# DXM Configuraton Tool v3

## Instruction Manual

Original Instructions
201127 Rev. A
21 June 2017

more sensors, more solutions

# Contents

# 1 DXM **Configuration** Tool

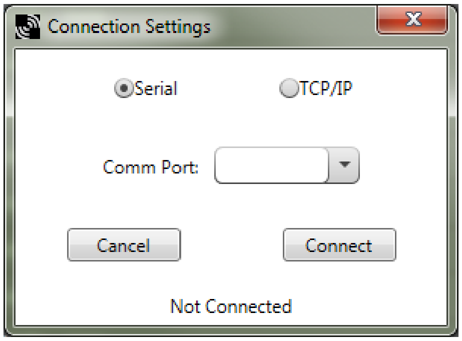
Configure the DXM Controller using the DXM Configuration Tool. The DXM Configuration Tool can be used stand-alone or connected to the controller using USB or Ethernet. The tool creates an XML file defined for the DXM Controller and can be used at the website level for configuration.

The DXM Configuration Tool restricts the naming of registers and rules to characters a-z, A-Z, 0-9, # $ _ - ( ) space.

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

There are two top-level menus similar to other Windows programs: File and Device.

- Use the File menu to manage the loading and saving of the XML configuration file created by the DXM Configuration Tool.
- Use the Device menu to handle the connection settings to the DXM Controller as well as upload or download the XML configuration files. Also part of the Device menu is the communications tools used to view data traffic on the serial bus, useful in ScriptBasic programming.



Connect to the DXM Controller by selecting the Device > **Connection Settings** menu. Connect via USB or Ethernet. Before attempting an Ethernet connection, first connect using USB so you can configure the Ethernet parameters before you connect to a live network.

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 Controller if needed; the tool automatically disconnects the COMM port, then reconnect it again.

For a simple tutorial using the DXM Configuration Tool see the *DXM Controller Configuration Quick Start Guide*.

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

# 2 **Software** Screens

The following sections explain the function of each screen.

## 2.1 **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 provide the mechanism to create event-driven conditions, such as events to the cloud, local logs, or an email address. There are three groups that make up action rules.

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 Tool. 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. Constants are applied first, cancelling any changes that may have occurred from other sources
2. Calculate (Math) rules are next, continually processed
3. Copy rules, processed only when a change of state is detected on the source register
4. Threshold rules, continually processed
5. Control Logic, continually processed
6. Trending, continually processed
7. Trackers, continually processed

### 2.1.1 Control Logic

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.

Control 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 Rule, a non-zero value in a Local Register is defined as a 1 value. Control Rules are evaluated when an input value changes state.

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. The invert flag 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] |
| 1 | 0 | 1 | 0 |
| 0 | 0 | No change | No change |
| 0 | 1 | 0 | 1 |
| 1 | 1 | Invalid [2] | |

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.

| 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 |

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.

[1] Optional inputs or outputs. Leave the optional inputs or outputs connected to 0 when not used.

[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) |

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 |
| 1 | 1 | 1 | ↑ | No change | No change |

The Binary Logic rules are based on zero and non-zero values and result in a 0 or 1. 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 Binary Logic rule requires two inputs; the NOT rule only has one input.

Optionally, the Binary Logic 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. Binary logic rules have the following functions:

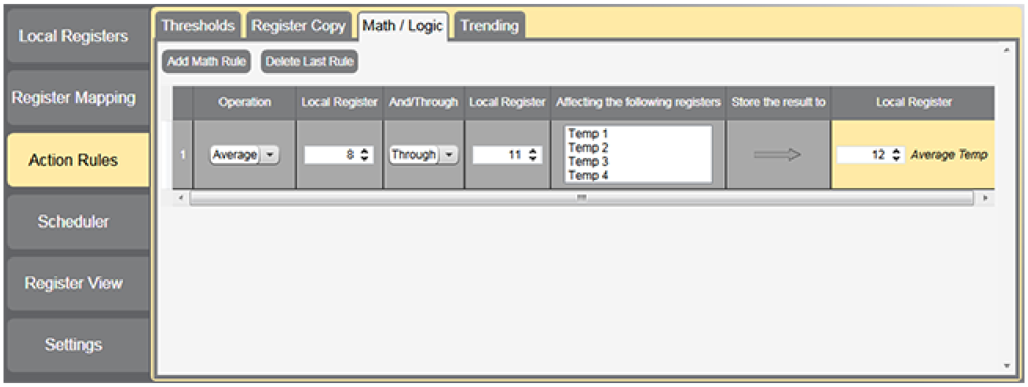
- AND—Output is high (1) only if both inputs are non-zero
- OR—Output is high (1) if either input is non-zero
- XOR—Output is high (1) if either, but not both, inputs are non-zero
- NOT—Input is inverted to the output
- NAND—Output is low (0) if both inputs are high (> 0)
- NOR—Output is high (1) if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

### Create a Control 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.

## 2.1.2 Math and Logic

Use the Math/Logic Rules screen to define simple operations using local registers.



| | Operation | Local Register | And/Through | Local Register | Affecting the following registers | Store the result to | Local Register |
|---|---|---|---|---|---|---|---|
| 1 | Average | 8 | Through | 11 | Temp 1<br>Temp 2<br>Temp 3<br>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.
- **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.

