ≥ 0xF000 (61440), the PGN is a broadcast rule. The message arrives and passes through the stack as long as the PGN matches the read rule.
- If PGN < 0xF000 (61440), it is a peer-to-peer message. To be received, the lower 8 bits of the PGN must match the bus address claimed by the DXM. (This check can be overridden by selecting **Accept peer to peer messages sent to any address**.) Because the lower 8 bits of the PGN (also known as the PDU Specific) are used as an address, the PGN in the read rule should have its lower 8 bits zeroed out to make the matching work.

6. Enter the **Local register byte width**.

Local registers are 32 bits, so it is possible to pack 1, 2, or 4 bytes of J1939 data into each local register. For J1939 messages with 8 bytes of data (the majority), packing means the data consumes 8, 4, or 2 local registers respectively depending on the choice.

Create a J1939 Write Rule

Create a J1939 write rule to transmit local register data in a J1939 message at a periodic interval.

These instructions assume the DXM is powered up and connected to a computer running the DXM Configuration Software.

Name	Address	Local register	PGN	Local register byte width	Time between sends
None	0	1	GPS Integer Reg0000	Two, 2	55 ms

1. From the **Register Mapping > J1939** screen, click **Add J1939 Write**.
2. Enter a **Name** for the rule.
This name does not affect the actual behavior of the system.
3. Enter a destination **Address** for the message.
The broadcast address is 255.
4. Enter the **Local register**.
The **Local register** is the data source's base address in local register memory space.
5. Enter the **PGN**.
Only PGNs in the range 0xFF00 (65280) to 0xFFFF (65535) are able to be specified by the manufacturer. Use caution when assigning data to PGNs outside of this range, because the data must adhere to the formatting specified by the Society of Automotive Engineers or risk being misinterpreted by other ECs on the bus.
6. Enter the **Local register byte width**.
Local registers are 32 bits wide, so it is possible to retrieve 1, 2, or 4 bytes of J1939 data from each local register. Because most J1939 messages have 8 bytes of data, the data is sourced from 8, 4, or 2 local registers, respectively, depending on the choice.

Example: Receive a PGN Using Broadcast Communication

A manufacturer's datasheet for an EC states it transmits its information on PGN 0xFF01 (65281).

Because this PGN is in the range 0xFF00–0xFFFF (65280–65535), the data is manufacturer-specific and not constrained by a definition controlled by the SAE.

1. On the **Register Mapping > J1939** screen, click **Add J1939 Read** to create a new read rule.
2. Enter a **Name**, for example, `Proprietary_msg1`.
3. Enter the **Source address** (the sender's bus address) or enter 255 to accept data from any address on the bus.
4. Enter the **Local register** (the base address for the data).
5. Enter a **PGN** of 65281.
6. Enter the **Local register byte width** (1, 2, or 4), which stores the bytes per local 32-bit register.

The following example J1939 message shows the relation between byte order on the bus and in the local register space:

	Byte1	Byte2	Byte3	Byte4	Byte5	Byte6	Byte7	Byte8
J1939 Data	0x01	0x23	0x45	0x67	0x89	0xAB	0xCD	0xEF
Reg. Address	Base	Base +1	Base +2	Base +3	Base +4	Base +5	Base +6	Base +7
1 byte/reg	0xEF	0xCD	0xAB	0x89	0x67	0x45	0x23	0x01
2 bytes/reg	0xEFCD	0xAB89	0x6745	0x2301	(n/a)	(n/a)	(n/a)	(n/a)
4 bytes/reg	0xEFCDAB89	0x67452301	(n/a)	(n/a)	(n/a)	(n/a)	(n/a)	(n/a)

Example: Receive a PGN Sent Using Peer-to-Peer Communication

A manufacturer's datasheet for a sensor says it transmits its information on PGN 0xCBF4 (52212).

Because this PGN is in the range 0x0000–0xEF00, (0–61184) this is meant to be a peer-to-peer message. The lower 8 bits of the PGN contain the destination address.

1. On the **Register Mapping > J1939** screen, click **Add J1939 Read** to create a new read rule.
2. Enter a **Name**, for example, `p2p_msg2`.

3. Enter the **Source address** (the sender's bus address) or enter 255 to accept data from any address on the bus.
4. Enter the **Local register** (the base address for the data).
5. Enter a **PGN** of 51968 or 0xCB00. Note that the lower 8 bits have been masked.
6. Enter the **Local register byte width** (1, 2, or 4) bytes per local register.
7. Enter the Address claim. As a peer-to-peer message, this PGN is intended for the device at address 0xF4 (244) only. There are two ways to allow the DXM to read this message:
 - Have the DXM claim address 0xF4 (244) on the bus; or
 - Select **Accept peer to peer messages sent to any address**

Example: Monitor Diagnostic Troubleshooting Codes

The J1939 standard specifies a method of transmitting diagnostic trouble codes. Active trouble codes are sent using PGN 65226 or 0xFECA (consult the J1939 documentation for other related PGNs, such as Previously Active Trouble Codes).

1. On the **Register Mapping > J1939** screen, click **Add J1939 Read** to create a new read rule.
2. Enter a **Name**, for example, `active_DTCs`.
3. Enter the **Source address** or 255 to accept data from any address on the bus.
4. Enter the **Local register** (the base address for the data).
5. Enter a **PGN** of 65226 or 0xFECA.
6. Enter the **Local register byte width** (1, 2, or 4) bytes per local register.

Each diagnostic trouble code consumes 8 bytes, but there may be more than one active code from a given EC. Such longer messages are sent using the Transport Protocol feature of J1939, which the DXM supports. It is important that the user reserve enough local register space for the messages in case there are more than the standard 8 bytes.

Example: Transmit a PGN Using Broadcast Communication

To transmit manufacturer-specific data on PGN 65296 or 0xFF10, follow these steps.

1. On the **Register Mapping > J1939** screen, click **Add J1939 Write** to create a new write rule.
2. Enter a **Name**, for example, `tx_msg2`.
3. Enter the **Address** (the destination address for the message, for example 49d=0x31).
4. Enter the **Local Register** (the base address to retrieve the data from).
5. Enter a **PGN** of 61184.
6. Enter the **Local register byte width** (1, 2, or 4) per local register.
7. Enter a **Time between sends** of 1500 ms.

If this message is observed as a standard CAN bus message, the 29-bit arbitration ID appears as follows: 0x1CEF3116.

- The leading 1C is the priority, which has been set to the lowest, or 8.
- EF is the higher 8 bits of the PGN.
- 31 is the destination address.
- 16 is the address that this DXM has claimed on the bus.

Example: Transmit a PGN Using Peer-to-Peer Communication

To transmit manufacturer-specific data on PGN 61184 or 0xEF00, follow these steps.

1. On the **Register Mapping > J1939** screen, click **Add J1939 Write** to create a new write rule.
2. Enter a **Name**, for example, `tx_msg2`.
3. Enter the **Address**.
4. Enter the **Local register** (the base address from which to retrieve the data).
5. Enter a **PGN** of 65296.
6. Enter the **Local register byte width** (1, 2, or 4) per local register.
7. Enter a **Time between sends** of 1500 ms.

Send Diagnostic Commands

The DXM firmware supports some diagnostic commands that can be entered through the DXM Configuration Software.

Use the buttons on the **J1939 Configuration** screen to send the following commands:

- Read device J1939 address and name
- Get traffic and filtering totals
- Clear traffic and filtering totals
- Get name and address claim totals

To manually send these commands, follow these instructions.

1. Go to the **Device > View Serial Activity** menu.
A **Traffic on port COMxx** window opens.
2. In the single-line text box at the bottom of the window, type a command. Click **SEND**.
The resulting serial traffic, including response, will be shown. The successful execution of CMD00xx always results in a response of RSP00xx, followed immediately by one or more parameters (xx indicates the Command Number).

Command (case sensitive, no spaces)	Command Name and Meaning	Sample Response	Fields in Response (after RSP00xx, where xx = confirmation of command number)
CMD0080	Address claimed	RSP008022	Decimal value of Address claimed by the DXM. For this example, 22.
CMD0081	NAME field	RSP00815A5ADA5EFFFFB4D A	ASCII string of the DXM's NAME field in hex. The NAME is eight bytes long, so the field will contain 16 hexadecimal digits.
CMD0082	Traffic and filtering	RSP00820,2,3,4	Totalizing counter. Number of Transmits (0), number of Read Rules satisfied (2), number of messages passed through stack (3), and number of messages passed through CAN peripheral of micro (4)
CMD0083	Statistics	RSP00830,1,2,3	Statistics on name and address claiming: Name, Address, Address fails, overrides
CMD0084	Clear traffic totalizer	RSP00840	Clears the totalizer values (traffic counting) that are accessed by CMD0082

3.4.3 Settings

Use the **Settings** screen to define general parameters, cloud services settings, logging parameters, Script Basic settings, networking and e-mail/SMS messages settings, administration parameters, notes, and I/O board parameters.

In the upper right of the Settings screens is a **Show advanced settings** checkbox. By default, this box is not selected, which hides some of the advanced configuration features. Screens with advanced configuration settings are: **System**, **Cloud Services**, **Ethernet**, and **Scripting**.

System Settings

Use **Settings > System** to define the time zone, Modbus Master serial interface, Modbus Slave serial interface parameters, and to manually enter your GPS coordinates.

Figure 5. System Settings screen

Device Time

Sets the time zone offset and displays the current time on the device or sync time with the PC.

Device Location/GPS

Defines the latitude and longitude for the device. The GPS data can be entered manually for fixed assets or by defining an external GPS unit connected to the master Modbus RS-485 bus. Select **Send Location to Cloud** to report this information to the Web site.

HTTP / Data Logs

Define when and how often to clear the HTTP and data logs.

Master/Slave Port Settings

Defines the Modbus master and slave serial port settings on the device (main RS-485 port).

The default communications settings are 19200 baud with no parity for both the master and slave ports, and 5s timeout with 5ms delay between messages for the master port. When changing the communications settings on the DXM, any devices attached to the bus also need to be changed, including the internal ISM radio.

The ISM radio communication parameters should be changed first using the User Configuration Software for DX80/Performance radios or the MultiHop Configuration Software for MultiHop radios.

Select the **Wireless Backbone** type from the drop-down list.

None—No wireless backbone behavior.

Modbus—Enables Modbus slave port to come through a MultiHop HE5 module plugged into the processor board.

Ethernet—Allows DXM to act as either a master or slave device when a wireless ethernet backbone module is plugged into the processor board. Selecting Ethernet causes two additional parameters to display: IP address and Subnet mask. These parameters apply only to the DXM's wireless Ethernet backbone configuration, not to its hardwired Ethernet connection. While a DXM-R90x is connected and Ethernet wireless backbone mode is selected, select either **Set DXM as Ethernet Master** or **Set DXM as Ethernet Slave** to assign that DXM the respective role within the wireless ethernet backbone network.

Radio Communications

Automatic Radio Polling continually polls the embedded DX80 ISM radio for data changes. Using automatic polling is optimal for data throughput from the radio, but monopolizes the bandwidth on the master RS-485 bus. If other resources are expected to share the master RS-485 bus, it may be better to access radio data using Register Mapping. Using **Automatic Radio Polling** allocates DXM Local Registers 1–768 for the DX80 ISM radio devices (the Gateway and Nodes 1–47)

The processor organizes the data in DXM **Local Registers** based on the user selections defined below.

None

Disables automatic radio polling.

The user must use Register Mapping or ScriptBasic to transfer register data with the ISM radio.

Group by Device - Inputs only

Only input data from the radio is collected and stored in the DXM Local Registers. The data is organized (grouped) by the device.

The first 16 registers (1–16) are the Gateway registers. Node 1 uses Local Registers 17–32, Node 2 uses Local Registers 33–48 and so on.

See the table for more details.

Group by Device - Inputs/Outputs

Input data from the radio is collected and stored in the DXM Local Registers. Local Registers defined as the outputs for devices are automatically written to the ISM radio when the contents change. The data is organized (grouped) by the device.

The first 16 registers (1–16) are the Gateway registers. Node 1 uses Local Registers 17–32, Node 2 uses Local Registers 33–48 and so on.

See the table for more details.

Group by In/Out - Inputs only

Only input data from the radio is collected and stored in the DXM Local Registers. The data is organized (grouped) by each input.

For example, all input 1 data is stored in the first 48 Local Registers (1–48), Gateway, Node 1–47). The next 48 registers (49–96) store input 2 data for all devices.

Local Registers 1–384 store inputs 1–8, Local Registers 385–768 store outputs 1–8.

See the table for more details.

Group by In/Out - Inputs/Outputs

Input data from the radio is collected and stored in the DXM Local Registers. Local Registers defined as the outputs for devices are automatically written to the ISM radio when the contents change. The data is organized (grouped) by each input.

For example, all input 1 data is stored in the first 48 Local Registers (1–48), Gateway, Node 1–47). The next 48 registers (49–96) store input 2 data for all devices.

Local Registers 1–384 store inputs 1–8, Local Registers 385–768 store outputs 1–8.

See the table for more details.

Table 1: DXM Local Registers organized by Device (GW=0, Nodes 1–47) where DXM Local Register address = (Device# × 16) + DevReg#

Device Type	Device Reg		Gateway	Node 1	Node 2	Node 3	Node 4		Node 47
Input 1	1	→	1	17	33	49	65		753
Input 2	2	→	2	18	34	50	66		754
Input 3	3	→	3	19	35	51	67	...	755
Input 4	4	→	4	20	36	52	68		756
Input 5	5	→	5	21	37	53	69		757
Input 6	6	→	6	22	38	54	70		758
Input 7	7	→	7	23	39	55	71		759
Input 8	8	→	8	24	40	56	72		760
Output 1	9	→	9	25	41	57	73		761
Output 2	10	→	10	26	42	58	74		762
Output 3	11	→	11	27	43	59	75	...	763
Output 4	12	→	12	28	44	60	76		764
Output 5	13	→	13	29	45	61	77		765
Output 6	14	→	14	30	46	62	78		766
Output 7	15	→	15	31	47	63	79		767
Output 8	16	→	16	32	48	64	80		768

Table 2: DXM Local Registers organized by Input/Output (GW=0, Nodes 1–47) where DXM Local Register address = ((DevReg# - 1) × 48) + (Device# + 1)

Device Type	Device Reg		Gateway	Node 1	Node 2	Node 3	Node 4		Node 47
Input 1	1	→	1	2	3	4	5		48
Input 2	2	→	49	50	51	52	53		96
Input 3	3	→	97	98	99	100	101	...	144
Input 4	4	→	145	146	147	148	149		192
Input 5	5	→	193	194	195	196	197		240
Input 6	6	→	241	242	243	244	245		288
Input 7	7	→	289	290	291	292	293		336
Input 8	8	→	337	338	339	340	341		384
Output 1	9	→	385	386	387	388	389		432
Output 2	10	→	433	434	435	436	437		480
Output 3	11	→	481	482	483	484	485	...	528
Output 4	12	→	529	530	531	532	533		576
Output 5	13	→	577	578	579	580	581		624
Output 6	14	→	625	626	627	628	629		672

Device Type	Device Reg		Gateway	Node 1	Node 2	Node 3	Node 4		Node 47
Output 7	15	→	673	674	675	676	677		720
Output 8	16	→	721	722	723	724	725		768

Depending on the model being configured, the Radio Communication settings may change.

Timeout

Set the communication timeout in hh:mm:ss.fff.

Delay Between Messages

Set the delay between the messages in hh:mm:ss.fff.

Cloud Services

Use **Cloud Services** to define the parameters to send register data to the website.

For instructions on how to push data to an Amazon Web Services (AWS) endpoint, refer to the technical note *Pushing to an Amazon Web Services (AWS) IoT Endpoint* (p/n [b_5933667](#))

Select **Show advanced settings** if it isn't already selected to view all configuration parameters.

Network Interface

The DXM uses the **Network Interface** settings to establish the push method and whether you are using an Ethernet or Cellular connection.

Select the **Push method**. Selecting **HTTP Cloud Push** or **AWS IoT Core** activates the additional parameter fields necessary to configure those options.

Push method

HTTP Cloud Push—Select to activate the Push interface drop-down list.

AWS IoT Core—Select to activate all the AWS parameters. The **AWS IoT Core** tab becomes visible after the selection is made.

Push interface

Select **Ethernet** or **Cell** from the drop-down list. The **Cellular** tabs become visible after the selection is made. The **Ethernet** tab is always visible as long as a DXM model other than DXM100-A1 is selected.

See [Ethernet Settings](#) on p. 36 and [Cellular](#) on p. 36.

Cloud Push

Apply scale and offset to push data

When selected, the DXM applies scales and offsets to local register values before pushing them to the cloud. Do not select this parameter when pushing data to the BannerCDS website (bannercds.com).

Values are uploaded as integers; floating point values are truncated to the integer during the upload process.

Cloud Push Interval

Defines the time interval for cyclical data pushes sent to a webserver or host system. Setting the **Cloud Push Interval** to zero disables cyclical push messages. When using pushes created by a threshold rule, the **Cloud Push Interval** is ignored. Cloud pushes created from ScriptBasic are independent from these settings.

For example, with a **Cloud Push Interval** set to 1 hour and the sample count set to 10, the DXM saves the register data every 6 minutes and pushes all data to the web server every hour.

Ethernet Retries per push interval

Used when pushing HTTP data to a webserver using Ethernet and defines the number of attempts made to send HTTP data to the web server before it will save the message into a local file to be pushed up at the next push interval. (default 5)

Push packet format

Default—Set to **Default** when pushing to the BannerCDS website (bannercds.com).

JSON—Set to **JSON** when pushing to third-party cloud services such as AWS IoT Core.

Push Port

Defines the HTTP push data port on the web server.

The factory default setting is port 80. Set the port to 443 when you are using HTTPS.

Sample count

Defines how many times between the **Cloud Push Interval** to save data. The sample points are saved, then sent at the next **Cloud Push Interval**.

HTTPS

Selecting **HTTPS** indicates to the DXM to use TLS (Transport Layer Security) as a sub-layer under regular HTTP application layering. HTTPS encrypts and decrypts user data to and from the web server.

The webserver is required to carry a certificate. Select **Use HTTPS** to enable TLS services. Not all servers/communication networks support TLS.

Enter a **Certificate CN**. A Certificate CN is required to be associated with one or more domain names, called common name (CN). A single name Certificate CN is typically www.yoursite.com. A wildcard certificate includes single level sub-domains. The certificate CN is a wildcard certificate; *.bannercds.com. If nothing is entered into this field, the BannerCDS CN will be used; *.bannercds.com.

Web Server

Define all the web server settings in the **Web Server** section of this screen.

Custom HTTP Headers

Users can create up to five **Custom HTTP Headers** to provide custom information to the web server. The custom headers are sent with every push to the web server. **Custom HTTP Headers** are text fields the user can define that will be included in the HTTP header when the data is pushed to the web server.

Gateway ID

From the **Gateway ID** drop-down list, select either **GUID** or **User Defined Text**.

For custom web servers the Site ID string can be changed from a GUID (Global Unique Identifier number) to a user-defined string of numbers or letters. The user-defined text is a unique site string defined by the web server when a site is created. Copy the string from the website into this field.

Host Header

A **Host Header** allows for multiple domains to reside at the same server address. Similar to how many people can share one phone number, dialing one number connects you to the phone but to talk to someone specific you need another piece of information. This is where the **Host Header** field is used. An IP address can get you to a server and the **Host Header** field allows for multiple domains residing at that server.

Not all servers require this field. When left blank, the intended target of the push message is the server name. The BannerCDS website does not require this field.

Page

Enter the **Page** that directs incoming data at the web server (/push.aspx)

Push Options

Include XML GUID in first push—Select to include the configuration file GUID (Global Unique Identifier) in the first initial push to the web server. The web server can then verify that the XML configuration file that is loaded into the DXM is the same as what is loaded into the web server.

Include serial number in pushes—Select to include the serial number in your data pushes.

Include model number in pushes—Select to include the model number in your data pushes.

Include cell connection quality in pushes—Select to include the quality of the cell connection in your data pushes.

Omit push failures in logs—Select to not report push failures in the logs.

Server Name/IP

Webserver address used by the DXM when pushing data to the cloud.

Enter the domain name, `push.bannercds.net`.

The DXM defaults to using a public DNS (domain name server) to resolve domain names. To use a specific DNS, enter the IP address under the **Settings > Network** tab.

Web Server Authentication

Web Server Authentication defines a username and password to be sent to the webserver with every push data set to validate the sending device before storing any data in the database. If the webserver is expecting login credentials, the DXM must be programmed with the username and password. This only provides login credentials for authentication to the server; this does not secure the data payload.