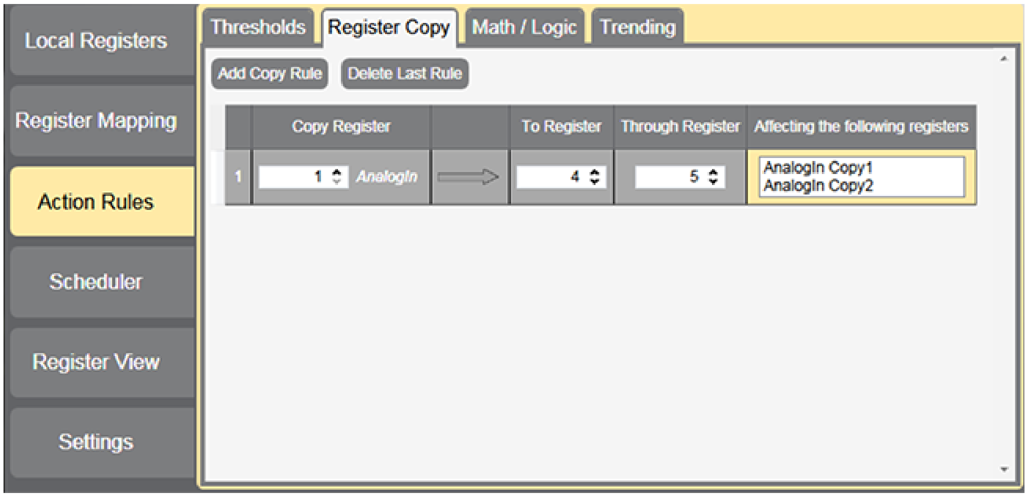
### Create a Math Rule

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.

## 2.1.3 Register Copy

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



| | Copy Register | | To Register | Through Register | Affecting the following registers |
|---|---|---|---|---|---|
| 1 | 1 AnalogIn | ⇨ | 4 | 5 | AnalogIn Copy1<br>AnalogIn Copy2 |

Add New Rule—Creates a new copy rule.

Copy Register—Starting register of the data source range of registers.

To Register—Starting register of the data target range of registers.

Through Register—Ending register of the data target range of registers.

### Create a Register Copy Rule

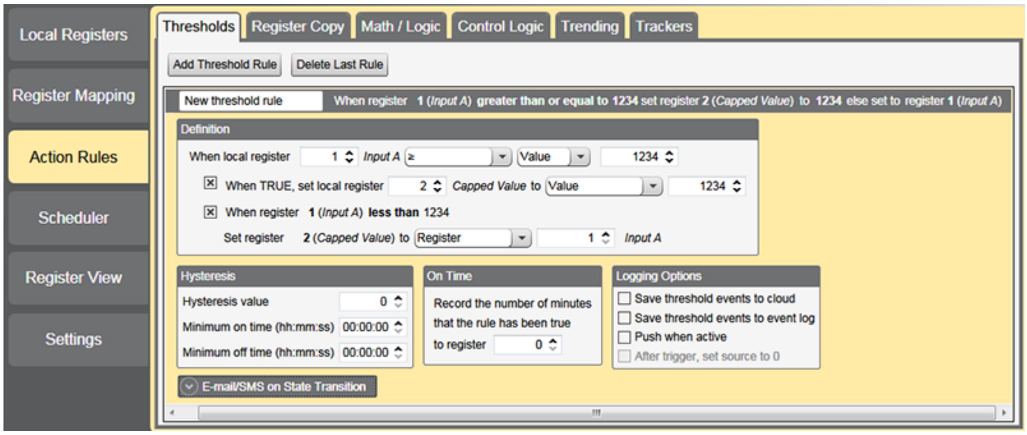
1. From the **Action** Rules > Register Copy screen, click Add New Rule.
2. Enter the Copy Register. This is the first register for the source of the data.
3. Enter the To Register and Through Register. These are the registers for the beginning and end of the target range of registers.
   - If you are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

## 2.1.4 Thresholds

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.

The local register value is the raw register value. The display scaling and offset are not applied for these comparisons.



New threshold rule — When register 1 (*Input A*) greater than or equal to 1234 set register 2 (*Capped Value*) to 1234 else set to register 1 (*Input A*)

When local register 1 *Input A* ≥ Value 1234

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

☒ When register 1 (*Input A*) **less than** 1234

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

Hysteresis value 0

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

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

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

☐ Save threshold events to cloud
☐ Save threshold events to event log
☐ Push when active
☐ After trigger, set source to 0

Create threshold rules to compare register values using mathematical functions.

Changed By—Local register value was changed by a defined value or local register value. The minimum On Time can be applied to define a time period at which the rate of change can be applied. This special treatment of the On Time parameter only applies to the Changed By comparison.

E-Mail/SMS—When a Threshold rule becomes active or inactive the controller can send and 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).

Equal To—Local register value is equal to a defined value or local register value.

Greater Than—Local register value is greater than a defined value or local register value.

Greater or Equal To—Local register value is greater than or equal to a defined value or local register value.

Hysteresis—Optional parameter that is enabled only when vales are nonzero. 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.

Less Than—Local register value is less than a defined value or local register value.

Less Than or Equal To—Local register value is less than or equal to a defined value or local register value.

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

- Sending threshold events to the cloud. An immediate push with the threshold register states is sent to the webserver when this rule becomes active.
- Saving the state to an internal event log. Go to **Settings** > Logging to set up the event log.
- Pushing 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**)

Not Equal To—The local register value is not equal to a defined value or local register value.

On Time—Stores in a local register how long (in minutes) the Threshold rule has been true.

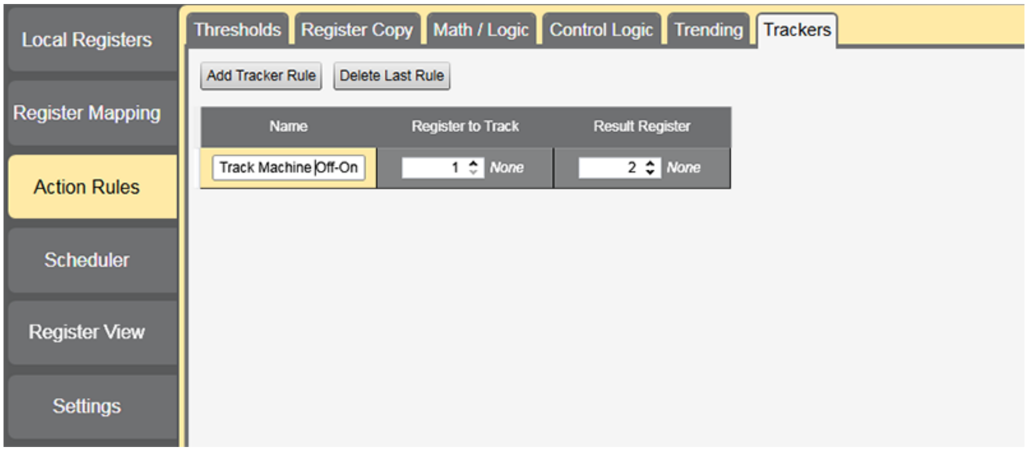
### Create a Threshold Rule

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.

## 2.1.5 Tracker Rules

Tracker rules monitor a Local Register and count the number of register transitions from 0 to a non-zero value (rising edge). The count is stored in another Local Register defined as the result register.

The speed at which it can count depends on how much work the DXM Controller is performing. Typical tracker rates should be around 1 to 2 times per second.



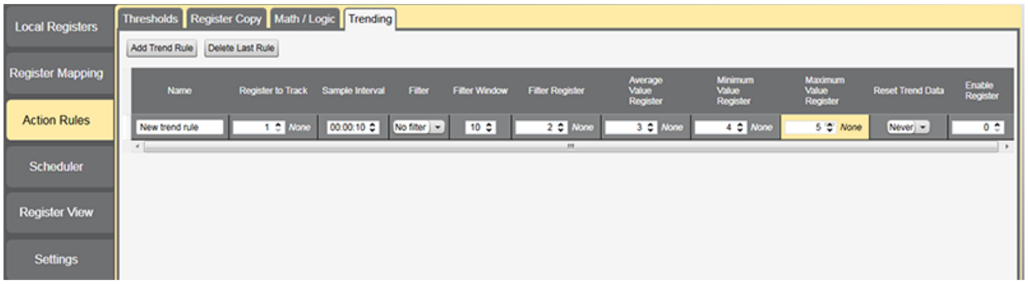
| Name | Register to Track | Result Register |
|---|---|---|
| Track Machine Off-On | 1 None | 2 None |

### Create a Tracker Rule

1. From the **Action** Rules > Trackers screen, click Add Tracker Rule.
2. Name your new tracker rule.
3. Select the Registers to Track from the list.
4. Select the Results Register to store the count in.

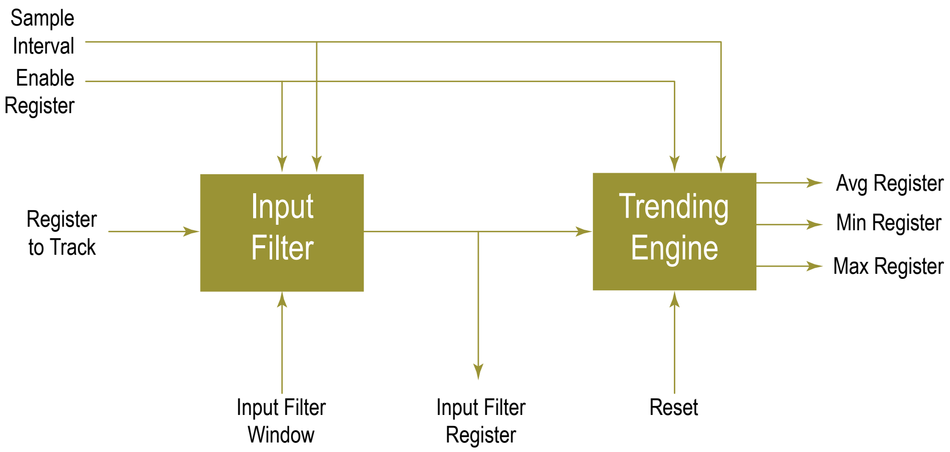
## 2.1.6 Trending and Filters

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.



| Name | Register to Track | Sample Interval | Filter | Filter Window | Filter Register | Average Value Register | Minimum Value Register | Maximum Value Register | Reset Trend Data | Enable Register |
|---|---|---|---|---|---|---|---|---|---|---|
| New trend rule | 1 None | 00:00:10 | No filter | 10 | 2 None | 3 None | 4 None | 5 None | Never | 0 |

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 Register parameter. The possible filters are:

**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.

The other Trending parameters are:

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)

Enable Register—Set to 1 to turn on trending; set to 0 to turn off trending. When disabled, the current data is held until the rule is enabled again.

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

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.

Filter Window—Defines the number of samples for a filter algorithm.