The DXM must be connected to the computer. Select **Require Authentication**, then enter a username and password. Manually cycle power to the DXM after the username and password are written to it. The credentials cannot be read from the DXM.



Important: After **Require Authentication** is selected and the username and password are sent to the DXM to be stored, go to **File > Save** to save the XML configuration file. Then send the new XML configuration file to the DXM. If the configuration file loaded into the DXM does not have **Require Authentication** selected, the username and password will not be sent.

AWS IoT Core

According to Amazon, "AWS IoT Core lets you connect IoT devices to the AWS cloud without the need to provision or manage servers. AWS IoT Core can support billions of devices and trillions of messages, and can process and route those messages to AWS endpoints and to other devices reliably and securely. With AWS IoT Core, your applications can keep track of and communicate with all your devices, all the time, even when they aren't connected." (<https://aws.amazon.com/iot-core/>)

To configure your system for AWS IoT Core:

1. Connect to a DXM700, DXM1000, DXM1200, DXM1500, or DXM-R90x1 model.
2. On the **Settings > Cloud Services** screen, select **AWS IoT Core** from the **Push method** drop-down list.
3. In the **Certificates** section, select and upload a **Certificate File**, a **Private Key File**, and a **Root CA File** to allow DXM700s to push to AWS IoT Core.

Note that these controls upload certificate files to the connected DXM700's microSD card and do not affect the DXM's actual configuration file.

AWS IoT Core

AWS Thing Endpoint—The URL of the host you'll be publishing AWS data to

ID—String that identifies this DXM when it publishes data

Port—The port to publish to; defaults to 8883 for an SSL connection

Print debug messages to serial console - When selected, the publish behavior will be viewable using the Serial Console in the Traffic menu while the DXM is connected

Certificates

Certificate File and Private Key File—The Certificate File (.cert.pem extension) and Private Key File (.private.key extension) can be downloaded as the first step of certificate creation on AWS IoT Core (Secure > Certificates > Create).

Root CA File—The standard Root CA file (.pem extension) is entitled Amazon Root CA 1 and can be found under the CA certificates for server authentication section of the following web page: <https://docs.aws.amazon.com/iot/latest/developerguide/server-authentication.html>

See [AWS IoT Core Settings](#) on p. 37.

Cellular

The **Cellular** settings screen displays only when **Cell** is selected as the push interface on the **Settings > Cloud Services** screen.

Cell Configuration

Select the DXM's cellular modem from the **Cell module** drop-down list.

- **SXI-LTE-001**—Banner Verizon 4G LTE Cat. 1 cellular modem for USA only
- **SXI-CATM1VZW-001**—Banner Verizon LTE Cat. M1 cellular modem for USA only
- **SXI-CATM1ATT-001**—Banner AT&T LTE CAT-M1 cellular modem for North America only (roams to Canada and Mexico on AT&T partner networks)
- **SXI-GSM-001**—Banner 3G HSPA (GSM) cellular modem for global usage

APN, **APN Username**, and **APN Password** are user-defined fields. The APN setting for the LTE cellular modem using a Banner Cloud Data Services wireless plan is "vzwinternet". The default APN for the selected Cell module will automatically be set unless the user enters a custom APN.

Cell Connection Acquisition

These parameters the interaction with the cellular network when trying to establish a connection.

Connection Retry—Defines how many attempts are to be made to create a connection with the wireless network.

Connection Retry Wait—When a cellular connection fails, the Connection Retry Wait parameter defines how long the system waits until it attempts to create another cellular connection.

Cell DNS

The DXM defaults to using a public DNS service to resolve domain names. Enter the IP address of a primary and secondary DNS server to select a particular DNS server.

The DXM defaults to using the carrier DNS service. To redirect the DXS requests to a different DNS service, enter a primary and secondary cell DNS.

Ethernet Settings

Use the **Ethernet** screen to configure the DXM's Ethernet connection for Cloud Services, Mail, Modbus TCP, and UDP console functionality.

Current Device IP Settings

The current IP address (when connected via Ethernet) can be read from the device or by using the LCD menu on the DXM Controller. Click **Get Settings From Device** when the device is connected via the USB port.

IP Address

Select a static IP address or select the automatic assignment of an IP address by selecting DHCP from the drop-down menu. If Static IP is selected, enter the IP and subnet addresses.

You can also enter static IP addresses using the DXM's LCD menu system. Entering IP Addresses using the menu system overrides the IP addresses in the XML configuration files. Clear the IP addresses in the menu system to use the IP address in the XML configuration file.

Profinet

Select **Enable Profinet** if needed. When Profinet is enabled, all other Ethernet settings are disabled. Profinet is available for the [DXM700](#), [DXM1000](#), [DXM1200](#), and [DXM1500](#) models.

UDP Console

Select **Enable UDP console** to output DXM status messages via UDP. These messages can be viewed using the UDP console utility found in the **Device** menu.

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AWS IoT Core Settings

This screen is only visible when a supported DXM model is connected and AWS IoT Core is selected as the push method.

Publish

To publish data via AWS IoT Core, at least one publish rule must be defined.

Enabled—Enables the publish rule

Topic—Denotes the topic to publish data to

Group—Defines a push group for this publish rule; when this rule publishes, data from all local registers that are configured with this push group publish. Each **Local Register** belongs to one of the 32 Publish Groups (numbered 1 through 32 and configurable within the AWS IoT Core section of the **Local Registers > Local Registers in Use > Edit Register** screen). A given register will be pushed with this specified group only if **Push to AWS IoT Core** is selected. If the configuration software opens an existing configuration file within which a local register is set as a member of multiple AWS IoT Core push groups, it will instead be parsed as a member of the largest push group specified for that register, omitting any additional group memberships denoted in the file.

Timer (hh:mm)—Rate at which data associated with this rule publishes. The maximum setting is 23 hours 59 minutes (23:59).

Subscribe

The DXM is capable of subscribing to AWS IoT Core topics published to by other sources.

Enabled—Select to enable the subscription

Topic—Denotes the topic to subscribe to

API Traffic Publish

Include in config—When selected, API Traffic Publish settings are included in the configuration regardless of whether they're enabled or disabled

Enabled—Enables API Traffic publish behavior

Topic—Destination topic to publish API Traffic to

Timer (hh:mm)—Rate at which to publish API Traffic data. The maximum setting is 23 hours 59 minutes (23:59).

Notifications

The DXM can email alarm conditions using Threshold rules and can email internal log files when the log files are full. The DXM must have an Ethernet or cellular network connection for e-mail alarm conditions.

Mail Server Settings		E-Mail Recipients	
SMTP server	<input type="text"/>	E-mail Recipient 1	Address <input type="text"/>
SMTP server port	<input type="text" value="25"/>	E-mail Recipient 2	Address <input type="text"/>
<input checked="" type="radio"/> No encryption		E-mail Recipient 3	Address <input type="text"/>
<input type="radio"/> Situational encryption		E-mail Recipient 4	Address <input type="text"/>
<input type="checkbox"/> Enable SMTP authentication		E-mail Recipient 5	Address <input type="text"/>
User name	<input type="text"/>	E-mail Recipient 6	Address <input type="text"/>
Password	<input type="text"/>	E-mail Recipient 7	Address <input type="text"/>
<input type="button" value="Send SMTP Password"/>		E-mail Recipient 8	Address <input type="text"/>
		E-mail Recipient 9	Address <input type="text"/>
		E-mail Recipient 10	Address <input type="text"/>

SMS Recipients	
Name	<input type="text" value="SMS Recipient 1"/>
Name	<input type="text" value="SMS Recipient 2"/>
Name	<input type="text" value="SMS Recipient 3"/>
Name	<input type="text" value="SMS Recipient 4"/>
Name	<input type="text" value="SMS Recipient 5"/>
Name	<input type="text" value="SMS Recipient 6"/>
Name	<input type="text" value="SMS Recipient 7"/>
Name	<input type="text" value="SMS Recipient 8"/>

Mail Server Settings

The server settings specify a SMTP (Simple Mail Transfer Protocol) server as well as provide the login credentials to the SMTP mail server. The SMTP server port defines where to send the e-mail message for submission. Port 25 or 587 is for typical sending e-mail. Some servers are set up to reject all messaging on port 25, but valid users authenticating on port 587 are allowed to relay mail to any valid address.

For mailing larger groups, create groups on the mail server. Define whether or not to use encrypted (secure) communications with the SMTP server. If your SMTP server does not require an encryption connection, select **No encryption**. If your SMTP server can select or de-select encryption as the connection between the SMTP server and client is negotiated, select **Situational encryption**.

If you enable authentication, you must enter the user name and password and click **Send SMTP Password**. This password is not stored in the XML configuration file and must be sent directly to the DXM by filling in the username and password and clicking **Send SMTP Password**.

SMS Recipients

Enter the list of people to send text messages to. Note that each cell phone server provider may have a slightly different address to send text messages to. Enter the message.

E-Mail Recipients

Enter the list of email addresses and the subject lines to use for these alert messages.

This is the global list of email addresses available to be used by the **Action Rules > Thresholds**. Select individual email addresses within the Threshold Rule. Email addresses for Logging are specified on the **Settings > Logging** screen.

Logging

Use **Settings > Logging** to define the local logging setup for the on-board SD card of the DXM. Up to three cyclical logs and one event log can be defined for threshold events. Click on the arrow to the left to expand the log configuration parameters.

The string length limit for each line in the Log file is 1,000 characters. Lines typically start with the time stamp followed by the values of each saved register. Discrete values (0/1) are short, but analog values could be up to 10 characters each. Taking an average of 6 characters for each value stored, the practical limit will be about 160 registers per log file.

The data log configuration parameters define the log file name, size, and what to do when the size is exceeded. Files can be sent via email when full.

View, save, or delete files stored on the micro SD card using the **Log file Management** section. The DXM needs to be connected to a PC for these features to operate.

An HTTP Log file is created for a data packet pushed to the web server. Successful pushes cause the HTTP log to be time-stamped and placed into a dated folder under the "_sxi" directory. Typically, these logs are deleted daily.

Transmissions that fail to make it to the web server accumulate in the HTTP Log file, retrying the failed attempts at the next cyclic interval. After 10 failed attempts, the HTTP Log file is time-stamped and saved on the SD card in a separate directory ("_sav") and must be retrieved manually.

Scripting

The DXM can run one ScriptBasic program. Use the **Scripting** screen to save, load, or delete script files on the DXM.

Files other than ScriptBasic files can be uploaded to the DXM. Files are placed in the root directory and can only be accessed by a ScriptBasic program.

Select **Show advanced settings** in the upper right of the screen to display the **ScriptBasic Network Options**.

Select a ScriptBasic file from the current ScriptBasic files window and select **Add Selected to Startup Scripts** to define which program should be run at boot time. Save the XML configuration file before loading to the device. A reboot is required to start a new script program.

To upload files:

1. Click **Upload**. A pop-up window appears.
2. Select the pull-down menu to select the file types: .sb, .esb or *.*.

Enable memory usage tracking

Enables an internal memory watcher program that tracks the memory allocation for a ScriptBasic program. The results are displayed on the DXM's LCD, under **System Info > Script**.

Script execution delay after DXM boot (ms)

Indicates the time (in ms) that the DXM should wait before it begins running the designated startup script after the DXM powers up.

ScriptBasic Network Options

TCP server enabled—ScriptBasic can operate as a server watching for Ethernet packets. Use the FILEIN command in ScriptBasic Default port is 8845.

TCP Client enabled—ScriptBasic can send Ethernet packets when this is enabled. Enter IP address of destination. Default port is 8845, port is selectable.

UDP enabled—Enable ScriptBasic to send/receive UDP data traffic. Enter IP address of destination.

Administration

The DXM manages two passwords that are defined on the **Settings > Administration** screen. Defining a **File Protection** password requires a password to be entered before a configuration file or ScriptBasic program file is loaded to the DXM. The LCD protection password requires the user to enter a password on the DXM LCD to unlock the LCD display of the DXM.

File Protection—Setting a password requires that a user enters a password before loading a configuration file or ScriptBasic file. The password is stored in the DXM and requires the DXM to be connected to the computer via USB port or Ethernet to set the password.

LCD Protection—The LCD passcode locks the DXM LCD display menu from operation. A valid passcode must contain 1–9 numbers with the first number being non-zero. The user has access to the full menu system when the passcode has been entered using the DXM LCD menu. The user can re-lock the display by selecting the **Display Lock** menu or the DXM will automatically re-lock the display after 15 minutes with no activity. If the DXM reboots, the device prompts the user for the passcode.

1. With the device connected, click on **Get Device Status**.
2. The device reports back if it is locked or unlocked.
3. To change, set, or clear a password select the appropriate action, fill in the required fields then click **Submit**.

Notes

Use the **Notes** screen to enter informational text about the configuration file or notes specific to the application.

The **Notes** screen can save up to 4096 characters of alphanumeric characters and some special characters (~ ! @ # \$ % ^ () _ - = + ? / } { []). The notes are stored in the beginning of the XML file.

I/O Board

The DXM I/O boards come in various combinations of inputs and outputs. The selection of the base board type can be set to **Manual** or **Auto detect**. When modifying parameters, always read (GET) the parameters first, edit, and then write (SEND) the new parameters back to the I/O board.

The I/O Board settings screen only displays when the selected **DXM Model** is DXM100, DXM100-A1, or DXM150.

Depending upon the amount of parameter data to see, click on one of the following buttons to read the current parameter settings:

GET all parameters and IO

Reads all the I/O board device level parameter data plus the input and output parameter settings.

GET parameters

Reads only the I/O board device parameters. Device level parameters effect the I/O board operation in general and are not specific to I/O points.

GET all IO points

Reads the parameters for all the inputs and outputs on the I/O board.

GET

Reads parameters for each individual I/O point, from one input or output.

Based on the number of changes made to the parameter data select one of the following buttons to write the data to the DXM I/O board:

SEND all parameters and IO

Writes all the I/O board device level parameter data plus the input and output parameter settings.

SEND parameters

Writes only the I/O board device parameters. Device level parameters effect the I/O board operation in general and are not specific to I/O points.

SEND all IO points

Writes the parameters for all the inputs and outputs on the I/O board.

SEND

Writes parameters for each individual I/O point, from one input or output.

Name

Assign a name to each device to it easier to track the device in the configuration software.

The **Name** must be less than 18 characters and contain only the standard alpha-numeric characters, the following standard ASCII characters: *, +, -, /, <, >, or a space.

Default Conditions

Default conditions are the conditions under which outputs are sent to their defined default state. These conditions apply to all outputs.

Selecting **Start Up** sets this radio's outputs to their default values when this radio is powered up.

A **Comms Timeout** refers to the communication between the host system and the selected radio (which may be any radio within the network). Selecting Communication Timeout sets this radio's outputs to their selected default values when the host system has not communicated with this radio within the time specified. Set the communication timeout in seconds.

After the radio problems are resolved with the parent radio or communication with the host system has resumed, the host system is responsible for writing the operating output value.

I/O Pulse Patterns

Setting the I/O pulse pattern establishes an on and off pattern that can be used for a discrete output or switch power.

I/O Pulse Patterns

Selected Pattern: Pattern 1

Add I/O Pulse Delete I/O Pulse ↑ ↓

Pulse Start Time	Pulse End Time
0 ms	240 ms

Define **I/O Pulse Patterns** by selecting specific timeslots to turn the output on or off. Although the pulse pattern was originally designed to turn on and off an indicator light, the pulse pattern can be set for any discrete output or switch power. Users may configure up to four different patterns per radio device. In the example shown, Pattern 1 is configured to turn on for the first 240 milliseconds within a 1280 millisecond range.

Device Restore

Use these commands to restore default settings to the selected device.

To restore default device parameters:

1. At the top of the screen, select a MultiHop device.
2. Click on **GET All Parameters** to get that device's I/O configuration.
3. In the **Device Restore** section, select the appropriate checkboxes.
 - **Restore Default I/O Configuration.** Restores default I/O configuration parameters to the values indicated in the device's datasheet, such as sample and report rates.
 - **Restore Default System Parameters.** Restore default system parameters, such as the radio configuration and binding code.
4. Click on **Restore Device** to restore the selected default values to your device.

Remap Registers or Register Aliasing

Use the **Remap Registers** section of the **Configure Device** screen to map registers to contiguous register locations to optimize Modbus read/write functions.

Device Restore

Remap Registers

Alias Registers (601-616)		Register Content (101-116)	
GET	SEND	GET	SEND
1	5	101	0
2	7	102	0
3	9	103	0
4	10	104	0
5	8	105	0
6	501	106	0
7	502	107	0
8	1	108	0
9	1	109	0
10	1	110	0
11	1	111	0
12	1	112	0
13	1	113	0
14	1	114	0
15	1	115	0
16	1	116	0

1. Verify the desired MultiHop Radio **Address** is selected in **Configuration Address**.
2. Click the arrow next to **Remap Registers**.
3. Fill in the source registers you would like to alias. The **Alias Registers** rows 1 through 16 are the user-defined entries of addresses of the registers to alias (rearrange). This alias table is stored in the MultiHop radio register addresses 601 through 616. In the example, source registers addresses 5, 7, 9, 10, 8, 501, and 502 are entered into the table.

The aliased **Register Contents** are in registers 101 through 116. For this example, when a host system reads Modbus registers 101 through 107 of the MultiHop radio, the register contents come from register 5, 7, 9, 10, 8, 501 and 502.

Inputs

The following parameters are used to configure the inputs.

The input parameters vary, depending on the enabled and available input types.

Input Configuration

Select **Enable** to turn on this input.

Sample Rate

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

Universal Configuration

After enabling the input, configure the universal input type.

Count on falling values

Select to count on a falling transition.

Count on rising values

Select to count on a rising transition.

Input Type

Select the input type from the drop-down list.

- NPN
- PNP
- 0-20mA
- 0-10V
- Thermistor
- Potentiometer
- Bridge
- NPN Raw Fast

Preset Value (Counter)

Enter a number in the selection box and press the Set Value button to write a preset counter value to the register.

Analog Configuration

Enable push on change of state

Enables push registers for this input. When the discrete input changes state, the register value is pushed to the master radio if this register is configured to be a push register. For analog inputs, use the threshold and hysteresis parameters to define "on" and "off" points.

Enable register full scale

Turning Fullscale ON sets the entire register range of 0 through 65535 to represent the selected minimum through maximum input values. With Fullscale turned on, a register value of 0 represents the selected minimum value in microamps (for current inputs). A register value of 65535 represents the selected maximum value in microamps. For example, a register value of 0 is 0 and the register value of 65535 represents 20 mA (or 20,000 microamps). With Fullscale turned OFF, the register value represents unit-specific input readings. For units of current (mA), register values are stored as microAmps. Voltage values are stored as millivolts. A sensor reading of 15.53 mA is stored as 15530.

Signal Conditioning

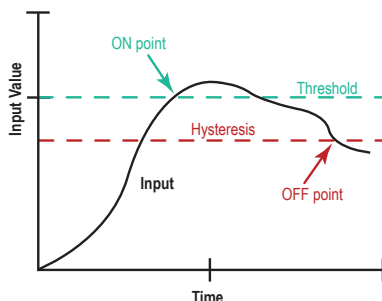
Delta

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

Hysteresis and Threshold (Analog)

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.



Median Filter

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

Set to one (1) to turn on the median filter.

Sample High and Sample Low

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

Tau Filter

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

Temperature Settings

Enable full scale (Temperature)

Turning Fullscale OFF sets the register range of 0x8000 (–32767) through 0x7FFF (+32768) to represent the range of input values. With Fullscale turned OFF, a register value of 1450 represents 72.5 degrees (register values = temperature × 20). With Fullscale turned ON, users can specify the register minimum and maximum range of values. These min/max values are represented in the register as 0 (min) and 65535 (max).

Temperature resolution

Select high to store temperatures values in the registers as the measured temperature × 20. Set to low to store temperature values in tenths of a degree (measured temp × 10).

For example, if the measured temperature is 20.5 degrees, turning temperature scaling to high stores the temperature value as 410 while use low resolution stores the temperature as 205.

Units

Select either Celsius or Fahrenheit for your temperature readings.

Switch Power Settings

Configure the following parameters for the switch power settings (inputs).

Enabled

Associates I/O switch power functions to a specific input. Do not use these parameters to configure continuous, or device-level, switch power. Select one of the available switch power (SP) checkboxes to link that switch power to the input you're currently configuring.

Voltage and Warm-Up

Select the desired voltage and warm-up time. The voltage setting establishes the voltage of the switch power. The warmup time is the length of time the switch power must be on before the device can sample the input.

Extended Input Read Settings

Use the Extended Input Read parameter to link multiple input sampling times together when all devices are powered by the same Switch Power. For battery-powered devices, this uses less energy and prolongs battery life. Define the Sample Rate, Warm-up time, and Voltage parameters for the first input. These parameters for follow-on linked inputs are ignored. Click on the **Extended Input Read** arrow to select the additional inputs to read when the switch power is active.

For example, set the Sample Rate, Warm-Up time, and Voltage for Universal Input 1. Select SP1 to power Universal Input 1. By selecting Extended Input Read for 2 and 3, the device will also read inputs 2 and 3 when it reads input 1.

Outputs

The following parameters are used to configure the outputs, including the switch power outputs.

The output parameters vary, depending on the enabled and available output types. To begin configuring your outputs, **Enable** the output.

Discrete Output

Default Output Value

Select the default output value. When the selected default condition occurs and Hold Last State parameter is set to OFF, this output is set to the selected default output value (e.g. out of sync, communication timeout, start up).

Hold Last State

Retains its last value during the selected default condition (out of sync, communication timeout, start up).

Use I/O Pulse Pattern

To use a programmed pulse pattern, select **Use I/O pulse pattern**, then select the appropriate pattern from the drop-down list. Define the patterns in the Device Parameters section of this screen.

Switch Power Output

When linking a switch power output to a specific input, select the **Enable** checkbox and set the **Enable default state** to OFF. Use the settings for the specific input to link the switch power output and set the voltage and warm-up time.

For continuous switch power, set the voltage on this screen and set the default state to ON. Verify the default "start-up" conditions are set in the device parameters screens.

Enable default state

When enabled, this switch power output remains on during the selected default condition (e.g. out of sync, communication timeout, start up). When disabled, the switch power cycles off during the selected default condition.

Hold Last Voltage

When set, the switch power output retains its last value during the selected default condition (e.g. out of sync, communication timeout, start up).

Use I/O Pulse Pattern

To use a programmed pulse pattern, select **Use I/O pulse pattern**, then select the appropriate pattern from the drop-down list. Define the patterns in the Device Parameters section of this screen.

Voltage

To set a voltage for the switch power output, select a value. When configured for continuous voltage output, this switch power output no longer cycles on, warms up the sensors, then cycles back down. Because the output voltage remains constant, continuous voltage is typically used with solar power installations.

Universal Out

After enabling the output, configure the universal output type.

Output is

Select the output type from the drop-down list.

0-20mA

0-10V

Enable register full scale

Turning Fullscale ON sets the entire register range of 0 through 65535 to represent the selected minimum through maximum input values. With Fullscale turned on, a register value of 0 represents the selected minimum value in microamps (for current inputs). A register value of 65535 represents the selected maximum value in microamps. For example, a register value of 0 is 0 and the register value of 65535 represents 20 mA (or 20,000 microamps). With Fullscale turned OFF, the register value represents unit-specific input readings. For units of current (mA), register values are stored as microAmps. Voltage values are stored as millivolts. A sensor reading of 15.53 mA is stored as 15530.

Hold last state (output)

Retains its last value during the selected default condition (out of sync, communication timeout, start up, etc).

H-Bridge Configuration

Enable this output and the H-Bridge configuration to configure its parameters.

Cap warmup time

Similar to the switch power warm-up time, the h-bridge capacitor warm-up time (hours:minutes:seconds) is the time allotted to charge the capacitor used to activate the h-bridge and latching solenoid.

Switch time

Time (hours:minutes:seconds) needed to activate the h-bridge and latching solenoid.

Use I/O Pulse Pattern

To use a programmed pulse pattern, select **Use I/O pulse pattern**, then select the appropriate pattern from the drop-down list. Define the patterns in the Device Parameters section of this screen.

Voltage

Voltage required to activate the h-bridge and latching solenoid.

3.4.4 Tools

The **Tools** screen provides utilities for reading and writing register values interactively, adding registers to the DXM's display, exporting protocol conversion configurations, and updating the DXM.

Register View

The Register View is a Modbus utility to help debug configurations and view register data for devices connected to the DXM.

The screenshot displays the 'Read/Write Source and Format' window. At the top, it shows settings for 'Data Format' (Decimal), 'Register source' (Local registers), 'Slave ID' (199), and 'Timeout' (5 sec). Below these are checkboxes for 'Show local register names' and 'Apply sign and register scaling to values'. The main area is divided into two panels: 'Read Registers' and 'Write Registers'. Each panel has a table with columns for 'Starting Register', 'ID', and 'Value'. The 'Read Registers' table shows registers 1 through 6 with values 0, 0, 0, 0, 0, and 0 respectively. The 'Write Registers' table shows registers 15 through 20 with values 0, 0, 0, 0, 0, and 0 respectively. There are also input fields for 'Starting Register' and 'Number of registers' in both panels.

Follow these steps to select the registers to view.

1. Connect to the DXM using USB or Ethernet.
2. From the **Register source** drop-down list, select between Local Registers (DXM), ISM registers (Gateway), remote device, I/O registers (available only when the selected model is DXM100, DXM100-A1, DXM150, DXM1000, and DXM1500), display registers, or DXM700 outputs (available only when the selected model is the DXM700). Enter a Slave ID when accessing remote devices. If the selected DXM model is a DXM-R90x, a **Port** drop-down list displays when the Remote device is selected as the Register source. This drop-down list specifies which UART bus to use when accessing remote devices.
3. Select the **Starting Register** to display and the **Number of registers**.

Read Registers

To read the contents of a specific register or range of registers, select the starting register and the number of registers to read from.

Click **Read Registers** to read the data once. The register values display in the **Read Registers** section. Select **Enable Polling**, specify a polling rate, and click **Read Registers** to create a constant polling loop.

Write Registers

To write values to a specific register or range of registers, select the starting register and the number of registers to write to. Enter the value to write to these registers and click **Write Registers** to send these defined values to the selected registers.

DXM Display

Use the **Local Registers > Local Registers in Use** screen to define which registers can be displayed under the Register menu of the DXM. Use the **DXM Display** screen to adjust the display order of the **Registers with LCD Permissions**. If the display order is not specified, the registers display in numerical order.

Registers with LCD permissions			#	Display order on LCD		
1	Humidity 1	➔	1	8	Temp 1	↑
2	Humidity 2		2	9	Temp 2	
3	None		3	10	Temp 3	↓
4	Humidity 1 Copy 1		4	11	Temp 4	
5	Humidity 1 Copy 2		5	1	Humidity 1	Remove
6	None		6	2	Humidity 2	
7	None		7	12	Average Temp	
8	Temp 1					
9	Temp 2					
10	Temp 3					
11	Temp 4					
12	Average Temp					
13	None					
14	None					

The Local Registers defined to be displayed on the LCD menu are shown in the left column.

1. Select the Local Register by clicking next to the **Registers with LCD Permissions** number.
2. Click the arrow button to populate the **Registers with LCD Permissions** in the **Display order** column.
3. After defining the Local Registers to display, adjust the order using the up and down arrows to the right of the **Display order** column.

If there are more Local Registers defined with LCD permissions than there are in the **Display order** column, the remaining registers display in the order of the Local Register number. A Local Register can only be shown once on the LCD.

Protocol Conversion Overview

The **Protocol Conversion Overview** screen displays a list of the EtherNet/IP (EIP) Inputs and Outputs associated with DXM registers.

Define the Local Registers to be EtherNet/IP registers on the **Local Registers > Local Register Configuration** screen.

EIP

Export to CSV

EIP Inputs

Inputs used/Total inputs 0/228

Register ID Register Name

EIP Outputs

Outputs used/Total outputs 0/228

Register ID Register Name

Scheduler

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

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

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

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

Reprogram

Use the configuration software to update the DXM's firmware. Previous firmware must be version 2.01 or later. For earlier firmware versions, contact Banner Engineering support.

Click **Get Device Information** to have the DXM read and display its serial number, model number, version, and firmware numbers for both the processor board and the I/O board.

By default, **Verify firmware compatibility before configuring DXM** is selected any time the configuration software launches. Deselect it to allow uploads of a configuration file without first verifying that the connected DXM's firmware supports the features. This field is not saved and will always be selected when the configuration software launches.

To reprogram the DXM, follow these instructions:

1. Apply power to the DXM,
 2. Connect the DXM to your PC using USB or Ethernet.
 3. On the menu bar, go to **Device > Connection Settings** and select the appropriate COMM port or enter the IP address.
 4. From the **Tools > Reprogram** screen, click **Select upgrade file**.
 5. Browse to the firmware HEX file location and select the file.
- Depending upon the connection, USB or Ethernet, the programming takes from 5 to 15 minutes to complete.

3.5 Configuration Instructions

3.5.1 Edit Registers Using the Local Registers in Use Screen

Use this screen to modify the parameters of any local registers being used.

Figure 6. Edit Register tab

1. Go to the **Local Registers > Local Registers in Use > Edit Register** section of the bottom of the screen. A list of the local registers being used displays.
2. Under the **Selected Register** box, select the register to define or modify. You may select the register by using the up/down arrows, directly entering a register number into the field, or clicking within the corresponding row in the **Local Registers in Use** table.

Only Local Registers that have already been changed from their default configuration are displayed in the **Local Registers in Use** table.

3. Using the drop-down lists, assign a name, register group, change the units, or make other configuration changes to this register.
4. To push register values to the web server, set **Cloud Permissions** to read.

If **Cloud Permissions** are set to Read, the web server only views data from the device and cannot write data to the device. If the permissions are set to Write, the web server only writes to the device and cannot read the data. If the permissions are set to Read/Write, the web server can read the data from the device and write to the device from the web.

The changes are automatically applied within the software, not the XML file. To change another register, use the up or down arrows to select another register number. To save these changes to the XML file, go to **File > Save**.

3.5.2 Modify Multiple Registers

Modify a range of registers from the **Local Registers > Local Registers in Use > Modify Multiple Registers** screen.

Select which parameter fields to modify. Most parameters have three selections.

- Unchanged—no changes
- Default—change to default settings
- Set—modify parameter. Other selections will appear based on the parameter.

Figure 7. Modify Multiple Registers screen

1. Enter the **Starting register** and **Ending register**.
2. Select the value to change using the drop-down list next to each value.
3. Enter the new value in the field provided.
4. To push register values to the web server, set **Cloud Permissions** to read.

If the **Cloud Permissions** are set to Read, the web server only views data from the device and cannot write data to the device. If the permissions are set to Write, the web server only writes to the device and cannot read the data. If the permissions are set to Read/Write, the web server can read the data from the device and write to the device from the web.

5. Click **Modify Registers** to save and apply the changes.

3.5.3 Configure the Cloud Data Services Settings

1. To configure the connection to the web server, go to the **Settings > Cloud Services** screen.

2. Copy and paste the **Site ID**.
The Site ID is that long string of numbers and letters from the Banner Cloud Data Services website.
3. Verify the **Server Name/IP** is set to `push.bannercds.com` and the **Page** is set to `/push.aspx` for sending to the website. To push to the demo website, set the Server Name/IP to `demopush.sensonix.net`.
4. Set the **Cloud Push Interval** to a value appropriate for your application.

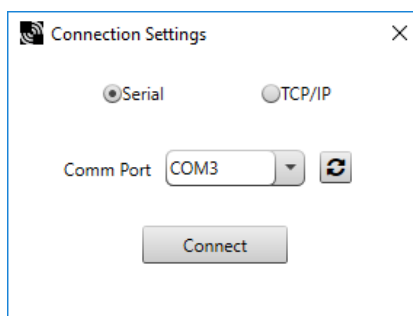
The **Cloud Push Interval** determines how often the device pushes the data to the web. The faster the push interval, the more data is sent to the site. Cellular plans can only push at an interval of 5 minutes or longer, while Ethernet connections can push at an interval of 1 minute or longer. The **Sample Count** specifies how many times the data is gathered within the **Cloud Push Interval**.

For example, if the **Cloud Push Interval** is 15 minutes and the **Sample Count** is set to 3, then during each data push (every 15 minutes), 3 samples are sent to the web. This is one sample every 5 minutes.

5. Save the configuration file by going to **File > Save**.

File names must be no more than 30 characters long, and should not contain any spaces or special characters.

6. With a USB cable connected to the device, go to the **Device > Connection Settings** menu.
7. Select the appropriate **Comm Port** and click **Connect**.



If multiple comm ports are visible, try each one until the software is able to connect to the device.

8. Go to **Device > Send Configuration to the Device** to upload the new XML file.

3.5.4 Creating Rules

Create a Read Rule

Each read rule defines a Modbus slave ID and register range to read and then store in the selected Local Registers.

Use the **Register Mapping > Read Rules** screen to create a new read rule.

1. Click **Add Read Rule**.
A new read rule is created.
2. Click the arrow next to the first rule to view the parameters.
The list of parameters opens.
3. Type in the rule's name in the 'none' field.
4. Select slave ID of the source device.
5. Select the number of registers to read from the source device.
6. Select the starting register of the source device.
7. Select the starting register of the local/target device.
8. Set the desired parameters.



Tip: Use fewer read rules for applications that require higher response times by taking advantage of the Alternative Modbus Register groupings for DX80 Performance Nodes as shown in the DXM Wireless Controller Instruction manuals.

Create a Write Rule

The write rules write Local Register data to the defined Modbus slave ID and registers. Use the **Register Mapping > Write Rules** screen to create a new write rule.

1. Click **Add Write Rule**.
A new write rule is created.
2. Click the arrow next to the first rule to view the parameters.
The user-defined parameters are displayed.
3. Type in the rule's name in the **None** field.
4. Select the number of registers to write to the target device.
5. Select the starting register of the local/source device.
6. Select the slave ID of the target device.
7. Select the starting register of the target device.
The ending register automatically fills in based on the starting register and the number of registers selected in step 4.
8. Set the desired parameters.



Tip: Use fewer read rules for applications that require higher response times by taking advantage of the Alternative Modbus Register groupings for DX80 Performance Nodes as shown in the DXM Wireless Controller Instruction manuals.

Create a Modbus TCP Write or Read Rule

Use the **Register Mapping > Modbus TCP > Write Rules** screen to define each Modbus TCP register write transaction to a selected Modbus TCP server device. Use the **Register Mapping > Modbus TCP > Read Rules** screen to define each Modbus TCP register read operation to a selected Modbus TCP server device.

1. Enable Modbus TCP.
2. Click **Add Write Rule** to create a new Write rule or click **Add Read Rule** to create a new Read rule.

3. Name your rule. The name has no affect on the rule's operation.
4. From the drop-down list, select the **Using device**. Device connections are defined on the **TCP Configuration** screen. A new write or read rule is created. Write and read rule parameters are written in a form of a sentence to make it easier to understand the Modbus operation.
5. Select the number of Local Registers, the starting register, Modbus ID, and the starting target register.
 - **Number of Registers**—For Write Rules, the number of internal Local Registers to write to the Modbus server. For Read Rules, the number of Modbus registers to read from the remote server device.
 - **Local Register Address**—For Write rules, the Local Register Address is the starting address of the Local Register data. For Read rules, the Local Register Address is the starting address of the Local Registers to put the read data
 - **Modbus ID**—An identifier also known as the unit number. If there are multiple devices at the server IP address, this field uniquely identifies the server. For other DXM devices this field will be 1. DXM devices to not respond to a unit number of 0.
 - **Remote Modbus Register Address**—For Write Rules, defines where to write the data in the server. For Read Rules, defines the starting address of the Modbus registers to read from the remote server device.

The **Local Registers in Use** drop-down list shows all Local Register names associated to this write or read rule.

Click **Delete Last Rule** to remove the last created rule.

Create a Threshold Rule

1. From the **Action Rules > Thresholds** screen, click **Add Threshold Rule**.
2. Enter the **local register** you are comparing.
3. Select the mathematical function and value.
4. Select what the system should do if the register value is true or false.
5. Select any other vales, such as **Hysteresis**, **On Time**, or **Logging Options**.
6. Select any email or text messages you'd like sent upon a state transition.

Create a Register Copy Rule

1. From the **Local Registers > Action Rules > Register Copy** screen, click **Add Copy Rule**.
2. Enter the **Copy Register**. This is the first register for the source of the data.
3. Enter the **To Register** and **Through Register**. These are the registers for the beginning and end of the target range of registers.

- If you are copying the contents of one register, enter the same register number into the **To Register** and **Through Register** fields.
- If you are copying a range of registers, the range is defined by the **To Register** and **Through Register**. The **Copy Register** is the starting register of the source range.

Create a Math Rule

Use math rules to perform mathematical calculations on registers and store the results.

1. From the **Action Rules > Math/Logic** screen, click **Add Math Rule**.
2. Enter a **Name** for your new math rule.
3. Select the desired **Operation** from the drop-down list.
4. Select the starting **Local Register**, And or Through, and the second (when using And) or ending (when using Through) **Local Register** to perform your mathematical calculations on.
5. Select the **Local Register** you'd like to store your results in.

Create a Control Logic Rule

1. From the **Action Rules > Control Logic** screen, click **Add Control Rule**.
2. **Name** your new rule.
3. Select the logical operator from the **Gate** drop-down list.
4. From the drop-down lists, select the Input 1, Input 2, Enable, and Clock options.
5. Select the **Output** options.

Create a Basic Trend Rule

To create a basic Trend rule, follow these steps.

1. From the **Action Rules > Trending** screen, click **Add Trend Rule**.
2. In the **Name** field, name your Trend Rule.
3. Define the **Register to Track**.
4. Define the **Sample Interval** (hours:minutes:seconds) you'd like to collect the data.
5. Select **Filters** and your **Filter Window**.
6. Enter the Local Registers to copy the **Average**, **Minimum**, and **Maximum** values into.

Create a Tracker Rule

1. From the **Action Rules > Trackers** screen, click **Add Tracker Rule**.
2. **Name** your new tracker rule.
3. Select the **Register to Track** from the list.
4. Select the **Transition to Track** from the drop-down list.
 - Rising edge—Transitioning from a zero to a non-zero value.
 - On time in ms—Length of time the register is on (non-zero), in milliseconds.
 - Off time in ms—Length of time the register is off (zero), in milliseconds.
5. Select the **Result Register** to store the count in.

3.5.5 Processing the Rules

Rules and functions are evaluated by the DXM in a specific order.

1. The read rules are executed first, beginning with the first rule defined and continuing in the order the rules were entered into the DXM Configuration Software.
2. After the read rules are executed, the write rules are processed, in the same order.
3. After the write rules are processed, the DXM Configuration Software starts over with processing the read rules.

The read/write rules take time to complete, not because they require processing power, but because each rule has a lengthy overall communication time relative to the processor execution cycle time. So, in parallel, the action rules are also solved.

Each action rule is processed in order, similar to the read/write rules. The groups of action rules are solved in this specific order:

1. Calculate (Math) rules are next, continually processed
2. Copy rules, processed only when a change of state is detected on the source register
3. Threshold rules, continually processed

4. Control Logic, continually processed
5. Trending, continually processed
6. Trackers, continually processed

3.5.6 Creating Events and Schedules

Create a Weekly Event

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

Figure 8. Scheduler > Weekly Events screen

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

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

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

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

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.

Figure 9. 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.

Create a Holiday Event

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

Figure 10. Scheduler > Holidays screen

Name	Start Date and Time	End Date and Time
New Holiday	Tuesday, February 19, 2019, 00:00	Tuesday, February 19, 2019, 00:01

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.

Create a Dynamic Schedule

Use the **Dynamic Update** screen to create a scheduler update file. The scheduler update file is a configuration XML file that contains only scheduler data definitions. When you upload the scheduler update file to a DXM that is running a defined schedule, the scheduler update file replaces the running schedule.

To use the Dynamic scheduler feature, follow these steps.

1. Create the main XML configuration file with the entire configuration of the DXM, including default scheduler settings.
2. Go to **Scheduler > Dynamic Update** and select **Enable dynamic scheduler**.
3. Go to **Device > Save** to save the XML configuration file.
4. Load the main XML file into the DXM.
The DXM is running the main configuration file and will accept scheduler update files.
5. Modify the schedule settings, then click **Save scheduler update file**.
The scheduler update file is created.
6. To load the scheduler update file, click **Load scheduler update file**.
7. To send the scheduler update file to the DXM, click **Send scheduler update to device**.
The new schedule defined in the scheduler update file replaces the existing operating schedule.

Enable dynamic scheduler—Enables scheduler update files to be accepted. This must be selected in main XML configuration file loaded into the DXM before it will accept scheduler update files.

Get scheduler update from device—Downloads the scheduler update file from the DXM.