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)

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)

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

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

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

## Create a Basic Trend Rule

See *Trending and Filters* on page 8 for definitions of all parameters and user-defined fields.

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. Set the Enable Register parameter to 1.
   The Enable Register turns on the Trend rule when the register is set 1 and turns off the Trend rule when set to 0.

4. Define the Register to Track.
5. Define the Sample Interval (hours:minutes:seconds) you'd like to collect the data.
6. Select Filters and your Filter Window.
7. Enter the Local Registers to copy the Average, Minimum, and Maximum values into.

## 2.2 Local Registers

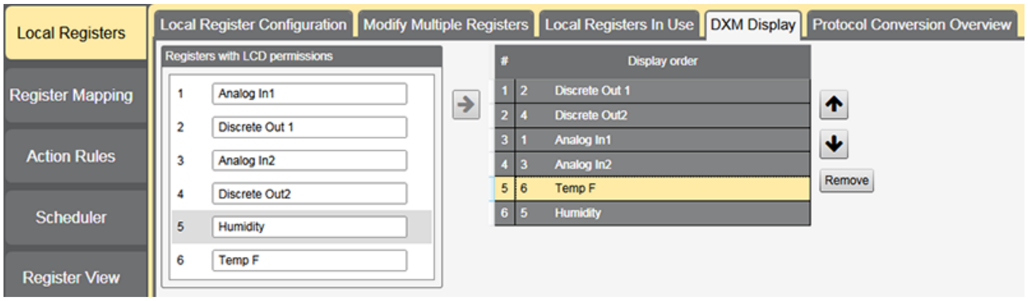
The main storage elements for the DXM Controller are its local registers. The local registers store up to 4-byte values that result from register mapping, action rules, or ScriptBasic. Since a Modbus register is only 16-bits, all transactions with Modbus devices use the lower 2-bytes (16-bits) of the local registers.

The local register characteristics are defined on the Local Registers tab of the DXM Configuration Tool.

- Local registers 1-845 are 32-bit unsigned integer based registers.
- Local registers 846-850 are special function registers that can be constants, timers, or reset registers.
- Local registers 851-900 are non-volatile registers with limited write capability for permanent data storage.
- Local registers 1001-1900 are 32-bit IEEE 754 floating point registers.

### 2.2.1 DXM Display

Use the Local Registers > Local Register **Configuration** screen to define which registers can be displayed under the Register menu of the DXM Controller. 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

| | |
|---|---|
| 1 | Analog In1 |
| 2 | Discrete Out 1 |
| 3 | Analog In2 |
| 4 | Discrete Out2 |
| 5 | Humidity |
| 6 | Temp F |

| # | | Display order |
|---|---|---|
| 1 | 2 | Discrete Out 1 |
| 2 | 4 | Discrete Out2 |
| 3 | 1 | Analog In1 |
| 4 | 3 | Analog In2 |
| 5 | 6 | Temp F |
| 6 | 5 | Humidity |

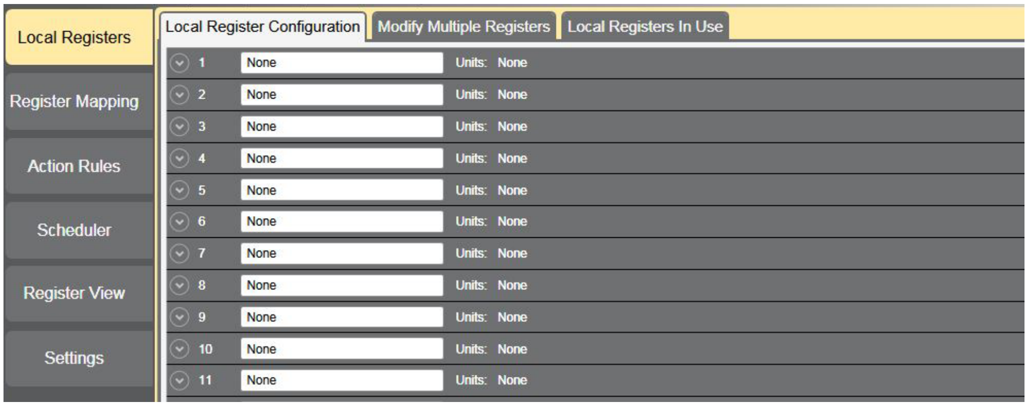
The Local Registers defined to be displayed on the LCD menu are shown in the left column.

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.

The display order can also be adjusted by selecting, dragging and dropping register within the Display order column.

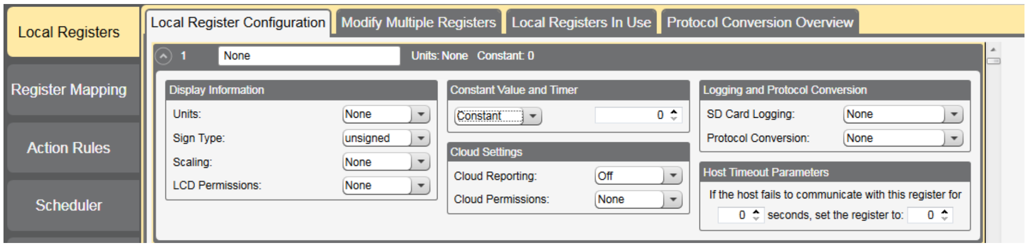
If there are more Local Registers defined with LCD permissions than there are in the Display order column the remaining registers will be displayed in the order of the Local Register number. A Local Register can only be shown once on the LCD.