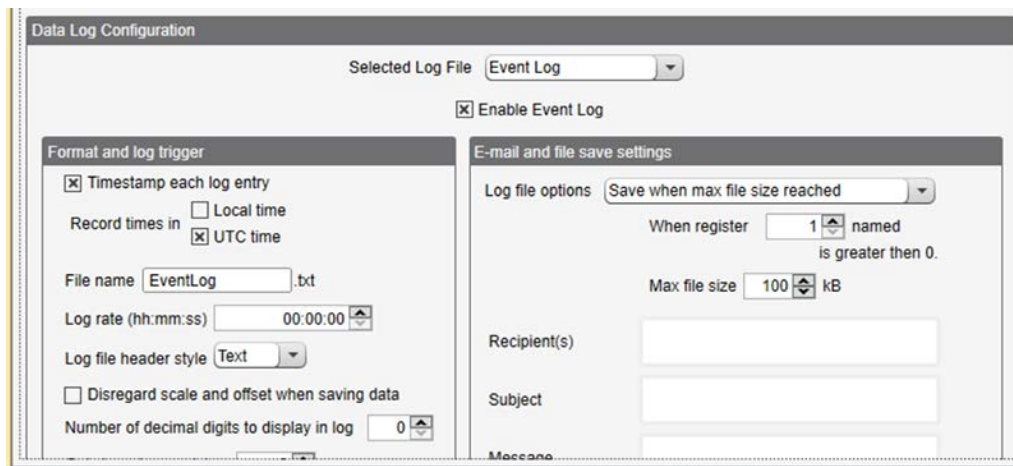
Send scheduler update from device—Uploads a scheduler update file to the DXM, replacing the existing schedule running on the DXM.

Save Scheduler update file—Saves a scheduler update file to the PC. The file only contains the scheduler configuration data.

Load scheduler update file—Loads a scheduler update file from the PC to the DXM Configuration Software software.

3.5.7 Create an Event Log or Data Log

Use the **Event Log** to track data only when the contents of the specified registers reaches the defined value. The **Data Logs** record the contents of the selected register at the defined rate.



1. Select **Enable Log** to enable the log file creation. The register data to be saved in the log is defined under the **Local Registers** tab.
2. Select **Timestamp each log entry** to date/time stamp each log entry. Select whether you want the time stamps to be in local time or UTC time.
The local time is determined from the device's time zone selection under on the **Settings > General** screen.
3. Name your Event or Data Log.
A date/time stamp is added to the end of the user-defined **File Name** then stored on the Micro SD card. New files will be created with a new date/time stamp.
4. Select whether or not you want to **Disregard scale and offset when saving data** for the register or apply the scale and offset defined on the **Local Register Configuration** screen.
Local Registers 1 through 845 are integer registers and are always stored as integers. Floating point Local Registers 1001 through 2000 are stored as floating point numbers.
5. Define the **Number of decimal points to display in log** (floating point data log only).
6. Define the **Email Parameters** for sending a log file when the log file is full.
7. For cyclical log files (log1-log3), specify the **Log Rate**.
8. Set the **Maximum File Size** before the DXM creates a new file. When emailing log files, keep the file sizes below 50 KB.
9. Select from the following **Log file options**.
 - Save when max file size reached—Save the log file to the internal DXM SD card when the defined Max file size is reached. The user must retrieve the file.
 - Save when register is non-zero—Save the log file to the internal DXM SD card when the defined Local Register is set to a non-zero value. The Local Register can be controlled by Action Rules, ScriptBasic, Scheduler, or Website. The user must retrieve the file.
 - Save Daily—The log file will be saved daily at 00:00 UTC time. The user must retrieve the file.
 - Email and Save when max file size reached—Email and save the log file to the internal DXM SD card when the defined Max file size is reached. You may define up to three recipients to receive the email. Define the SMTP parameters on the **Settings > Network** screen.
 - Email and Save when register is non-zero—Email and save the log file to the internal DXM SD card when the defined Local Register is set to a non-zero value. The Local Register can be controlled by Action Rules, ScriptBasic, Scheduler, or Website. You may define up to three recipients to receive the email. Define the SMTP parameters on the **Settings > Network** screen.
 - Email and Save Daily—The log file will be emailed and saved daily at 00:00 UTC time. You may define up to three recipients to receive the email. Define the SMTP parameters on the **Settings > Network** screen.
10. Enter the **Recipient** email address, **Subject**, and **Message** for the log file.
You may define up to three email recipients, separated by commas.

3.5.8 What is a Scheduled Push?

A scheduled push uses the DXM's **Scheduler** function to force a data push at a specific time. Use the DXM Configuration Software software to create, save, and upload the configuration file to the DXM.

Create a Scheduled Push

These instructions assume you have installed the latest version of the DXM Configuration Software and have launched it on your Windows-based PC.

The following example creates an automatic data push that runs at 11pm, Monday through Friday.

1. Define all local registers to push to the webserver.
 - a) Go to the **Local Registers > Local Registers in Use** screen.
 - b) Click the register number to display that register's parameters.
 - c) Set **Cloud settings** to Read.
 - d) Set **LCD Permissions** to Read to display the local register to the DXM's LCD.
2. Define the scheduled event.
 - a) Go to the **Scheduler > Weekly Events** screen.
 - b) Click **Add Weekly Event**.
 - c) Click the arrow next to the new event to view all parameters.
 - d) Enter a name for the event.
 - e) Select the local register. For this example, we are using local register 12.
 - f) Click on the days of the week that this local register will be changed. For this example, we have selected Monday through Friday.
 - g) Select the start value and the specific time you want this event to occur. For this example, we have selected the start value of 1, to occur at 23:00 hours (11 pm).
 - h) Select the end value and specific time you want this event to occur. For this example, the register value returns to zero at 23:01 (11:01 pm), one minute later.

3. Create an Action rule to push data to the webserver.
 - a) Go to the **Local Registers > Action Rules > Thresholds** screen.
 - b) Click **Add Threshold Rule**.
 - c) Click the arrow next to the new rule to view all parameters.
 - d) Enter a name for the rule.
 - e) Fill in the parameters. For our example, we are setting local register 13 to 1 when local register 12 is 1.
 - f) Select **Push when active**.

When the value of register 12 is 1, the DXM pushes the defined data set to the webserver.

The Scheduler creates the timed event that occurs Monday through Friday. At the scheduled time and day, the value of local register 12 is set to 1 for one minute. The Action rule watches local register 12, and when the value is 1, the action rule creates a push event to the webserver.

Configure the DXM to Access the Webserver

Before the DXM can read or write data to the webserver, you must define or confirm several parameters.

1. Go to the **Settings > System** screen and set the **Device Time** and time zone.
The device time can be verified on the DXM LCD.
2. Select whether or not the DXM should use daylight saving time (DST).
3. On the **Settings > Cloud Services** screen, set the **Cloud push interval** to none.
This allows the action rule to push data.
4. Under the **Web Server** section, verify the **Site ID** is accurate. This Site ID is unique for every device and is created by the website.

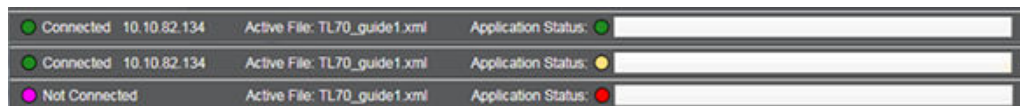
Save and Upload the Configuration File

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

Changes to the XML file are not automatically saved. Save your configuration file before exiting the tool and before sending the XML file to the device to avoid losing data. If you select **DXM > Send XML Configuration to DXM** before saving the configuration file, the software will prompt you to choose between saving the file or continuing without saving the file.

1. Save the XML configuration file to your hard drive by going to the **File > Save As** menu.
2. Go to the **DXM > Send XML Configuration to DXM** menu.

Figure 11. Status indicator bar



- If the Application Status indicator is red, close and restart the DXM Configuration Tool, unplug and re-plug in the USB or Ethernet cable and reconnect the DXM to the software.
- If the Application Status indicator is green, the file upload is complete.
- If the Application Status indicator is yellow, the file transfer is in progress.

The device reboots and begins running the new configuration.

3.5.9 Sending Text Alerts and Commands

A DXM100 or DXM150 with a cellular modem can send text messages on defined conditions and can receive text messages to trigger actions.

This short example uses the DXM Configuration Software to create text alerting messages and SMS commanding.

For more DXM information, refer to the appropriate instruction manual.

- DXM Configuration Tool Instruction Manual (p/n [158447](#))
- DXM100-Bx Wireless Controller Instruction Manual (p/n [190037](#))

Hardware requirements:

- A DXM model with a cellular modem installed (the cell modem must have a wireless plan and be provisioned on the cellular network)
- DXM Configuration Software software downloaded from [www. bannerengineering.com](http://www.bannerengineering.com)

This example configuration:

1. Reads four discrete inputs from the I/O board of the DXM.
2. Writes the values into Local Registers 1 through 4.
3. Defines a math rule to logically 'OR' the input values.
4. Uses a threshold rule to define when to send a text message.

Configure the Local Registers

After defining each Local Register, set the LCD Permissions flag to Read to display the register data on the DXM's LCD.

1. Define Local Registers 1 through 4 to hold the read data from the four discrete inputs on the I/O board.
2. Define Local Register 6 to hold the results of the logical OR math rule.

- Define Local Register 7 to hold the results of the threshold rule.

The screenshot shows the 'Local Registers In Use' table with the following data:

ID	Register Name	Register Group	Units	Signed	Constant or Timer	Cloud Settings	LCD Permissions	Protocol Conversion	Log Files	Read Rules	Write Rules	Threshold Rules	Copy Rules
1	Input1		None	No		None	None	None	None				
2	Input2		None	No		None	None	None	None				
3	Input3		None	No		None	None	None	None				
4	Input4		None	No		None	None	None	None				
5	AnyInputActive		None	No		None	None	None	None				
7	ThresholdMet		None	No		None	None	None	None				

Below the table is the 'Edit Register' form for 'Register 1'. It includes fields for Name (Input1), Register group, Units (None), Value type (None), Scaling (None), Sign type (Unsigned), and Storage / Connectivity options (LCD permissions, SD card logging, Cloud settings, Protocol conversion).

Create the Read and Math/Logic Rules

The I/O board is Modbus device ID 200.

- Create the Read Rule to read the I/O board inputs.

The screenshot shows the 'RTU Read' configuration screen. The 'Read Settings' section includes:

- Remote type: Holding register
- Frequency: 00:00:01.000 (hh:mm:ss.fff)
- Scale value: 0.000000, Scale offset: 0
- Apply offset before scale value: ☐
- Error condition: Apply value 0 after 0 read failures
- Floating point: ☐ Swap words
- On register: 0

The 'Local Register Names' list on the right contains: Input1, Input2, Input3, Input4.

- Go to the **Register Mapping > RTU > RTU Read** screen.
 - Create a Read Rule that reads data from I/O board and writes it to Local Registers 1 through 4.
 - Set the **Frequency** to one second.
- Create the Math/Logic Rule to determine when the send the text message.

The screenshot shows the 'Math / Logic' configuration screen. The 'Add Math Rule' section includes:

- Name: Or Inputs
- Operation: Logical OR
- Local Register: 1
- And/Through: Through
- Local Register: 4
- Affecting the following registers: Input1, Input2, Input3, Input4
- Store the result to: 6
- Local Register: AnyInputActive

- Go to the **Local Registers > Action Rules > Math/Logic** screen.
 - Write a logic rule that ORs Local Registers 1 through 4 and stores the result in Local Register 6. If any of the Local Registers is 1, a 1 is written into Local Register 6.
- Create the Threshold Rule to send the text message.
- The Threshold Rule defines the condition to send a text message using an if-then-else structure.

If Local Register 6 is greater than zero, **then** set Local Register 7 to a value of 1, **else** set Local Register 7 to a value of 0.

- Under the **Email/SMS on State Transitions** section, select the defined phones to email or text.
- Select the **Minimum on time** and **Minimum off time**. This example sets both to 5 seconds. The threshold rule must be active or inactive for at least 5 seconds before a text message is sent.

Define the SMS Recipients

- On the configuration software, go to the **Settings > Notifications** screen.
- In the **SMS Recipients** section, click on the arrow next to **Name**. The list of recipients displays.
- Enter a name, phone number, and a short message into the fields. After these fields are defined, the information displays in the threshold rule.

Define the General and Cloud Services Parameters

- On the **Settings > System** screen, set the time zone and select **Device observes DST** if the device will be observing Daylight Saving Time (DST). This allows the correct time to display on the DXM's LCD.
- On the **Settings > Cloud Services** screen, set the **Push interface** drop-down to **Cell**.
- On the **Settings > Cellular** screen, set up the cellular firewall as shown.

In our example, phone number 111-222-3333 sends text messages to the DXM. For your configuration, change this phone number for both sending text messages and sending commands via text message.

The default input settings on the I/O board are set to sinking (NPN). Connecting a switch to ground to any of the inputs should cause a text message to be sent. View the value of each Local Register defined in the configuration file by using the DXM's LCD, under the **Registers** menu.

Save and Upload the Configuration File

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

Changes to the XML file are not automatically saved. Save your configuration file before exiting the tool and before sending the XML file to the device to avoid losing data. If you select **DXM > Send XML Configuration to DXM** before saving the configuration file, the software will prompt you to choose between saving the file or continuing without saving the file.

1. Save the XML configuration file to your hard drive by going to the **File > Save As** menu.
2. Go to the **DXM > Send XML Configuration to DXM** menu.

Figure 12. Status indicator bar



- If the Application Status indicator is red, close and restart the DXM Configuration Tool, unplug and re-plug in the USB or Ethernet cable and reconnect the DXM to the software.
- If the Application Status indicator is green, the file upload is complete.
- If the Application Status indicator is yellow, the file transfer is in progress.

The device reboots and begins running the new configuration.

SMS Commands

The DXM100 and DXM150 models with a cellular modem can be remotely accessed using SMS messages. The incoming firewall provides security and only defined phone numbers are permitted to access the DXM. Responses may take 20 seconds or more, depending upon the cellular network.

Simple text messages can:

- Push data to the cloud
- Reboot the DXM
- Read to or write from Local Registers

A DXM requires a few minutes after powering up before it can accept SMS messages. Initial cellular connection times vary based on the wireless network. An 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.

push

Triggers an http push to a webserver. The DXM Controller accepts the message, executes the action, and sends an acknowledgement text message back to the user.

Example: Texting push forces defined local registers to be sent to a webserver.

push <send>

DXM acknowledgement text message: Register push requested

reboot

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

Example: Texting reboot forces the processor to reboot.

reboot <send>

DXM acknowledgement text message: rebooting...

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: Texting gr1 retrieves the value for register 1

gr1 <send>

DXM acknowledgement text message: Register 1 is 0

srN,X

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

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

sr1,10 <send>

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

Cell Number — The cell phone number to text (DXM's cell number) is found on the DXM LCD display under the **System Info > Cell** menu.

The cell phone number is not available on the DXM LCD display until the DXM has sent a message to the cellular network. This is done by a push to a webserver or a text message sent from the DXM. The cell phone number can also be acquired from the cellular plan provider.

3.5.10 Emailing DXM Log Files

The DXM can email log files after you configure a few parameters. Use the DXM Configuration Software to create the XML configuration file. After you have the basic XML configuration file, follow these steps.

1. Define the network interface: cellular or Ethernet
2. Define the data log email address
3. Define the email Simple Mail Transfer Protocol (SMTP) server settings

To review this example, load the configuration file **EmailCellLogTest_Rackspace.xml**.

The SMTP server authentication parameters (username, password) are not stored the XML configuration file. Manually enter these values into the DXM. For more information, see [Configure the SMTP Server Settings for Email](#) on p. 64.

Define the Network Interface to Use Cell or Ethernet

On the DXM Configuration Software, use the **Settings > Cloud Services** screen to define the Network Interface to use either cell or Ethernet.

1. On the DXM Configuration Software, go to the **Settings > Cloud Services** screen.
2. Under the **Network Interface** section, use the **Push interface** drop-down list to select **Cell**.
3. On the **Settings > Cellular** screen. In the **Cell Configuration** section, select your cellular model from the **Cell module** drop-down list.

Define the Log File Parameters

Use the DXM Configuration Software to define the log parameters.

1. Go to the **Settings > Logging** screen. Under **Data Log Configuration**, use the drop-down list to change the **Selected Log File** to Data Log 1.

The screenshot shows the 'Logging' tab selected in the top navigation bar. Below the navigation bar, there is a list of log files (currently empty) and buttons for 'Refresh list', 'Save selected file', 'Save all files', 'Delete selected file', and 'Delete all files'. The 'Data Log Configuration' window is open, showing 'Data Log 1' selected. The 'Enable Data Log 1' checkbox is checked. The 'Format and log trigger' section includes: 'Timestamp each log entry' (checked), 'Record times in' (Local time selected), 'File name' (LogFile1.txt), 'Log rate (hh:mm:ss)' (01:00:00), 'Log file header style' (Text), 'Disregard scale and offset when saving data' (unchecked), 'Number of decimal digits to display in log' (0), and 'Only log when register' (0) named is greater than 0. The 'E-mail and file save settings' section includes: 'Log file options' (Email and save when register is non-zero), 'When register' (101) named is greater than 0, 'SendEmail' (test@gmail.com), 'Subject' (LogFile1 - Timer Triggered Email - Log 1), and 'Message' (Email was triggered by Local Register 101 not equal to zero).

In this example, Data Log 1 is enabled with a log rate of 1 second. Each entry in the log file is time stamped with the local time. The header is in a text format. The log file options specify the email log is sent when Local Register 101 is non-zero.

2. Select **Enable Data Log 1**.
3. Using the **Local Registers > Local Registers in Use** screen, configure Local Register 100 as a timer that counts every second.

The screenshot shows the 'Local Registers in Use' configuration screen for Register 100. The 'Selected Register' is 100. The 'Clear Register' button is visible. The 'Register Overview' section shows: Name (Email Timer), Register group (None), and Units (None). The 'Value Options' section shows: Value type (Counter), 1 second, Scaling (None), and Sign type (Unsigned). The 'Storage / Connectivity' section shows: LCD permissions (None), SD card logging (None), Cloud settings (None), and Protocol conversion (None).

4. From the **Local Registers > Action Rules > Thresholds** screen, define an Threshold Rule that sets Local Register 101 to 1 when Local Register 100 is 90 (90 seconds).
5. Define an Threshold Rule that resets Local Register 100 back to zero to restart the timer.

The screenshot displays two configuration windows from the Sure Cross DXM Configuration Software v4.

Top Window: EmailTimerMaxCheck
 Title: When Local Register 100 (Email Timer) equals 90 set Local Register 101 (SendEmail) to 1 else set to 0
 Definition:
 When Local Register 100 Email Timer = Value 90
☒ When TRUE, set Local Register 101 SendEmail to Value 1
☒ When Local Register 100 (Email Timer) not equal to 90
 Set Local Register 101 (SendEmail) to Value 0
 Hysteresis:
 Hysteresis value 0
 Minimum on time (hh:mm:ss) 00:00:00
 Minimum off time (hh:mm:ss) 00:00:00
 On Time:
 Record the number of minutes that the rule has been true to Local Register 0
 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

Bottom Window: ResetEmailTimer
 Title: When Local Register 100 (Email Timer) greater than or equal to 91 set Local Register 100 (Email Timer) to 0
 Definition:
 When Local Register 100 Email Timer ≥ Value 91
☒ When TRUE, set Local Register 100 Email Timer to Value 0
☐ When Local Register 100 (Email Timer) less than 91
 Set Local Register 100 (Email Timer) to Local Register 100 Email Timer
 Hysteresis:
 Hysteresis value 0
 Minimum on time (hh:mm:ss) 00:00:00
 Minimum off time (hh:mm:ss) 00:00:00
 On Time:
 Record the number of minutes that the rule has been true to Local Register 0
 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

6. On the **Local Registers > Local Registers in Use** screen, set the Log flags for each Local Register you want logged to the log files.

Configure the SMTP Server Settings for Email

Use the **Settings > Notifications** screen to define the Simple Mail Transfer Protocol (SMTP) server settings.

At this time, defining a Google or Yahoo account for a SMTP server will not work when using cellular.

1. Verify the DXM is connected to the network.
2. On the **Settings > Notifications** screen, enable SMTP authentication.
3. Enter the **SMTP server** address and **SMTP server port**.
4. Enter the username and password.

The screenshot shows the 'Mail Server Settings' configuration window.

SMTP server: smtp.emailsrvr.com
 SMTP server port: 587
☒ No encryption
☐ Situational encryption
☒ Enable SMTP authentication
 User name: smtp1@sensonix.me
 Password: SX!smtPd3M1
 Send SMTP Password

- Click **Send SMTP Password** to save the username and password to the DXM.

The username and password are not stored in the XML configuration file. The DXM Configuration Software uploads this information to the DXM to be stored in non-volatile memory.

The **Notifications** settings in this example also work on Ethernet. To use Ethernet instead of cell, change the **Network Interface** on the **Settings > Cloud Services** screen to Ethernet.

3.5.11 Verifying Communication Between a Modbus Sensor and MultiHop Radio or DXM

Follow these steps to monitor a Modbus Banner Engineering sensor connection and/or operation status when the sensor is connected to a MultiHop radio or a DXM Controller with an embedded MultiHop module.

Required equipment includes:

- Wireless DXM Controller master with a MultiHop radio module
- Wireless DXM Controller slaves and/or MultiHop slave radios
- Modbus sensor such as the Temperature/Humidity Modbus Sensor model M12FTH3Q, or an SDI-12 sensor
- Windows-based PC running the DXM Configuration Tool v3 (downloaded from the Banner website)

To confirm an active radio communication between the sensor and radio, define **Read Rules** and **Action Rules**. Use two local registers to monitor each Modbus RTU sensor. Use an optional third register to monitor how long the sensor was not communicating with the radio.

- Connect to the DXM Controller master radio using serial or TCP/IP.
- Define the **Local Registers**.
- Define the **Read Rule**.
- Define the **Threshold/Action Rule**.
- Repeat these steps for each Modbus sensor and MultiHop slave radio you'd like to track.

Define the Local Registers

Define the local registers used to verify the connection between a Modbus sensor and a MultiHop radio.

- Go to the **Local Registers > Local Registers in Use** screen.
- Define a register to hold a data point.

Figure 13. Example data point for a relative humidity (RH) Modbus sensor.

ID	Register Name	Register Group	Units	Signed	Constant or Timer	Cloud Settings	LCD Permissions	Protocol Conversion	Log Files	Read Rules	Write Rules	Threshold Rules
1	Humidity 1		RH	No		ReadWrite	ReadWrite	None	None	Modbus RTU		New threshold rule
2	Humidity 2		RH	No		ReadWrite	ReadWrite	None	None	Modbus RTU		
3	None		None	No		ReadWrite	ReadWrite	None	None	Modbus RTU		
4	Humidity 1 Copy 1		RH	No		ReadWrite	ReadWrite	None	None	Modbus RTU		
5	Humidity 1 Copy 2		RH	No		ReadWrite	ReadWrite	None	None	Modbus RTU		
6	None		None	No		ReadWrite	ReadWrite	None	None	Modbus RTU		

Edit Register **Modify Multiple Registers**

Selected Register: 1

Register Overview

Name: Humidity 1

Register group:

Units: RH

Value Options

Value type: None

Scaling: Divide

Scale value: 100.00

Scale offset: 0.0000

☐ Apply offset before scale value

Sign type: Unsigned

Storage / Connectivity

LCD permissions: Read/Write

SD card logging: None

Cloud settings: Read/Write

Protocol conversion: None

Clear Register

Figure 14. Example data point for a wind speed SDI-12 sensor.

The screenshot shows the 'Local Registers' tab in the configuration software. The 'Local Registers In Use' table lists registers 7 through 14 and 1001. Register 1001 is selected, and the 'Edit Register' dialog is open. The dialog shows the following details for register 1001:

Register Overview	Value Options	Storage / Connectivity
Name: 102 Ave Wind Speed	Value type: None	LCD permissions: Read
Register group: Weather Information	Scaling: Multiply	SD card logging: None
Units: Custom	Scale value: 2.2370, Scale offset: 0.0000	Cloud settings: Read
	<input type="checkbox"/> Apply offset before scale value	Protocol conversion: None

- Define a register to be used as an alarm notification register when the MultiHop radio cannot communicate with the sensor.

Figure 15. Example alarm notification register for a relative humidity sensor.

The screenshot shows the 'Local Registers' tab in the configuration software. The 'Local Registers In Use' table lists registers 7 through 15 and 1001. Register 15 is selected, and the 'Edit Register' dialog is open. The dialog shows the following details for register 15:

Register Overview	Value Options	Storage / Connectivity
Name: Failure to Read RH	Value type: None	LCD permissions: Read
Register group: Environmental	Scaling: None	SD card logging: None
Units: on/off	Sign type: Unsigned	Cloud settings: Read
		Protocol conversion: None

Figure 16. Example alarm notification register for a wind speed sensor.

The screenshot shows the 'Local Registers' tab in the configuration software. The 'Local Registers In Use' table lists registers 7 through 19 and 1001. Register 19 is selected, and the 'Edit Register' dialog is open. The dialog shows the following details for register 19:

Register Overview	Value Options	Storage / Connectivity
Name: Speed Sensor Alarm	Value type: None	LCD permissions: Read
Register group: Sensor Connection	Scaling: None	SD card logging: Log 1
Units: on/off	Sign type: Unsigned	Cloud settings: Read
		Protocol conversion: None

- Define a register to be used to track how long the Modbus sensor was not communicating with the master radio.

Figure 17. Example communication register for a temperature/relative humidity sensor.

The screenshot displays the 'Local Registers' section of the software. A table lists various registers with their IDs, names, groups, units, and permissions. Below the table, the 'Edit Register' dialog is open for register 22, showing configuration options for its name, group, units, value type, scaling, error condition, and storage/connectivity settings.

ID	Register Name	Register Group	Units	Signed	Constant of Timer	Cloud Settings	LCD Permissions	Protocol Conversion	Log Files	Read Rules	Write Rules	Threshold
8	Temp 1		None	No		ReadWrite	ReadWrite	None	None			
9	Temp 2		None	No		ReadWrite	ReadWrite	None	None			
10	Temp 3		None	No		ReadWrite	ReadWrite	None	None			
11	Temp 4		None	No		ReadWrite	ReadWrite	None	None			
12	Average Temp		None	No		ReadWrite	ReadWrite	None	None			
13	None		None	No		ReadWrite	ReadWrite	None	None			
14	None		None	No		ReadWrite	ReadWrite	None	None			
15	Failure to Read RH	Environmental	on/off	No		Read	Read	None	None			
19	Wind Speed Sensor Alarm	Sensor Connection	on/off	No		Read	Read	None	Log 1			
22	RH Comm Alarm Time	Environmental	hours	No		Read	Read	None	Log 1			
1001	DS2 Ave Wind Speed	Weather	mph	Yes		Read	Read	None	None			

Edit Register (Selected Register: 22)

Register Overview:
 Name: RH Comm Alarm Tim
 Register group: Environmental
 Units: Custom hours

Value Options:
 Value type: None
 Scaling: Divide
 Scale value: 60.0000
 Scale offset: 0.0000
☐ Apply offset before scale value
 Sign type: Unsigned

Storage / Connectivity:
 LCD permissions: Read
 SD card logging: Log 1
 Cloud settings: Read
 Protocol conversion: None

Create a Read Rule

Create a Read Rule to define how often to read the sensor register and what to do if the communication attempt fails.

1. Go to the **Register Mapping > RTU > RTU Read** screen.
2. Click **Add Read Rule** to create a Read Rule.
3. Name the Read Rule and define from which slave ID this register is being read, how many registers are being read, and the starting register.
4. Define how often to read this register (**Frequency**).
5. Define what value should be written to the register (**Apply value**) after the number of failed read attempts (**read failures**).

Figure 18. Example read rule for monitoring the relative humidity sensor connection..

The screenshot shows the configuration for a read rule named 'Garage Humidity'. It specifies reading 1 register starting at 101 from slave ID 19. The frequency is set to 00:05:00.000 (5 minutes). The error condition is set to 'Apply value 125 after 5 read failures'. The local register name is 'Garage Humidity'.

Garage Humidity From slave ID 19 read 1 registers starting at 101 through 101 to local registers starting at 4 through 4

Read Settings:
 Remote type: Holding register
 Frequency: 00:05:00.000 hh:mm:ss.fff
 Scaling: Scale value 0.000000 Scale offset 0
☐ Apply offset before scale value
 Error condition: Apply value 125 after 5 read failures
 Floating point: ☐ Swap words
 On register: 0

Local Registers Names:
 Garage Humidity

Figure 19. Example read rule for monitoring the wind speed sensor connection.

The screenshot shows the configuration for a read rule named 'DS2 Speed_Dir_Temp C'. It specifies reading 2 registers starting at 11101 from slave ID 20. The frequency is set to 00:01:00.000 (1 minute). The error condition is set to 'Apply value 150 after 5 read failures'. The local register name is 'DS2 Ave Wind Speed'.

DS2 Speed_Dir_Temp C From slave ID 20 read 2 registers starting at 11101 through 11102 to local registers starting at 1001 through 1001

Read Settings:
 Remote type: Holding register
 Frequency: 00:01:00.000 hh:mm:ss.fff
 Scaling: Scale value 0.000000 Scale offset 0
☐ Apply offset before scale value
 Error condition: Apply value 150 after 5 read failures
 Floating point: ☐ Swap words
 On register: 0

Local Registers Names:
 DS2 Ave Wind Speed

For the relative humidity example, local register 4 (Garage Humidity) will be populated with the value from Modbus ID 19, register 101. The DXM master radio attempts to communicate with the Modbus sensor (Slave ID 19) every 5 minutes. After five consecutive unsuccessful attempts, the value of 125 is placed in the local register 19 (Failure to Read Garage RH).

For the wind speed example, local register 1001 (DS2 Wind Speed) will be populated with the value from Modbus ID 20, register 11101 and 11102. The DXM master radio attempts to communicate with the Modbus sensor (Slave ID 20) every 1 minute. After five consecutive unsuccessful attempts, the value of 150 is placed in the local register 19 (Failure to Read DS2 Wind Sensor).



Note: You must place the SDI-12 sensor results in the 32-Bit Floating Point Register set in the DXM Controller. When using an SDI-12 sensor and an SDI-12 enabled MultiHop radio, when the DXM master or remote radios cannot communicate with the sensor, a value of 65535 is entered into the Results Register for that sensor in the Local Registers.

Select an alarm value that makes sense for the potential values of the application, but won't adversely affect graphing or charting the data point for analysis. For the RH example, the normal value for this local register is between 0 and 100. Therefore, 125 is not too excessive but is different enough to be a trigger value. For the wind speed example, 150 is a good choice.

Create a Threshold Rule

Create an action rule to define the behavior of the system when the communication fails.

1. Go to the **Local Registers > Action Rules > Thresholds** screen.
2. Click **Add Threshold Rule**.
3. Define a **Threshold Rule** so that when the local register Failure to Read value equals the error value (125 for relative humidity, 150 for wind speed), a value of 1 is entered into the Communication Alarm register.

Figure 20. Example threshold/action rule for a humidity sensor communication failure.

T/H Sensor Comms Error When register 4 (Garage Humidity) equals 125 set register 19 (Failure to Read Garage RH) to 1

Definition

When local register 4 Garage Humidity = Value 125

☒ When TRUE, set local register 19 Failure to Read Garage RH to Value 1

☐ When register 4 (Garage Humidity) not equal to 125

Set register 19 (Failure to Read Garage RH) to Value 0

Hysteresis

Hysteresis value 0

Minimum on time (hh:mm:ss) 00:00:00

Minimum off time (hh:mm:ss) 00:00:00

On Time

Record the number of minutes that the rule has been true to register 22 RH Comm Alarm Time

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

SMS

Recipient	Send
SMS Recipient 1	<input checked="" type="checkbox"/>
SMS Recipient 2	<input type="checkbox"/>

E-Mail

Recipient	Send
E-mail Recipient 1	<input checked="" type="checkbox"/>
E-mail Recipient 2	<input type="checkbox"/>

Figure 21. Example threshold/action rule for a wind speed sensor communication failure.

Wind Speed Sensor Alarm When register 1001 (DS2 Ave Wind Speed) equals 150 set register 19 (Wind Speed Sensor Alarm) to 1

Definition

When local register 1001 DS2 Ave Wind Speed = Value 150

☒ When TRUE, set local register 19 Wind Speed Sensor Alarm to Value 1

☐ When register 1001 (DS2 Ave Wind Speed) not equal to 150

Set register 19 (Wind Speed Sensor Alarm) to Value 0

Hysteresis

Hysteresis value 0

Minimum on time (hh:mm:ss) 00:00:00

Minimum off time (hh:mm:ss) 00:00:00

On Time

Record the number of minutes that the rule has been true to register 0

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

SMS

Recipient	Send
SMS Recipient 1	<input checked="" type="checkbox"/>
SMS Recipient 2	<input type="checkbox"/>

E-Mail

Recipient	Send
E-mail Recipient 1	<input checked="" type="checkbox"/>
E-mail Recipient 2	<input type="checkbox"/>

For the relative humidity example, when this register's value equals 1, local register 22 tracks how long this Modbus sensor was not able to be reached. The alarm is sent to the web server service, and the event is logged in the Events Log on the DXM. A message is sent to one SMS recipient and one email recipient, although you can configure it to send more messages if necessary.

3.5.12 Using Action Rules to Control External Sensors

Action rules allow for simple logic functions and simple manipulation of local register data. The processing of an action rule is autonomous from other local register functions.

- Threshold rules create event-driven conditions, such as events to the cloud, local logs, or an email address
- Register Copy rules copy the contents of one register to another
- Math/Logic rules deal with 32-bit register logic with results from 0 to 4,294,967,295
- Control Logic rules are binary rules, with the results being either 0 or 1
- Trending rules find average, minimum, and maximum values
- Tracker rules monitor a Local Register value and store the result of a function in another register

The DXM can control external sensors using the timer/counter feature and Action Rules. In this example, the DXM controls a sensor using a cyclical loop with a timer. To configure this application, you must

1. Define the Local Registers
2. Define the Read/Write Rules
3. Define the Action Rules

One of the local registers is defined as a timer, which starts counting at zero. When 45 seconds has passed, the output is turned on to supply power to the sensor. At 55 seconds, the data is captured from the I/O board and saved. At 65 seconds, the output is turned off and the counter reset.

Define the Local Registers

Use the DXM Configuration Software to define the local registers needed to control the external sensor.

This task assumes you have downloaded and installed the latest version of the DXM Configuration Software onto a Windows-based PC.

1. Go to the **Local Registers > Local Registers in Use** screen.
2. Name local register 1 to contain the read data from the DXM I/O board.
3. Define local register 2 to be a 100 ms timer/counter.

ID	Register Name	Register Group	Units	Signed	Constant or Timer	Cloud Settings	LCD Permissions	Protocol Conversion	Log Files	Read Rules	Write Rules	Threshold Rules
1	ReadMap Data		None	No		None	None	None	None	Modbus RTU Read Input		SaveReadData
2	Timer1 100ms		None	No	100 ms	None	None	None	None			Timer at 45 sec Timer at 55 sec Timer at 60 sec
3	Sample 45sec		None	No		None	None	None	None		Modbus RTU Write Output	Timer at 45 sec
4	CaptureData 55sec		None	No		None	None	None	None			Timer at 55 sec SaveReadData
5	Read 60sec		None	No		None	None	None	None			Timer at 60 sec ResetCounter
6	Sampled Data		None	No		None	None	None	None			SaveReadData

Selected Register: 2

Register Overview

Name: Timer1 100ms

Register group:

Units: None

Value Options

Value type: Counter

Value: 100 ms

Scaling: None

Sign type: Unsigned

Storage / Connectivity

LCD permissions: None

SD card logging: None

Cloud settings: None

Protocol conversion: None

Clear Register

4. Name local register 3 to hold the result of Action Rule 1 (when the timer/counter reaches 45 seconds, this register value is 1).
5. Name local registers 4 and 5 to hold the results of Action Rules 2 and 3.
6. Name local register 6 as the saved sensor data.
7. Set the LCD permission to Read on all registers so that the register values display on the LCD.

After this configuration file is saved and uploaded to the DXM, the register values display on the LCD under the **Register** menu.

Create the Read and Write Rules

Use Read/Write maps to write local register values to other Modbus devices or read Modbus registers from other Modbus devices.

For our example, the DXM I/O board is another Modbus device (slave ID 200) to read to or write from.

1. Go to the **Register Mapping > RTU > RTU Read** screen. Click **Add Read Rule**.
A new read rule is created.
2. Click the arrow next to the new read rule to display the parameters.
3. Name your read rule.
4. Enter the **From slave ID** and the number of registers to read from.
For this example, we want to read from slave ID 200, the DXM100 I/O board (the DXM700 I/O board is slave ID 203).
5. Enter the frequency you'd like to read from this register.
For our example, we'd like to read the selected register every 1 second.
6. Go to the **RTU Write** screen and click **Add Write Rule**.
A new write rule is created.
7. Click the arrow next to the new write rule to display the parameters.
8. Name your write rule.
9. Enter the parameters to write from the local register to the target register.
For our example, we have to write from local register 3 to a holding register on slave ID 200, register 501. This writes a local register to an output on the DXM I/O board (slave ID 200) to control the power to the external sensor. We want to write at a **Frequency of On Change of local register data** so that the output register 501 only changes when the local register value changes from 0 to 1.

Create the Action Rules

Five Action Rules define the logic statements required to complete the application. The first three action rules define when the timer is greater than 45 seconds, greater than 55 seconds, and greater than 60 seconds. The final two rules capture the read data and reset the timer back to zero to restart the process.

1. Go to the **Local Registers > Action Rules > Thresholds** screen and click **Add Threshold Rule**.
2. Name the first action rule (checks the timer to see if it has reached 45 seconds or greater) and enter the necessary parameters.

For this example, we want to check when local register 2 (the timer/counter) is greater than or equal to 45 seconds. When true, it sets local register 3 to 1, otherwise, set local register 3 to zero.

3. Create the second and third action rules, which also check the timer count (local register 2) and change the values of local register 4 (CaptureData 55sec) and local register 5 (Read 60sec), respectively.
4. Create the fourth action rule to sample the sensor data.

The screenshot shows the 'SaveReadData' action rule configuration. The rule is triggered when register 4 (CaptureData 55sec) equals 1. The action is to set register 6 (Sampled Data) to the value of register 1 (ReadMap Data). The configuration includes a 'Definition' section with the following conditions:

- When local register 4 (CaptureData 55sec) equals 1, set register 6 (Sampled Data) to register 1 (ReadMap Data).
- When TRUE, set local register 6 (Sampled Data) to register 6 (Sampled Data).
- When register 4 (CaptureData 55sec) not equal to 1, set register 6 (Sampled Data) to register 6 (Sampled Data).

The 'Hysteresis' section shows a hysteresis value of 0, minimum on time of 00:00:00, and minimum off time of 00:00:00. The 'On Time' section shows a record of the number of minutes that the rule has been true to register 0. The 'Logging Options' section includes checkboxes for 'Save threshold events to cloud', 'Save threshold events to event log', 'Push when active', and 'After trigger, set source to 0'. The 'E-mail/SMS on State Transition' option is also available.

This action rule detects when local register 4 (timer at 55 seconds) is 1. The value of local register 6 is set to the value of local register 1 (ReadMap Data). When the value of local register 4 is not 1, local register 6 remains unchanged.

5. Create action rule 5 to reset the counter value and begin the count again.

The screenshot shows the 'ResetCounter' action rule configuration. The rule is triggered when register 5 (Read 60sec) equals 1. The action is to set register 2 (Timer1 100ms) to 0. The configuration includes a 'Definition' section with the following conditions:

- When local register 5 (Read 60sec) equals 1, set register 2 (Timer1 100ms) to 0.
- When TRUE, set local register 2 (Timer1 100ms) to 0.
- When register 5 (Read 60sec) not equal to 1, set register 2 (Timer1 100ms) to 0.

The 'Hysteresis' section shows a hysteresis value of 0, minimum on time of 00:00:00, and minimum off time of 00:00:00. The 'On Time' section shows a record of the number of minutes that the rule has been true to register 0. The 'Logging Options' section includes checkboxes for 'Save threshold events to cloud', 'Save threshold events to event log', 'Push when active', and 'After trigger, set source to 0'. The 'E-mail/SMS on State Transition' option is also available.

When the timer/counter register has reached 60 seconds (local register 5 is 1), set the value of the timer register back to 0. Otherwise, do not change the value.

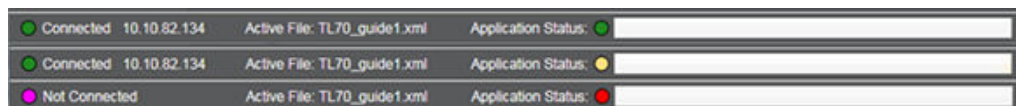
Save and Upload the Configuration File

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

Changes to the XML file are not automatically saved. Save your configuration file before exiting the tool and before sending the XML file to the device to avoid losing data. If you select **DXM > Send XML Configuration to DXM** before saving the configuration file, the software will prompt you to choose between saving the file or continuing without saving the file.