### 2.2.2 Local Register **Configuration**



| | | |
|---|---|---|
| 1 | None | Units: None |
| 2 | None | Units: None |
| 3 | None | Units: None |
| 4 | None | Units: None |
| 5 | None | Units: None |
| 6 | None | Units: None |
| 7 | None | Units: None |
| 8 | None | Units: None |
| 9 | None | Units: None |
| 10 | None | Units: None |
| 11 | None | Units: None |

Click on the arrow of the local register to expand the window to show all characteristics that can be configured with the tool.


Local Registers
Register Mapping
Action Rules
Scheduler
Local Register Configuration
Modify Multiple Registers
Local Registers In Use
Protocol Conversion Overview

1 None Units: None Constant: 0

Display Information
Units: None
Sign Type: unsigned
Scaling: None
LCD Permissions: None

Constant Value and Timer
Constant 0

Cloud Settings
Cloud Reporting: Off
Cloud Permissions: None

Logging and Protocol Conversion
SD Card Logging: None
Protocol Conversion: None

Host Timeout Parameters
If the host fails to communicate with this register for 0 seconds, set the register to: 0

The configurable characteristics are:

Cloud—Enables the cyclical reporting of this register value to the web site. The rate of the cyclical push of data is defined under the **Settings** > Cloud Services tab. The Cloud Permissions flag defines how the local register is displayed and controlled at the web server.

Constant—Forces the local register to be set to a user-specified value. This can be useful to compare values when using action rules.

Display **Information**—Units, Sign Type, Scaling and LCD Permissions define the display characteristics for the web site and DXM LCD registers menu.

Host Timeout Parameters—Provides a safety net mechanism for failed communications situations between a host system and the DXM Controller. If a host system fails to interact with this register for a user defined time, the register will be set to a user defined value.

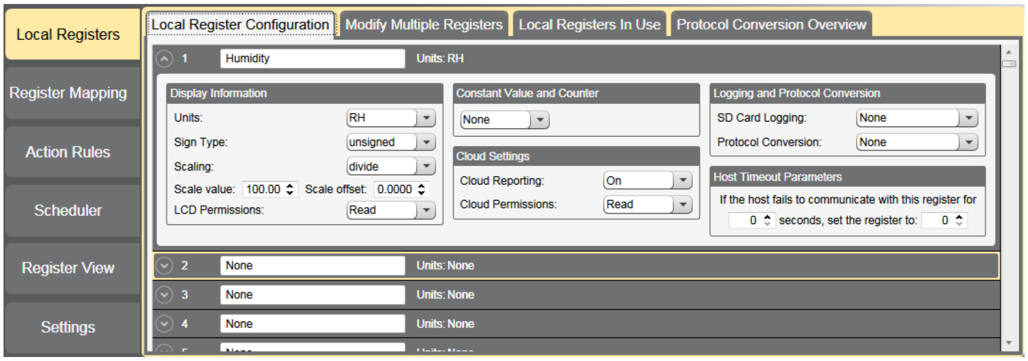
Logging and Protocol Conversion—Defines the onboard micro SD card storage of this local register based on a cyclical rate or an event change. Up to three different log files can be stored on the micro SD card, each with different logging definitions. The micro SD card logs are set up under the **Settings** > Logging tab. The Protocol Conversion section defines this local register to be an input or output when used with the different protocols enabled on this device. Ethernet/IP™ uses this register definition.

Reset—Local Registers 846–850 are reset registers. These registers reset a processor if the register is not written to within a specified time. The Reset register is typically used with ScriptBasic to detect if the program is in a bad state. Within the time is specified, the DXM Controller must be programmed to write to this register before this time limit is reached or the processor is reset.

Timer—A Local Register defined as a Timer increments every 100 ms, or 1 second. Write to the Local Register to start the timer at a specific value.

## Modify Local Registers Individually

This example configuration sets the device to push registers values to the web server.



1 Humidity Units: RH

Display Information
Units: RH
Sign Type: unsigned
Scaling: divide
Scale value: 100.00 Scale offset: 0.0000
LCD Permissions: Read

Constant Value and Counter
None

Cloud Settings
Cloud Reporting: On
Cloud Permissions: Read

Logging and Protocol Conversion
SD Card Logging: None
Protocol Conversion: None

Host Timeout Parameters
If the host fails to communicate with this register for 0 seconds, set the register to: 0

2 None Units: None
3 None Units: None
4 None Units: None

1. Go to the Local Registers > Local Register **Configuration** screen.

   The local registers are a pool of integer and floating point registers that can be used by the controller to save data that was created, store data from external devices, or store basic constants. The local registers are where the user defines the data sent to the web server.

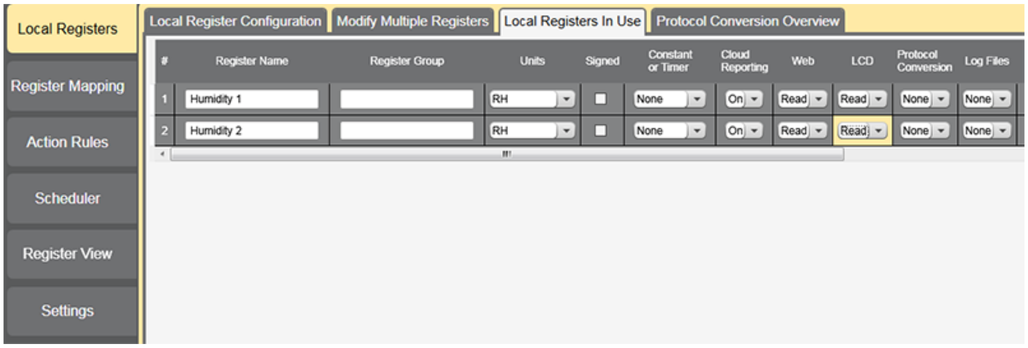
   This screen shows how each local register is defined.
2. Click on the down arrow next to the first line for Local Register 1.
   The parameters for Local Register 1 display.
3. To push the register values to the web server, set Cloud **Reporting** to ON.
4. Set the Cloud Permissions to read.