1. Save the XML configuration file to your hard drive by going to the **File > Save As** menu.
2. Go to the **DXM > Send XML Configuration to DXM** menu.

Figure 22. Status indicator bar



- If the Application Status indicator is red, close and restart the DXM Configuration Tool, unplug and re-plug in the USB or Ethernet cable and reconnect the DXM to the software.

- If the Application Status indicator is green, the file upload is complete.
 - If the Application Status indicator is yellow, the file transfer is in progress.
- The device reboots and begins running the new configuration.

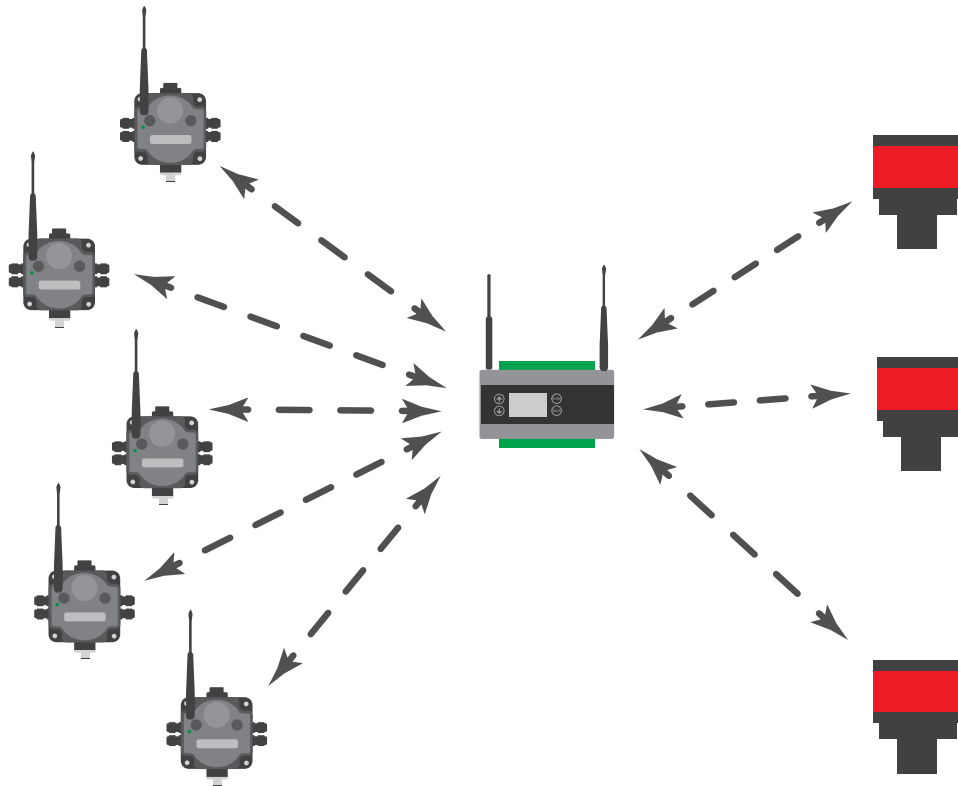
3.5.13 Map Many Inputs to One Output Using Action Rules

Use the DXM and Action Rules to read multiple inputs, logically OR the values, then write the result to an output or outputs. There are unlimited variations that can be accomplished using Action Rules and Read/Write maps.

This example does not explain how to use the DXM Configuration Software or discuss details of the DXM configuration. For help using the DXM Configuration Software, refer to the DXM Configuration Software Instruction Manual (p/n [158447](#)). For help setting up the various operations of the DXM, refer to:

- DXM100-Bx Wireless Controller Instruction Manual (p/n [190037](#))
- DXM150-Bx Wireless Controller Instruction Manual (p/n [190038](#))
- DXM700-Bx Wireless Controller Instruction Manual (p/n [207894](#))
- DXM1200-Bx Wireless Controller Instruction Manual (p/n [216539](#))

The example application is saved in the configuration file `ManytoOne.xml`. The applications reads a single discrete input on five different DX80 Nodes. If any input is activated, three different TL70 wireless stack light outputs are turned on. The discrete input is connected to the wireless Nodes on input 1 and the output on the stack lights are on the first output (Modbus register 9 on the Wireless TL70 Node)



1. Define the DXM Local Registers.
2. Define the DXM's Action Rules.
3. Create the register Read and Write Rules.
4. Save the configuration file and upload the file to the DXM.

Define the Local Registers

The Local Registers are the global storage area. Data is read from or written to the Local Registers.

1. Go to the **Local Registers > Local Registers in Use** screen.
2. Define the first five Local Registers as the Node 1 through 5 switch registers by naming them and setting **LCD permissions** to Read.

- Define Local Register 6 to be the output data transmitted to the Wireless TL70 Nodes by naming it and setting **LCD permissions** to Read.
- Define Local Registers 7 through 9 for the output data to be sent to the TL70 Nodes by naming them and setting **LCD permissions** to Read.
This example uses TL70 OUT A through OUT C.

The local registers are set up for the Action Rules and Read/Write Rules.

ID	Register Name	Register Group	Units	Signed	Constant or Timer	Cloud Settings	LCD Permissions	Protocol Conversion	Log Files	Read Rules	Write Rule:
1	N1 Input 1		None	No		None	Read	None	None		
2	N2 Input 1		None	No		None	Read	None	None		
3	N3 Input 1		None	No		None	Read	None	None		
4	N4 Input 1		None	No		None	Read	None	None		
5	N5 Input 1		None	No		None	Read	None	None		
6	Logic OR		None	No		None	Read	None	None		
7	N6 Out 1		None	No		None	Read	None	None		
8	N7 Out 1		None	No		None	Read	None	None		
9	N8 Out 1		None	No		None	Read	None	None		

Create the Action Rule

Create an Action Rule that logically ORs Local Registers 1 through 5 and writes the ORed value to Local Register 6, the results register for the light outputs.

- Go to the **Local Registers > Action Rules > Math/Logic** screen and click **Add Math Rule**.
- Name the math rule.
- From the drop-down lists, select Logical OR (**Operation**), Local Registers 1 through 5, and store the result in Local Register 6.

Name	Operation	Local Register	And/Through	Local Register	Affecting the following registers	Store the result to	Local Register
OR Registers	Logical OR	1	Through	5	N1 Input 1 N2 Input 1 N3 Input 1 N4 Input 1 N5 Input 1	→	6 Logic OR

- Go to the **Local Registers > Action Rules > Register Copy** screen and click **Add Copy Rule**.
- Name the copy rule.
For this example, the copy rule is named CopyOut.
- From the drop-down list, select the Local Register to out from.
Our example is copying from Local Register 6.
- From the drop-down lists, select the Local Register(s) to copy to.

Name	Copy Register	To Register	Through Register	Affecting the following registers
CopyOut	6 Logic OR	7	9	N6 Out 1 N7 Out 1 N8 Out 1

Our example is copying to Local Registers 7 through 9. The names of the target registers are listed.

Create the Read and Write Rules

Define the rules to read the switch input values from the internal DX80 Gateway (Modbus Slave 1) and write the values to Local Registers.

The DXM's internal ISM radio is Modbus Slave ID 1.

The four DX80 Gateway registers to read for Nodes 1 through 5, input 1, are 6802 through 6806. This register location organizes the Modbus registers by each input.

Define the Write Rule to write values to the Wireless TL70 Node registers. For this example application, the three Wireless TL70s are Nodes 5, 6, and 7. Because the DX80 Gateway handles all Modbus registers, write to the Gateway Modbus registers for Nodes 5 through 7, register 9, at addresses 8002–8004.

See *Alternate Modbus Register Organization in the DX80 Host Controller Systems Manual* (p/n [132114](#)) for more information about alternate Modbus registers.

1. Go to the **Register Mapping > RTU > RTU Read** screen and click **Add Read Rule**.
2. Click the arrow to display the read rule parameters.
3. Name your new rule.
4. From the drop-down lists, read **From slave ID 1, read 5 registers starting at 6802 to local registers starting at 1**.

5. Set the **Frequency** to 0.50 seconds.
6. Go to the **Register Mapping > RTU > RTU Write** screen and click **Add Write Rule**.
7. Click the arrow to display the write rule parameters.
8. Name the write rule and select the following parameters. Select a write **Frequency** of On change of local register data.

9. Create a second write rule, similar to the first one, that takes the logical OR value from Local Register 6 and writes it to DXM LED 1.

For more information on the user programmable indicator LEDs, see the DXM100/1000-Bx Instruction Manual (p/n [190037](#)).

Save and Upload the Configuration File

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

Changes to the XML file are not automatically saved. Save your configuration file before exiting the tool and before sending the XML file to the device to avoid losing data. If you select **DXM > Send XML Configuration to DXM** before saving the configuration file, the software will prompt you to choose between saving the file or continuing without saving the file.

1. Save the XML configuration file to your hard drive by going to the **File > Save As** menu.
2. Go to the **DXM > Send XML Configuration to DXM** menu.

Figure 23. Status indicator bar



- If the Application Status indicator is red, close and restart the DXM Configuration Tool, unplug and re-plug in the USB or Ethernet cable and reconnect the DXM to the software.
- If the Application Status indicator is green, the file upload is complete.
- If the Application Status indicator is yellow, the file transfer is in progress.

The device reboots and begins running the new configuration.

3.5.14 Enabling Flash State Recognition on a TL70 Wireless Tower Light

These instructions describe how to enable the TL70 Wireless Tower Light to recognize a 0.8 Hz to 6 Hz flashing state produced on the input. This feature allows each light segment to have two separate states that can be recognized and tracked for reporting or triggering rules or functions within the DXM100 Wireless Controller.

To enable the flash state recognition, change the Report Type and I/O Configuration using the DX80 User Configuration Tool. The TL70 must be bound to either the DXM100 or a DX80 Gateway.



Important: If using the Machine Monitoring / OEE Solutions Guide, this Tech Note DOES NOT need to be followed as the script loaded into the file will automatically do this for any TL70 Wireless Tower Light bound to the DXM.

Equipment Used

- DXM100 OR DX80 Performance Series Gateway (either 900 MHz or 2.4 GHz)
- TL70DXNx TL70 Wireless Tower Light (900 MHz or 2.4 GHz to match the DXM100 or Gateway) with RF Firmware version 6.4 or higher

Configure for Flashing Recognition

1. Download the DX80 User Configuration Tool (UCT) from Banner website and install on computer.
2. Apply power to the DXM or DX80 Gateway and the TL70 Wireless Tower Light.
3. Follow binding procedures listed on the TL70 datasheet to bind the Node to the Gateway.
4. Using a USB cable, connect the Gateway to the computer with UCT installed.
5. Connect the UCT to the Gateway going to the **Device > Connection Settings** menu.
6. Select **Serial** if using a DX80 Gateway or **Serial DXM** if using the DXM100. Select the COM port the USB cable is plugged into and click **Connect**. If you are unsure which COM port and multiple appear, attempt to connect to each one of them until you are successful.
7. Go to the **Configuration** screen and select **Nodes Currently in the System** from the drop-down list. Click **Get devices in system**.
8. Use the arrow next to the Node(s) that appear below the Gateway bar to expand the Node's parameters.
9. Read the current parameters for each input of the Node. Click **GET** next to that input. This takes less than one minute for each **GET**.
10. For each input (1 through 6) that needs to recognize flashing states, use the arrow next to that input to expand its parameters.
 - a. Under **I/O configuration**, change the **Report Type** to Analog
 - b. Under **Serial options** change the **IO configuration** to 24
11. Click **SEND** next to that updated input to send the new parameters to the device.
12. Repeat steps 9 through 11 for each input and Node that needs to recognize a flashing input.

Flashing Input States

Typical TL70 Wireless Tower Lights only indicate an ON or OFF state via a 1 or 0 when reading the input status for each light module. With the flashing input updates as described are applied, the unit displays four different states when reading the input status:

- 0 - OFF state

- 1 - ON state
- 2 - FLASHING OFF State
- 3 - FLASHING ON State

The input status 2 and 3 rotate back and forth as long as the light recognizes an input that is transitioning between ON and OFF at a frequency of at least 0.8 Hz and no faster than 6 Hz. If the input is transitioning slower than 0.8 Hz or faster than 6 Hz it may not display the input FLASHING status correctly.

4 Additional Information

4.1 Sending Text Messages Between DXMs

Only the DXM100 and DXM150 models can send and receive text messages.

Communicating from one DXM to another DXM using SMS text messaging is possible with a ScriptBasic program. The data is sent using cellular text messaging at a cyclical rate but that can be changed to send data when something changes. This example uses one DXM as the data originator (pitcher) and the other DXM as the receiver (catcher), although this could be bi-directional.

However, because the communications between DXMs uses SMS text messaging, verify your cellular wireless plan includes SMS messages to allow the text messaging rate programmed in the DXM system.

Some basic information must be set in the ScriptBasic program and XML configuration file for both devices to make texting communications work. That information is:

- Enter the cellular phone number to send text messages into the ScriptBasic program.
- For this example, define the cyclical interval to send text messages.
- Open the software firewall on the receiver (catcher) DXM for the phone number of the transmitter DXM (pitcher).

The two XML files, **Cellular_SMS_MappingPitcher.xml** and **Cellular_SMS_MappingCatcher.xml** can be loaded directly into two cellular DXMs and should be functional as is. The ScriptBasic program must be changed to provide the phone number of the receiver (catcher) DXM cell modem. Manually load the ScriptBasic program onto the transmitter (pitcher) DXM using the DXM Configuration Software, from the **Settings > Scripting** screen.

4.1.1 Configure the Transmitter DXM

To configure the transmitter (pitcher) DXM, follow these steps.

Upload the pre-configured configuration files to your DXM, or follow these instructions to update an existing xml file.

1. Launch the DXM Configuration Software and go to the **Local Registers > Local Register Configuration** screen.
2. Define register 1 is the Analog Input and define register 10 is a timer used to schedule the SMS messages.

#	Register Name	Register Group	Units	Signed	Constant or Timer	Cloud Permissions	LCD Permissions	Protocol Conversion	Log Files	Read Rules
1	Analog Input		mA	<input type="checkbox"/>	None	None	Read	None	None	Modbus RTU - Analog Input 1
10	Timer		None	<input type="checkbox"/>	Timer 1 second	None	Read	None	None	

3. Define a Read Rule to read Universal input 1 and write the value into Local Register 1.

Add Read Rule Clone Selected Rule Delete Selected Rule ↑ ↓

⌵ Analog Input 1 From slave ID 200 read 1 registers starting at 1 through 1 to local registers starting at 1 through 1

Read Settings

Remote type: Holding register

Frequency: 00:00:05.000 hh:mm:ss.fff

Scaling: Scale value 0.000000 Scale offset 0

☐ Apply offset before scale value

Error condition: Apply value 0 after 0 read failures

Floating point: ☐ Swap words

On register: 0

Local Register Names

Input1

4. Set the Network's **Push interface** to Cell.
5. Set the **Cloud push interval** to None.

The screenshot displays the 'Cloud Services' configuration window. It features several tabs: System, Cloud Services (active), Cellular, Ethernet, Notifications, Logging, Scripting, Administration, and I/O Board. A 'Show advanced settings' checkbox is checked. The 'Network Interface' section has a 'Push interface' dropdown set to 'Cell' and 'Ethernet retries per push interval' set to 5. The 'Cloud Push' section includes 'Cloud push interval' (None), 'Push packet format' (Default), an unchecked 'Apply scale and offset to push data' checkbox, 'Sample count' (1), 'Push port' (80), and an unchecked 'Print push debug messages to serial console' checkbox. The 'HTTPS' section has an unchecked 'Use HTTPS' checkbox and a 'Certificate CN' field. The 'Web Server' section includes 'Server name / IP' (push.bannercds.com), 'Page / Topic' (/push.aspx), 'Host header', 'Gateway ID is' (GUID), a 'Clear' button, a GUID field, a 'Custom HTTP Headers' dropdown, and 'Push Options' with checked boxes for 'Include XML GUID in first push' and 'Include serial number in pushes'. The 'Web Server Authentication' section has an unchecked 'Require Authentication' checkbox, 'Username' and 'Password' fields, and a 'Send Authentication' button.

- From the **Settings > Scripting** menu, manually load the ScriptBasic program (Cellular_SMS_Mapping.sb) to the transmitter (pitcher) DXM by clicking **Upload File**.

The ScriptBasic program needs to be loaded manually, separate from the XML configuration file. The setting of the ScriptBasic program to run at start up time is already configured in the XML file.

4.1.2 ScriptBasic Program Contents

The ScriptBasic program running on the transmitter (pitcher) DXM creates a SMS text message to the receiver (catcher) DXM.

The first section of the program defines constants and variables for the follow-on program. The constant that should be adjusted is the phone number, **PhoneNumberA**. The reset of the constants and variables can be left alone for basic operation.

SMS_Interval

Defines how often the DXM creates the test message.

Currently set to 30 seconds.

PhoneNumberA

Constant that represents the cellular phone number of the receiver (catcher) DXM.

Defined within the ScriptBasic program.

The beginning of the program starts with a SETREG command that writes a configuration register in the I/O board to make Universal input 1 a 4–20mA input. Not all applications will require this step.

The main program loop starts with the WHILE command. The first GETREG command reads the analog input value from Local Register 1, the next GETREG command reads the TIMER register.

The IF statement checks to see if the timer has reached the maximum value. If so, the program sends the SMS text message.

The **Message** variable is loaded with "sr1,xxxx". The value xxxx is the analog value read from Local Register 1.

The TIMER register is written to zero, then the text message is sent using the FILEOUT command.

The PRINT commands throughout the program will show up on the console output in the DXM Configuration Software.

The last command, SLEEP(1) causes the program to wait 1 second and then repeat the process. The WEND command defines the end of the WHILE loop, so that all programming statements between the WHILE and the WEND are executed forever.

```
' ScriptBasic program to send a SMS text message every minute to send and analog input
' to an analog output on another DXM using a cellular connection.
```

```

CONST In1_reg = 1
CONST In1Type_reg = 3306
CONST AnalogType4_20 = 2
CONST Timer_reg = 10
CONST LED_regs = 1102
CONST SMS_Interval = 30
CONST PhoneNumberA = "4403180566"
CONST SMS_Out = 3
,
CONST LocalReg = 199
CONST IOBoardSID = 200
CONST DisplaySID = 201
CONST HoldingReg = 0
,
AnalogInputData = 0
TimerValue = 0
Message = 0
Result = 0
WrErr = 0
,
' Set the universal input 1 type to 0-20ma (type 2)
' Not all applications will need to setup a universal input type, this example does...
WrErr = SETREG(In1Type_reg, AnalogType4_20, IOBoardSID, HoldingReg)
,
' MAIN LOOP
WHILE(1)
  'Read I/O to detect change.
  AnalogInputData = GETREG(In1_reg, LocalReg, HoldingReg)
  'Timer to indicate when to send a message.
  TimerValue = GETREG(Timer_reg, LocalReg, HoldingReg)
  ,
  'Send SMS message if timer has reached SMS_Interval
  IF TimerValue >= SMS_Interval THEN
    PRINT"Input data read: ",AnalogInputData, "\n"
    PRINT"Send SMS message...\n"
    Message = "sr1," &AnalogInputData
    ' Reset the timer register to zero
    WrErr = SETREG(Timer_reg, 0, LocalReg, HoldingReg)
    ' Send SMS message to PhoneNumberA
    Result = FILEOUT(SMS_Out, 0, 0, PhoneNumberA, Message )
    IF Result = 0 THEN
      PRINT"SMS message: ", Message, " Phone#: ",PhoneNumberA, "\n"
    ELSE
      PRINT" *** ERROR - Cellular \n"
    END IF
  END IF
  SLEEP(1)
END IF
WEND
END

```

4.1.3 Configure the Receiver DXM

The receiver (catcher) DXM requires little configuration. The SMS text message it receives from the transmitter DXM is a standard format that it understands and knows what to do with it. The receive string, sr1,xxxx indicates to Set Register 1 with value xxxx.

Upload the pre-configured configuration files to your DXM, or follow these instructions to update an existing xml file.

1. On the DXM Configuration Software and go to the **Local Registers > Local Register Configuration** screen.
2. Set the Network's **Push interface** to Cell.
3. Set the **Cloud push interval** to None.
4. On the **Settings > Network** screen, go the **Cell Software Firewall** section and select **Open software firewall**.
5. Define Local Register 1 as the analog output. The SMS message updates this register when the text message is received.
6. Define a **Write Rule** to read Local Register 1 and write it to the I/O base board analog output 1.

4.2 Verifying Communication Between a MultiHop Radio and DXM Controller

Follow these steps to monitor the communications connection between a DXM acting as a master radio and the MultiHop slave radios in a wireless network.

Required equipment includes:

- Wireless DXM Controller master with a MultiHop radio module
- Wireless DXM Controller slaves and/or MultiHop slave radios
- Windows-based PC running the DXM Configuration Tool v4 (downloaded from the Banner website)

To confirm the radio communications connection between the master and slave radios, define Read Rules and Action Rules. Use two local registers to monitor each MultiHop radio. Use an optional third register to monitor how long the slave radio was not communicating with the master radio.

1. Connect to the DXM Controller with the MultiHop master radio using serial or TCP/IP.
2. Define the Read Rule.
3. Define the Threshold/Action Rule.
4. Repeat these steps for each MultiHop slave radio you'd like to monitor.

4.2.1 Define the Local Registers

Define the local registers used to verify the connection between a DXM Controller with the MultiHop master radio and a MultiHop slave radio.

1. Go to the **Local Registers > Local Registers in Use** screen.
2. Define a register to hold a data point. For this example, we will define a Tank Level monitoring data point.

3. Define a register to be used as an alarm notification register when the MultiHop master radio cannot communicate with the MultiHop slave radios.
4. Define a register to be used to track how long the MultiHop slave radio was not communicating with the master radio.

ID	Register Name	Register Group	Units	Signed	Constant or Timer	Cloud Settings	LCD Permissions	Protocol Conversion	Log Files	Read Rules	Write Rules
23	Tank Water Level	Water Level	Inches	No		Read	Read	None	None	Modbus RTU Tank Level	
25	Tank Water Level RF Conn Alarm	RF Connection Alarms	on/off	No		Read	Read	None	None		
26	Water Tank RF Conn Alarm Time		Hours	No		Read	Read	None	Log 1		

4.2.2 Create a Read Rule

Create a Read Rule to define how often to read the sensor register and what to do if the communication attempt fails.

1. Go to the **Register Mapping > RTU > RTU Read** screen.
2. Click **Add New Rule** to create a Read Rule.
3. Name the Read Rule and define from which slave ID this register is being read, how many registers are being read, and the starting register.

For the Tank Level example, we are reading one register (register 7) from slave ID 22.

4. Define how often to read this register (**Frequency**).
5. Define what value should be written to the register (**Apply value**) after the number of failed read attempts (**read failures**).

Select an alarm value that makes sense for the potential values of the application, but won't adversely affect graphing or charting the data point for analysis. For this example, we will use an alarm value of 25, because the likely values for this application will range from 0 to 20. The alarm value of 25 will be written to local register 23 after five read failures.

4.2.3 Create a Threshold Rule

Create an action rule to define the behavior of the system when the communication fails.

1. Go to the **Local Registers > Action Rules > Thresholds** screen.
2. Click **Add Threshold Rule**.
3. Define a **Threshold Rule** so that when the local register Failure to Read value equals the error value (25 for the tank level register), a value of 1 is entered into the Communication Alarm register.

Water Lvl Radio RF Alarm When register 23 (Tank Water Level) equals 25 set register 25 (Tank Water Level RF Conn Alarm) to 1

Definition

When local register 23 (Tank Water Level) equals Value 25

☒ When TRUE, set local register 25 (Tank Water Level RF Conn Alarm) to Value 1

☐ When register 23 (Tank Water Level) not equal to 25

Set register 25 (Tank Water Level RF Conn Alarm) to Value 0

Hysteresis

Hysteresis value 0

Minimum on time (hh:mm:ss) 00:00:00

Minimum off time (hh:mm:ss) 00:00:00

On Time

Record the number of minutes that the rule has been true to register 26 (Water Tank RF Conn Alarm Time)

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

SMS		E-Mail	
Recipient	Send	Recipient	Send
SMS Recipient 1	<input checked="" type="checkbox"/>	E-mail Recipient 1	<input checked="" type="checkbox"/>
SMS Recipient 2	<input type="checkbox"/>	E-mail Recipient 2	<input type="checkbox"/>
SMS Recipient 3	<input type="checkbox"/>	E-mail Recipient 3	<input type="checkbox"/>
SMS Recipient 4	<input type="checkbox"/>	E-mail Recipient 4	<input type="checkbox"/>
SMS Recipient 5	<input type="checkbox"/>	E-mail Recipient 5	<input type="checkbox"/>
SMS Recipient 6	<input type="checkbox"/>	E-mail Recipient 6	<input type="checkbox"/>
SMS Recipient 7	<input type="checkbox"/>	E-mail Recipient 7	<input type="checkbox"/>
SMS Recipient 8	<input type="checkbox"/>	E-mail Recipient 8	<input type="checkbox"/>
SMS Recipient 9	<input type="checkbox"/>	E-mail Recipient 9	<input type="checkbox"/>
SMS Recipient 10	<input type="checkbox"/>	E-mail Recipient 10	<input type="checkbox"/>

For the tank level example, when this register's value equals 1, local register 26 tracks how long this remote MultiHop slave radio was not able to be reached. The alarm is sent to the web server service, and the event is logged in the Events Log on the DXM. A message is sent to one SMS recipient and one email recipient, although you can configure it to send more messages if necessary.

5 Troubleshooting

5.1 Manually Install the DXM Driver

If the DXM fails to connect over USB, first power down the DXM and unplug the USB cable from the PC, then follow these steps.

1. Verify the Windows update is configured to download device drivers.
 - a) On your Windows-based PC, go to the **Start** menu and select **Devices and Printers**.
 - b) Right-click the name of your computer, then select **Device installation settings**.
 - c) Select **Yes, do this automatically (recommended)**, then click **Save Changes**. If you're prompted for an administrator password or confirmation, type the password or provide confirmation. If Yes is already selected, click **Cancel** to close the dialog box.
2. Apply power to the DXM and plug the USB cable back into the computer.
The computer should recognize the DXM. If not, go to step 3.
3. If the DXM is still unrecognized, follow these steps.
 - a) Open Windows File Explorer and browse to either: C:\Program Files (x86)\Banner Wireless\DXM Configuration Platform\Drivers or C:\Program Files\Banner Wireless\DXM Configuration Platform\Drivers.
 - b) Copy the files banner2001_cdc.cat and banner2001_cdc.inf into c:\Windows\inf.
 - c) From the **Start** menu, go to **Control Panel > Hardware and Sound > Device and Printers > Device Manager**. The DXM Controller should appear as an unknown device.
 - d) Right-click on the DXM icon and select **Properties**.
 - e) Click the **Driver** tab.
 - f) Click **Update Driver**.
 - g) Click **Browse my Computer** for the driver software.
 - h) Click **Let me pick from a list of device drivers on my computer**.
 - i) Select AT91 CDC class driver and click **Next**. The process is complete. If AT91 is not present, go to the next step.
 - j) Select **Show All Devices** and click **Next**.
 - k) The system drivers display. Under Manufacturer, search for Banner Engineering Corp.
 - l) Select the DXM Wireless Controller and click **Next**.
 - m) A warning message appears stating that installing this device driver is not recommended. Click **Yes**.
 - n) If the Device Manager lists a com port with the DXM Wireless Controller title, the driver successfully installed.

5.2 Update the Software

The software version displays in the lower right corner. If there is a red exclamation point in front of the version number, you are not running the most recent version of the software.

Follow these steps to update your software.

1. Click on the red exclamation point.
An **Update Application** pop-up box appears, listing the newest version available.
2. Click on the version number link.
The newest version of the software downloads to the download directory listed in your browser.
3. Close the software program. If you leave the software running while updating, you will need to reboot the computer.
4. If you have downloaded a ZIP file, unzip the file and double-click the EXE to install the software. If you have downloaded an EXE file, double-click the file to install the software.

5.3 Reset the Controller if the Password is Lost

If the device is locked and the password is lost, go to the DXM to clear the password. Clearing the password from the controller also erases the configuration file and all ScriptBasic programs. To clear the password:

1. Remove the power from the device.
2. Set DIP switch 4 to the ON position.
3. Disconnect the Ethernet cable.
4. Apply power to the device.
5. Immediately after powering up, press and hold the reset button on the processor board.
After 10 to 15 seconds, all LEDs on the processor board flash quickly for a second. All files are erased and the password is cleared.
6. Remove the power from the device.

7. Set DIP switch 4 to the OFF position.
8. Reconnect the Ethernet cable.
9. Apply power to the device.
This erases all files from the device.
10. Reload your configuration files.

6 Product Support and Maintenance

6.1 Updating the DXM Processor Firmware

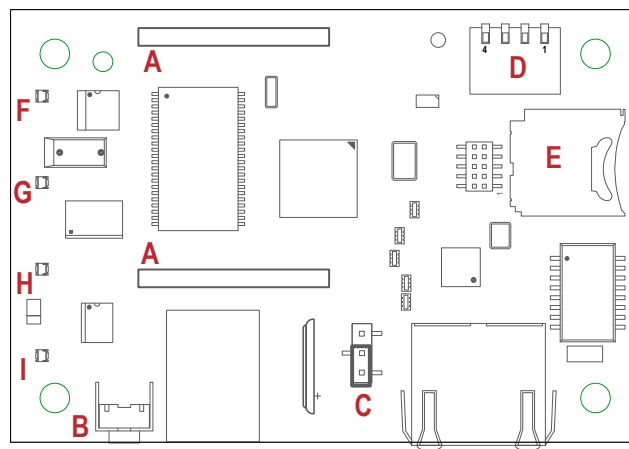
There are two different update procedures, depending on the DXM firmware version of your device.

6.1.1 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.

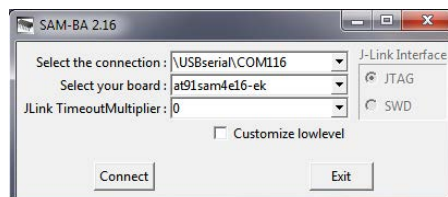
1. Download the SAM-BA software from <http://www.microchip.com/developmenttools/productdetails.aspx?partno=atmel+sam-ba+in-system+programmer>.
2. Install the SAM-BA program.
3. Set the processor board jumper (jumper C, shown below in the "boot load off" position).

Figure 24. Processor board



- a) Disconnect the DXM Controller from its power supply.
 - b) Open the hardware cover.
 - c) Using your fingers or tweezers, move the jumper to the "boot load on" position (jumper on the top two pins).
 - d) Connect the DXM back to its power supply.
 - e) The lower left LED on the I/O base board is solid when power is turned on. After the LED begins flashing, remove power.
 - f) Move the jumper back to its original position.
 - g) Replace the hardware cover.
 - h) Connect the DXM back to its power supply.
4. Launch the SAM-BA program. Select the COM port and correct board. Click **CONNECT**.

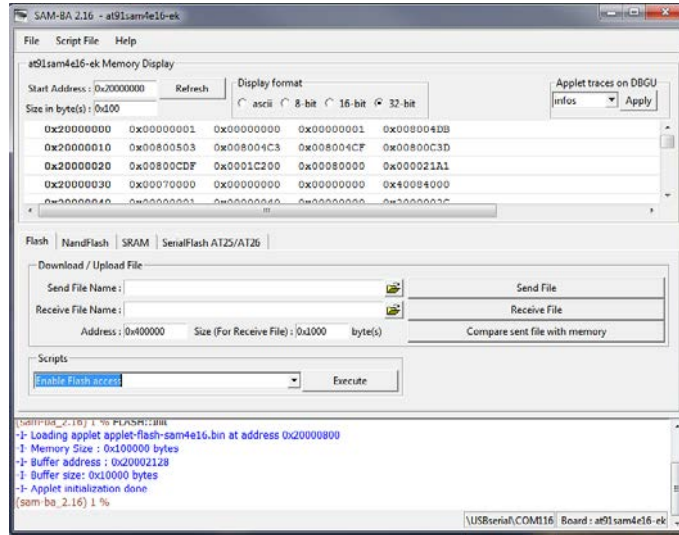
Figure 25. Popup screen



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

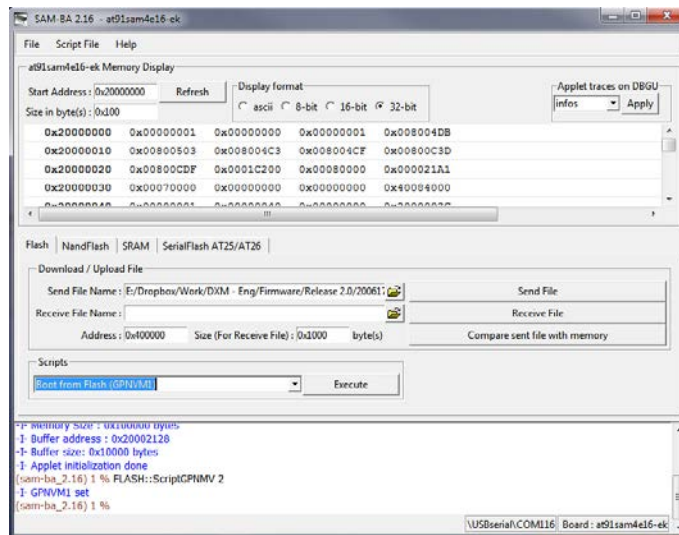
5. On the **SCRIPTS** pull-down menu select **ENABLE FLASH ACCESS**. Click **EXECUTE**.

Figure 26. SAM-BA popup window



6. In the **SCRIPTS** pull-down menu, select **BOOT FROM FLASH (GPNVM1)**. Click **EXECUTE**. Click **EXECUTE** again if the message indicates it failed.
7. In the **Flash** tab, click on the folder icon for the **Send File Name** field. Select the boot load file (must be a *.bin file) and click **SEND FILE**. The file is: [DXM PROCESSOR FIRMWARE V2.02](http://www.bannerengineering.com) or go to the software section of the Wireless Reference Library on www.bannerengineering.com.

Figure 27. SAM-BA popup window



The load process takes a few seconds.

8. After the load is complete, the program asks if you want to lock the flash region. Click **NO**.
9. Close the SAM-BA bootloader program.
10. Cycle the power to the DXM.

The new code should now be running and the LEDs should be on.

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

DXMs with processor firmware version 2.0 or later have a built-in boot loader program to update the firmware. Use the configuration software version 3 or later, the Banner Cloud Data Services webserver, or manually write the files on the SD card to update the firmware.

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

Table 3: Update process overview

Reprogramming Step	Approximate time required	Description
Loading new firmware file (*.HEX)	configuration software: 2 minutes over Ethernet or 15 minutes over USB Banner Cloud Data Services: 2 minutes over Ethernet or 5 minutes over Cellular	Send the new firmware image to the DXM. After the new image is on the device, the controller resets. LED3 is red during the loading process.
Verify the contents of the new firmware file	1 minute	When the DXM finds a file that should be installed, LED4 (amber) flashes at about a 1 second rate while the contents of the file are validated.
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 DXM 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 DXM resets and begins running the new firmware

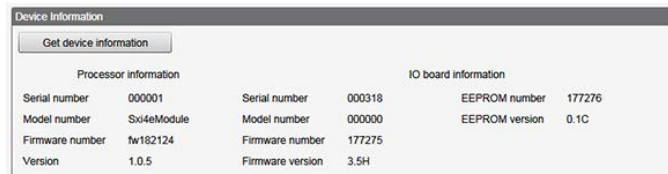
The firmware file names follow an 8.3 filename convention. The first 5 characters are the firmware part number in hexadecimal; the last 3 characters of the part number are the major/minor version number. For example, if 30FA9052.hex is the firmware programming file, 200617 decimal (30FA9 hex) is the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

Update Your DXM Processor Firmware Using the DXM Configuration Tool

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

- Using the DXM Configuration Software version 3 or later, connect to the DXM via USB³ or Ethernet.
File loads to the DXM will take about 15 minutes using USB or approximately 2 minutes using Ethernet.
- On the DXM Configuration Software, go to **Settings > General > Device Information** to verify the current firmware version.
You must load a different version with the same firmware number for the boot loader to operate. Download firmware files from the Banner website.

Figure 28. Device Information



Device Information			
Get device information			
Processor information		IO board information	
Serial number	000001	Serial number	000318
Model number	Sx14Module	Model number	000000
Firmware number	1w182124	Firmware number	177275
Version	1.0.5	Firmware version	3.5H
		EEPROM number	177276
		EEPROM version	0.1C

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

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

Update Your Processor Firmware Using the Banner Cloud Data Services Website

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

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

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



Site Configuration		Xcel Configuration		Site Info		Initial Push		Alarm Info	
Authentication: OFF	Auth Configure: OFF	File Name: FinalTestCell.xml	File Upload: 10/20/2018 09:02 (2018/10/20)	Last Push: 10/20/2018 09:02	Last SPS: None	Device Firmware: v2.00.00a000017	Model: 177271	Serial: 000270	MAC: None
		Push Method: Cellular	Push Interval: 00:00:00	GPS Update: 40/20h/20m	Pending Updates: None	Registries in Last Day: 0	Max: 10/20/2018 00:13:56	Cell Number: 000000	Cell Name: 000000
		Registries Estimate per Day: 400							

³ While the file download is in process over a USB connection, do not use other applications on the PC. After the DXM reboots for a firmware update, the USB port may be unresponsive. Clear the connection by disconnecting the USB cable and restarting the DXM Configuration Software software.

Data collected from the DXM is displayed.

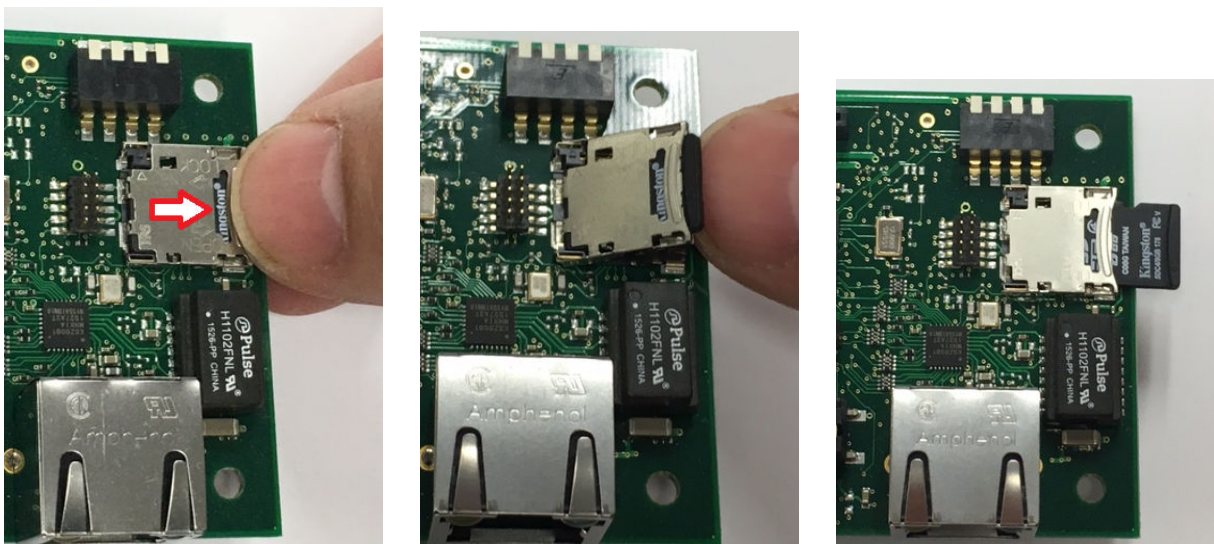
2. From the main **Dashboard > Sites** screen, click on **Update**.
A popup box appears.
3. Set the **Communications Type** to **Push Reply**, and set the **Update Type** to **Firmware file**.
4. Choose the appropriate **Upload File (*.HEX)** and click **Queue**. Click **Close**.
At the next scheduled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

Update Your Processor Firmware Manually

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

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

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



- a) Open the cover housing to the DXM.
 - b) Use your fingernail to slide the top metal portion of SD card holder.
 - c) The metal cover hinges upward, allowing access to the remove the SD card.
 - d) Press down on the SD cover and slide back into position to close the SD card holder.
3. Insert the micro SD card into an SD card reader to access the data from a PC.
 4. Load the new firmware file (*.hex) into the BOOT directory of the micro SD card.
 5. Re-insert the micro SD card into the DXM by sliding the card into the holder.
 6. Reconnect the DXM to its power supply.
The automatic boot process should begin. If the boot process does not begin, verify the firmware file is correct and it is a different version than what is currently installed on the device.

6.2 DXM Configuration Software v4 Release Notes

The following updates are included in the DXM Configuration Software v4 (content ID b_4496867). The release notes are content ID b_4498817.

Date	Version	Release Notes
16 Jan 2019	4.0.3	Initial release of the version 4 software. Note that the official name of all configuration tools has changed to "configuration software" to reserve "tools" to represent hardware.