   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.

   This tells the website to display the register and sets this register to read only at the website. The register's contents displays under the Registers menu.

## 2.2.3 Local Registers in Use

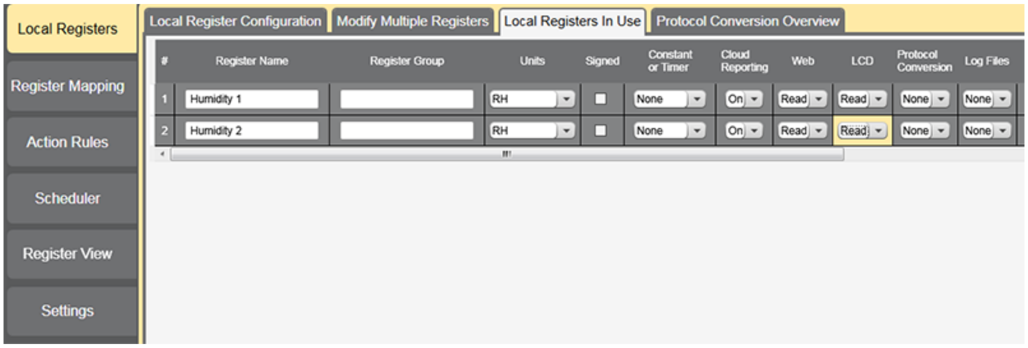
Use the Local Registers in Use tab to view a list of all the local registers used by your device.



| # | Register Name | Register Group | Units | Signed | Constant or Timer | Cloud Reporting | Web | LCD | Protocol Conversion | Log Files |
|---|---|---|---|---|---|---|---|---|---|---|
| 1 | Humidity 1 | | RH | ☐ | None | On | Read | Read | None | None |
| 2 | Humidity 2 | | RH | ☐ | None | On | Read | Read | None | None |

### Modify Registers Using the Local Registers in Use Screen

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



| # | Register Name | Register Group | Units | Signed | Constant or Timer | Cloud Reporting | Web | LCD | Protocol Conversion | Log Files |
|---|---|---|---|---|---|---|---|---|---|---|
| 1 | Humidity 1 | | RH | ☐ | None | On | Read | Read | None | None |
| 2 | Humidity 2 | | RH | ☐ | None | On | Read | Read | None | None |

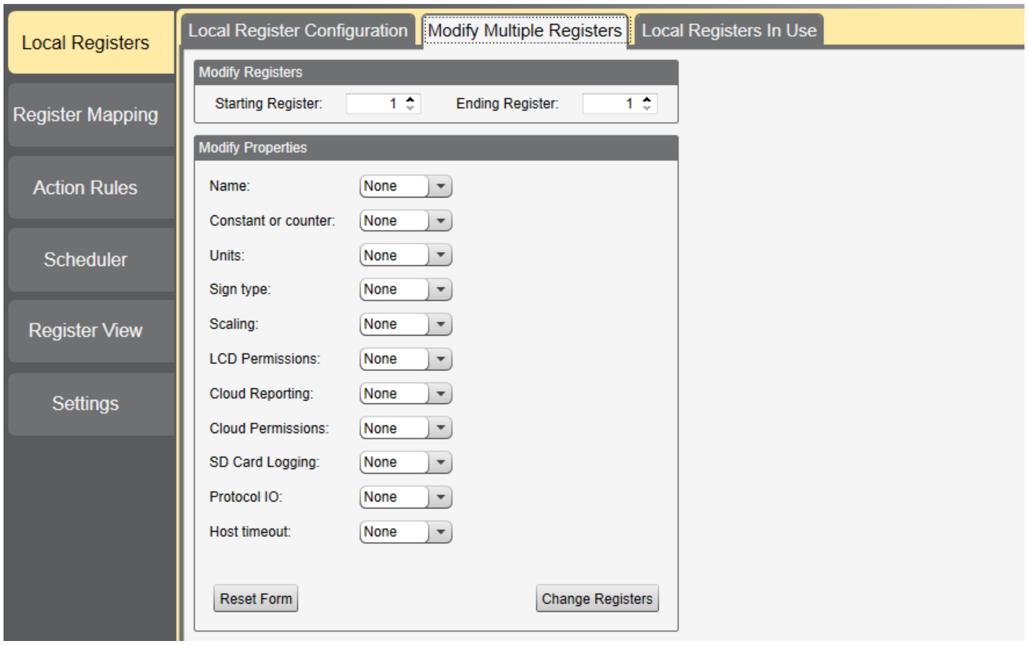
1. Go to the Local Registers > Local Registers in Use screen.
   A list of the local registers being used displays.
2. Using the drop-down lists, change the desired parameters.
3. To push register values to the web server, set Cloud **Reporting** to on and Web to read.

   If Web is 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.

   This tells the website to set this register to read only at the website. The register's contents displays under the Registers menu.

## 2.2.4 Modify **Multiple** Registers

To change multiple registers at once, use the Modify **Multiple** Registers tab.



Modify Registers

Starting Register: 1 Ending Register: 1

Modify Properties

Name: None
Constant or counter: None
Units: None
Sign type: None
Scaling: None
LCD Permissions: None
Cloud Reporting: None
Cloud Permissions: None
SD Card Logging: None
Protocol IO: None
Host timeout: None

Change Registers—Click to save your changes and apply them to the selected register(s).

Ending register—Ending register in the range of registers to change.

Reset Form—Click to reset any changed data.

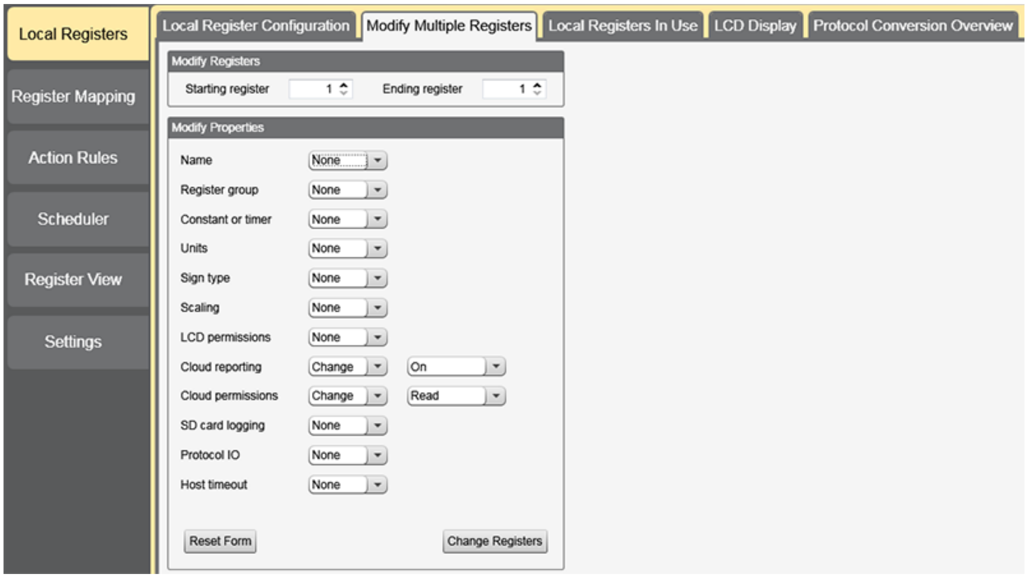
**Starting** register—First register in the range of registers to change.

Modify **Properties**—List of register properties that can be user-defined. The register properties include:

Name
Register group
Constant or timer
Units
Sign type
Scaling
LCD permissions
Cloud reporting
Cloud permissions
SD card logging
Protocol IO
Host timeout

## Modify **Multiple** Registers

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



Modify Registers

Starting register 1
Ending register 1

Modify Properties

Name None
Register group None
Constant or timer None
Units None
Sign type None
Scaling None
LCD permissions None
Cloud reporting Change On
Cloud permissions Change Read
SD card logging None
Protocol IO None
Host timeout None

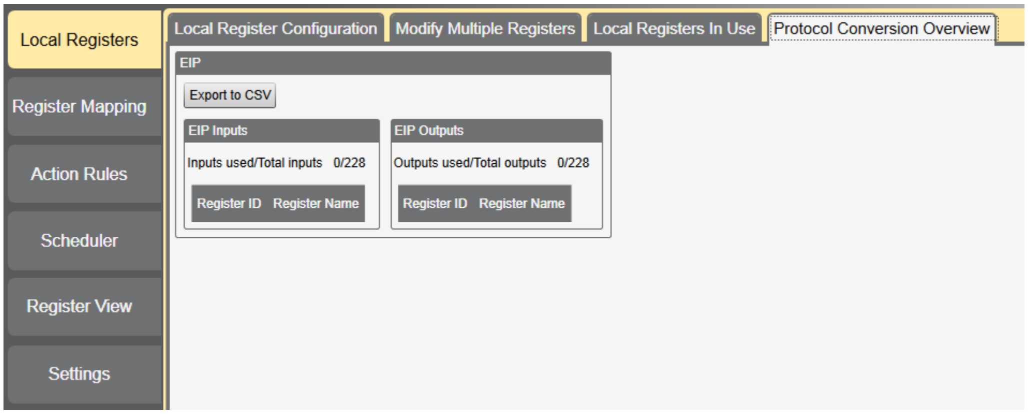
1. Enter the **Starting** register and Ending register.
2. Select the value to change using the drop-down list next to each value.
3. Enter the new value in the field provided.
4. To push register values to the web server, set Cloud **Reporting** to on and Cloud Permissions to read.

   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.

   This tells the website to set this register to read only at the website. The register's contents displays under the Registers menu.
5. Click Change Registers.

### 2.2.5 Protocol Conversion Overview

This screen displays a list of the EitherNet/IP (EIP) Inputs and Outputs associated with DXM Controller registers.