Date	Version	Release Notes
18 Feb 2019	4.0.11	<p>Changed application name from "DXM Configuration Tool" to "DXM Configuration Software".</p> <p>If you are upgrading from v4.0.3 to v4.0.11, you may need to manually delete the "DXM Configuration Tool v4" shortcut from your desktop. A new shortcut named "DXM Configuration Software v4" will be created when you update.</p> <p>Added "Clone" and "Delete" functionality to Action Rules, Register Mapping, and Scheduler screens. Click any table row on one of these screens, then click the appropriate button to either duplicate or remove that row.</p> <p>Register View improvements: Bug fixes for register names and read/write operations; "Register source" options are now updated based on the selected Device Model.</p> <p>Updated labels throughout application for consistency and clarity.</p>
1 Mar 2019	4.0.14	<p>Users can now convert DXM700 configurations to DXM100/DXM150 configurations via the Model Select screen</p> <p>Cloud permissions and Cyclic push local register parameters have been combined into a single parameter called Cloud settings</p> <p>Various UI improvements and bugfixes</p>
22 Mar 2019	4.0.18	<p>Action rules and Register Mapping rules can now be reordered within their respective tables using the arrow buttons on the table headers.</p> <p>Updated validation for configuration file load. Any configuration file can now be loaded (regardless of which DXM device model it targets) if its Register IDs are valid for the currently-selected device model in the software.</p>
10 Apr 2019	4.0.21	<p>The Edit Register panel now includes a "Clear Register" button, which resets the selected register to its default parameters.</p> <p>Added warnings when configuring unusually fast Modbus RTU messaging rates.</p> <p>Assorted bug fixes for read/write rules, display registers, and I/O Board settings.</p>
15 May 2019	4.1.7	Added support for DXM100-A1 devices; UI improvements for various controls
22 Jul 2019	4.2.5	<p>Fixed localization issue on Modbus Timeout setting.</p> <p>Bugfixes and improvements for I/O Board settings.</p> <p>Fixes for Register Viewer handling of virtual registers</p>
15 Apr 2020	4.8.4	<p>Added Simple Setup Mode to perform automatic network discovery and start pushing data to the cloud</p> <p>Added support for DXM1000 and DXM1200 devices</p> <p>Added support for AWS IoT cloud platform</p>
1 Dec 2020	4.10.9	<p>Added new Solutions Guide mode, which allows for easy configuration of Solutions Guide sensors to push to the cloud</p> <p>Added support for PROFINET</p> <p>Software is now able to load and update outdated configuration files to the latest format</p> <p>Added Signed 16-bit Integer register type</p> <p>Added support for additional sensor models in Simple Setup mode</p> <p>Improved in-application status notifications and error messages</p> <p>Renamed DXM-AG1 device model to DXM-A1</p>
7 Jun 2021	4.10.28	<p>Converted the MQTT to AWS IoT Core; Improved AWS IoT Core interface</p> <p>Added DXM1500 and DXM-R90x support</p> <p>Device comms and configuration file bug fixes</p> <p>The Push method drop-down was replaced by a pair of radio buttons (denoting HTTP Cloud Push and AWS IoT Core)</p>

6.3 Contact Us

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7 Glossary of Wireless Terminology

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

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

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

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

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

active threshold	An active threshold is a trigger point or reporting threshold for an analog input.
a/d converter	An analog to digital converter converts varying sinusoidal signals from instruments into binary code for a computer.
address mode	The Sure Cross® wireless devices may use one of two types of addressing modes: rotary dial addressing or extended addressing. In rotary dial address mode, the left rotary dial establishes the network ID (NID) and the right rotary dial sets the device address. Extended address mode uses a security code to "bind" Nodes to a specific Gateway. Bound Nodes can only send and receive information from the Gateway they are bound to.
antenna	Antennas transmit radio signals by converting radio frequency electrical currents into electromagnetic waves. Antennas receive the signals by converting the electromagnetic waves back into radio frequency electrical currents.
attenuation	Attenuation is the radio signal loss occurring as signals travel through the medium. Radio signal attenuation may also be referred to as free space loss. The higher the frequency, the faster the signal strength decreases. For example, 2.4 GHz signals attenuate faster than 900 MHz signals.
baseline filter (M-GAGE)	Under normal conditions, the ambient magnetic field fluctuates. When the magnetic field readings drift below a threshold setting, the baseline or drift filter uses an algorithm to slowly match the radio device's baseline to the ambient magnetic field.
binding (DX80 star networks)	<p>Binding Nodes to a Gateway ensures the Nodes only exchange data with the Gateway they are bound to. After a Gateway enters binding mode, the Gateway automatically generates and transmits a unique extended addressing (XADR), or binding, code to all Nodes within range that are also in binding mode. The extended addressing (binding) code defines the network, and all radios within a network must use the same code.</p> <p>After binding your Nodes to the Gateway, make note of the binding code displayed under the *DVCFG > XADR menu on the Gateway's LCD. Knowing the binding code prevents having to re-bind all Nodes if the Gateway is ever replaced.</p>
binding (MultiHop networks)	<p>Binding MultiHop radios ensures all MultiHop radios within a network communicate only with other radios within the same network. The MultiHop radio master automatically generates a unique binding code when the radio master enters binding mode. This code is then transmitted to all radios within range that are also in binding mode. After a repeater/slave is bound, the repeater/slave radio accepts data only from the master to which it is bound. The binding code defines the network, and all radios within a network must use the same binding code.</p> <p>After binding your MultiHop radios to the master radio, make note of the binding code displayed under the *DVCFG > -BIND menu on the LCD. Knowing the binding code prevents having to re-bind all radios if the master is ever replaced.</p>
binding (serial data radio networks)	Binding the serial data radios ensures all radios within a network communicate only with the other radios within the same network. The serial data radio master automatically generates a unique binding code when the radio master enters binding mode. This code is transmitted to all radios within range that are also in binding mode. After a repeater/slave is bound, the repeater/slave radio accepts data only from the master to which it is bound. The binding code defines the network, and all radios within a network must use the same binding code.
bit packing i/o	Bit packing uses a single register, or range of contiguous registers, to represent I/O values. This allows you to read or write multiple I/O values with a single Modbus message.
booster (boost voltage)	A booster is an electronic circuit that increases a battery-level voltage input (3.6V) to a sensor operating voltage output (5 to 20 V).
CE	The CE mark on a product or machine establishes its compliance with all relevant European Union (EU) Directives and the associated safety standards.

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



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

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

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

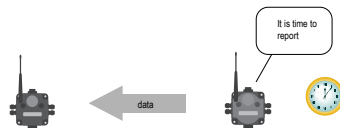
contention architecture Contention architecture is a wireless communication architecture that allows all network devices access to the communications channel at the same time. This may lead to transmission collisions.

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

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

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

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



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



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



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



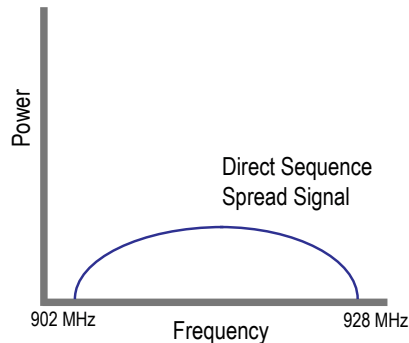
With a debounce filter, the signal is interpreted to change state only once.

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

decibel	<p>A decibel is a logarithmic ratio between a specific value and a base value of the same unit of measure. With respect to radio power, dBm is a ratio of power relative to 1 milliWatt. According to the following equation, 1 mW corresponds to 0 dBm.</p> <p>Equation: $P_{mW} = 10^{x/10}$ where x is the transmitted power in dBm, or $dBm = 10 \log(P_{mW})$</p> <p>Another decibel rating, dBi, is defined as an antenna's forward gain compared to an idealized isotropic antenna. Typically, $dBm = dBi = dBd + 2.15$ where dBi refers to an isotropic decibel, dBd is a dipole decibel, and dBm is relative to milliwatts.</p>
deep sleep mode	<p>Potted Puck models, potted M-GAGE models: Some battery-powered M-GAGE radios ship in a "deep sleep" mode to conserve battery power. While in "deep sleep" mode, the M-GAGE does not attempt to transmit to a parent radio and remains in "deep sleep" until an LED light at the receiving window wakes it up. M-GAGES that ship in "deep sleep" mode are typically the potted M-GAGES that require an LED Optical Commissioning Device to configure the M-GAGE.</p> <p>Wireless Q45 Sensors: If the Wireless Q45 Sensor fails to communicate with the Gateway for more than 5 minutes, it enters sleep mode. The radio continues to search for the Gateway at a slower rate and the LEDs do not blink. To wake up the sensor, press any button. After the Q45 wakes up, it will do a fast rate search for the Gateway for five more minutes.</p>
default output conditions/triggers	<p>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.</p> <p>Device Power Up—Power-up events occur every time the device is powered up.</p> <p>Out of Sync—Out-of-sync events occur when the radio is out of sync with its master radio.</p> <p>Host Link Failure—Host link failure is when the defined timeout period has elapsed with no communications between the host system (or Modbus master device) and the DX80 Gateway, typically about four seconds. These events trigger when a host link failure has been detected.</p> <p>Node Link Failure—Node link failures are determined by the polling interval or the out-of-sync timing. When a Node detects a communications failure with the Gateway and the Node Link Failure flag is set, the output points are set to the user-defined states and the inputs are frozen.</p> <p>Gateway Link Failure—Gateway link failures are determined by three global parameters: Polling Interval, Maximum Missed Message Count and Re-link Count. When the Node's Gateway Link Failure flag is set and the Gateway determines a timeout condition exists for a Node, any outputs linked from the failing Node are set to the user-defined default state.</p>
default output value	<p>Default output values are specific values written to output registers. For discrete outputs, this is a 1 (on) or 0 (off) value. For analog outputs the value can be any valid register value. When a default condition occurs, these default output values are written to the output register.</p>
delta	<p>The delta parameter defines the change required between sample points of an analog input before the analog input reports a new value. To turn off this option, set the Delta value to 0.</p>
determinism	<p>A deterministic system defines how network endpoints behave during the loss of communications. The network identifies when the communications link is lost and sets relevant outputs to user-defined conditions. Once the radio signal is re-established, the network returns to normal operation.</p>
device, node, or radio address/ID (DX80 Networks)	<p>The Node address is a unique identifier for each wireless device on a network and is set using the rotary dials. For the DX80 networks, Gateways are identified as device 0. Nodes are assigned addresses (NADR) from 01 to 47 using the rotary dials.</p>
directional antenna	<p>A direction antenna, or Yagi, is an antenna that focuses the majority of the signal energy in one specific direction.</p>



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



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

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

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

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

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

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

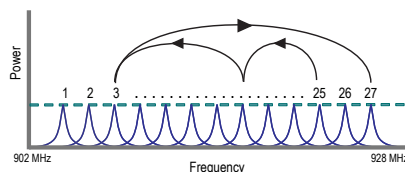
FlexPower Banner's *FlexPower*® technology allows for a true wireless solution by allowing the device to operate using either 10 to 30 V DC, 3.6 V lithium D cell batteries, or solar power. This unique power management system can operate a *FlexPower* Node and an optimized sensing device for up to 5 years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

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

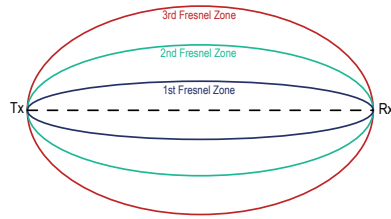
For the 900 MHz radio band: $FSL = 31.5 + 20 \log d$ (where d is in meters).

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

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



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



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

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

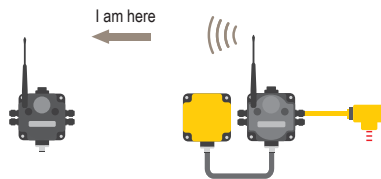
Gateway A Sure Cross® Gateway is the wireless sensor network master device used to control network timing and schedule communication traffic. Similar to how a gateway device on a wired network acts as a "portal" between networks, the Sure Cross Gateway acts as the portal between the wireless network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

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

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

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

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



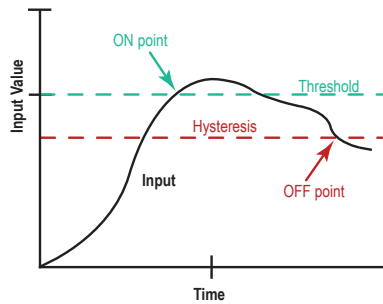
hibernation/ storage mode While in **storage mode**, the radio does not operate. To put any integrated battery Sure Cross radio into storage mode, press and hold button 1 for five seconds. To wake the device, press and hold button 1 for five seconds. The radio is in storage mode when the LEDs stop blinking, but in some models, the LCD remains on for an additional minute after the radio enters storage mode. After a device has entered storage mode, you must wait one minute before waking it.

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

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

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

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



Industrial, Scientific, and Medical Band (ISM)

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

latency

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

lightning arrestor

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



line of sight

Line of sight is the unobstructed path between radio antennas.

link failures

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

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

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

local and non-local registers

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

master/slave relationship

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

maximum bad count

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

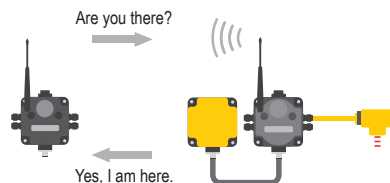
maximum misses

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

median filter

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

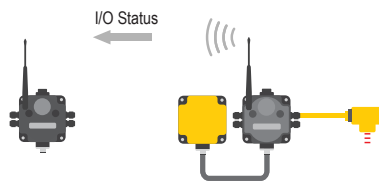
Modbus	Modbus is a master-slave communications protocol typically used for industrial applications.
Modbus/TCP	Modbus/TCP is an open standard protocol very similar to Modbus RTU except that it uses standard Internet communication protocols.
MultiHop	<p>MultiHop networks are made up of one master radio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



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

radiation pattern	An antenna's radiation pattern is the area over which the antenna broadcasts an easily received signal. The radiation pattern/shape changes based on the antenna type and gain.
re-link count	The re-link count is the number of completed polling messages the Gateway receives from a Node before a lost RF link is considered re-established and normal operation resumes.
remote antenna	A remote antenna installation is any antenna not mounted directly to the Sure Cross wireless device, especially when coaxial cable is used. Always properly install and ground surge suppressors in remote antenna systems.
repeater radio	A repeater radio extends the transmission range of a wireless network. Repeaters are typically used in long-distance transmission.
report interval/ rate	The report rate defines how often the Node communicates the I/O status to the Gateway. For FlexPower® applications, setting the report rate to a slower rate extends the battery life.



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

rotary dial address mode	See: <i>address mode</i>
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Received Signal Strength Indicator (RSSI)	An RSSI is the measurement of the strength of received signals in a wireless environment. See <i>Site Survey</i> .
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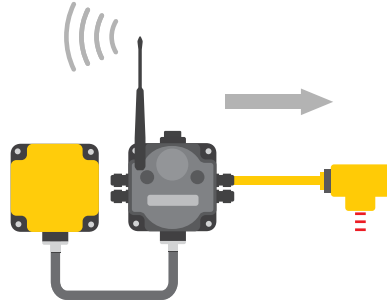
resistance temperature detector (RTD)	An RTD is a temperature measurement device that measures the electrical resistance across a pure metal. The most commonly used metal is platinum because of its temperature range, accuracy, and stability.
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RTDs are used for higher precision applications or for longer wire runs because RTDs can compensate for wire length. In industrial applications, RTDs are not generally used at temperatures above 660° C. Though RTDs are more accurate, they are slower to respond and have a smaller temperature range than thermocouples.

sample high/ sample low (analog I/O)	For analog inputs, the sample high parameter defines the number of consecutive samples the input signal must be above the threshold before a signal is considered active. Sample low defines the number of consecutive samples the input signal must be below the threshold minus hysteresis before a signal is considered deactivated. The sample high and sample low parameters are used to avoid unwanted input transitions.
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sample high/ sample low (discrete I/O)	For discrete inputs, the sample high parameter defines the number of consecutive samples the input signal must be high before a signal is considered active. Sample low defines the number of consecutive samples the input signal must be low before a signal is considered low. The sample high and sample low parameters are used to create a filter to avoid unwanted input transitions. The default value is 0, which disables this feature. The value range is 1 through 255.
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sample interval/ rate	The sample interval, or rate, defines how often the Sure Cross device samples the input. For battery-powered applications, setting a slower rate extends the battery life.
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sample on demand

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

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

signal-to-noise ratio (SNR)

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

The equations for calculating SNR are:

$SNR = 20 \times \log (V_s/V_n)$ where V_s is the signal voltage and V_n is the noise voltage;

$SNR = 20 \times \log (A_s/A_n)$ where A_s is the signal amplitude and A_n is the noise amplitude; or

$SNR = 10 \times \log (P_s/P_n)$ where P_s is the signal power and P_n is the noise power.

single-point ground

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

site survey

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

slave ID

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

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

sleep mode

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

slow scan mode

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

SMA connector

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

spread spectrum

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

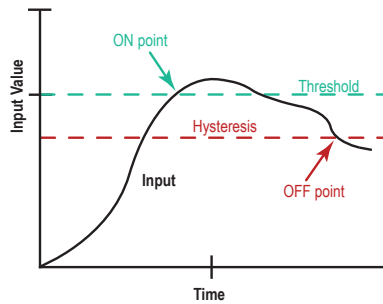
star networks

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



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

switch power	Efficient power management technology enables some <i>FlexPower</i> devices to include an internal power output supply, called switch power (SP), that briefly steps up to power sensors (ideally, 4 to 20 mA loop-powered sensors). The warmup time denotes how long the sensor must be powered before a reliable reading can be taken. After the warmup time has passed, the input reads the sensor, then the switched power shuts off to prolong battery life.
system operating margin (fade margin)	The system operating margin, or fade margin, is the difference between the received signal level (in dBm) and the receiver sensitivity (also in dBm) required for reliable reception. It is recommended that the receiver sensitivity be more than 10 dBm less than the received signal level. For example, if the signal is about -65 dB after traveling through the air and the radio receiver is rated for -85 dB, the operating margin is 20 dB — an excellent margin.
tau filter	Set to zero (0) to turn off the tau filter. Set to 1 (weakest filter) through 6 (strongest filter) to turn on the tau filter. (In the DX80 products, the Low Pass Filter is a combination of the median filter and the tau filter.)
TCP/IP	TCP/IP stands for Transfer Control Protocol / Internet Protocol and describe several layers in the OSI model that control the transfer and addressing of information.
time-division multiple access (TDMA)	TDMA is a wireless network communication architecture that provides a given slot of time for each device on the network, providing a guaranteed opportunity for each device to transmit to the wireless network master device.
thermistor	A thermistor is a temperature-sensitive resistor that changes resistance based on temperature fluctuation.
thermocouple	<p>A thermocouple is a temperature measuring device consisting of two dissimilar metals joined together so that the difference in voltage can be measured. Voltage changes in proportion to temperature, therefore the voltage difference indicates a temperature difference.</p> <p>The different "types" of thermocouples use different metal pairs for accuracy over different temperature ranges. Thermocouples are inexpensive, relatively interchangeable, have standard connectors, and have a wide temperature range of operation. They can be susceptible to noise, with the wire length affecting accuracy. Thermocouples are best suited for applications with large temperature ranges, not for measuring small temperature changes over small ranges.</p>
threshold and hysteresis	Threshold and hysteresis work together to establish the ON and OFF points of an analog input. The threshold defines a trigger point or reporting threshold (ON point) for a sensor input. Setting a threshold establishes an ON point. Hysteresis defines how far below the threshold the analog input is required to be before the input is considered OFF. A typical hysteresis value is 10% to 20% of the unit's range.



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

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

- timeout interval** The Timeout Interval is the total elapsed time before the system flags an error condition. This is a calculated value from Polling Interval (sec) × Maximum Misses.
- topology** Topology is the pattern of interconnection between devices in a communication network. Some examples include point to point, bus, ring, tree, mesh, and star configurations.
- transceiver** A transceiver includes both a transmitter and receiver in one housing and shares circuitry; abbreviated as RxTx.
- wireless sensor network (WSN)** A wireless sensor network is a network of low-power electronic devices that combine sensing and processing ability. The devices use radio waves to communicate to a gateway device, connecting remote areas to the central control process.
- Yagi** Yagi is the name commonly given to directional antennas. The full name of the antenna is a Yagi-Uda antenna, named for the developers Shintaro Uda and Hidetsugu Yagi, both of Tohoku Imperial University in Sendai, Japan. Yagi antennas may also be called beam antennas or directional antennas.



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