EIP

EIP Inputs
Inputs used/Total inputs 0/228

EIP Outputs
Outputs used/Total outputs 0/228

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

## 2.3 Register Mapping

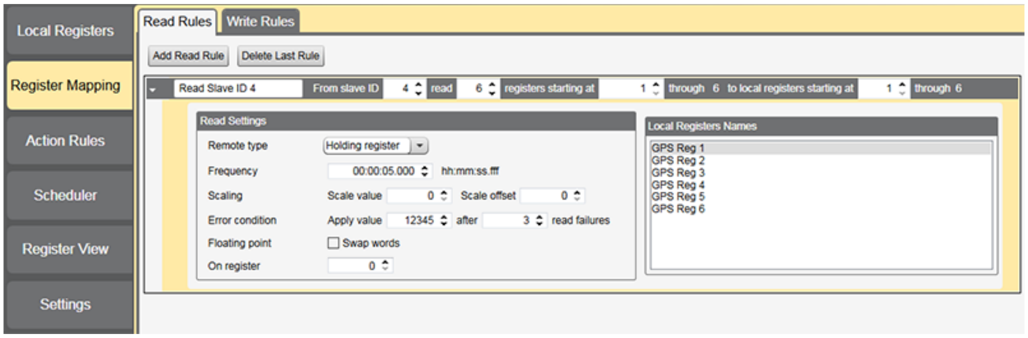
The Register Mapping function is has two main components, a read rule and a write rule. As the name implies, the rules allow the user to program the ability to read or write information from internal or external Modbus slaves to/from the local registers. On the DXM Controller, use the read/write rules to access the Modbus registers of the LCD display, I/O base board, and the internal ISM radio.

DXM Configuration Tool 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.

### 2.3.1 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.



Read Slave ID 4 From slave ID 4 read 6 registers starting at 1 through 6 to local registers starting at 1 through 6

Read Settings

Remote type: Holding register

Frequency: 00:00:05.000 hh:mm:ss.fff

Scaling: Scale value 0 Scale offset 0

Error condition: Apply value 12345 after 3 read failures

Floating point: □ Swap words

On register: 0

Local Registers Names

GPS Reg 1
GPS Reg 2
GPS Reg 3
GPS Reg 4
GPS Reg 5
GPS Reg 6

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

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 Controller 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.

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—Adjusts the read value by multiplying the scale value and then adding the offset value. The result is held in the local register.

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

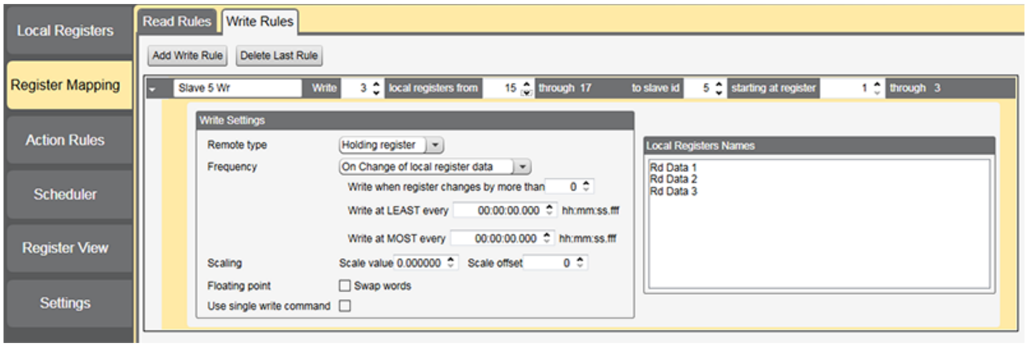
#### Create a Read Rule

Use the Register Mapping > Read Rules screen to create a new read rule. See *Read Rules* on page 15 for a complete list of user-defined parameters.

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.

### 2.3.2 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.



Slave 5 Wr Write 3 local registers from 15 through 17 to slave id 5 starting at register 1 through 3

Write Settings

Remote type: Holding register

Frequency: On Change of local register data

Write when register changes by more than 0

Write at LEAST every 00:00:00.000 hh:mm:ss.fff

Write at MOST every 00:00:00.000 hh:mm:ss.fff

Scaling: Scale value 0.000000 Scale offset 0

Floating point: □ Swap words

Use single write command □

Local Registers Names

Rd Data 1
Rd Data 2
Rd Data 3

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

**Floating** Point - Swap Words—A floating point value is a 32-bit value requiring two consecutive Modbus register reads or writes. The DXM Controller 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.

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—Adjusts the local register write value by multiplying the scale value, adding the offset value, then writing to the Modbus slave device.

### Create a Write Rule

Use the Register Mapping > Write Rules screen to create a new write rule. See *Write Rules* on page 15 for a complete list of user-defined parameters.

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 registered selected in step 4.
8. Set the desired parameters.

## 2.3.3 Processing the Rules

Rules and functions are evaluated by the DXM Controller 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 Tool.
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 Tool 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. Constants are applied first, cancelling any changes that may have occurred from other sources.
2. Calculate (Math) rules are next, continually processed.
3. Copy rules, processed only when a change of state is detected on the source register.
4. Threshold rules, continually processed.
5. Trending, continually processed.

### 2.3.4 J1939

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 × 8 + 15 + 20 = 128 bits long. At the standard rate of 250 kbits/sec, a J1939 packet is a little over 500 µs 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 Controller functions as a protocol converter between its internal local register space and J1939 PGNs.

Users must configure the DXM Controller to select the J1939 PGNs to be monitored, which is known as creating a J1939 Read Rule. Similarly, the DXM Controller 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 Controller local registers may be accessed using the scripting engine in the DXM Controller.

At startup, the DXM Controller 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 Tool 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 Tool, go to the Register Mapping > J1939 screen and click Check device for J1939 address 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.

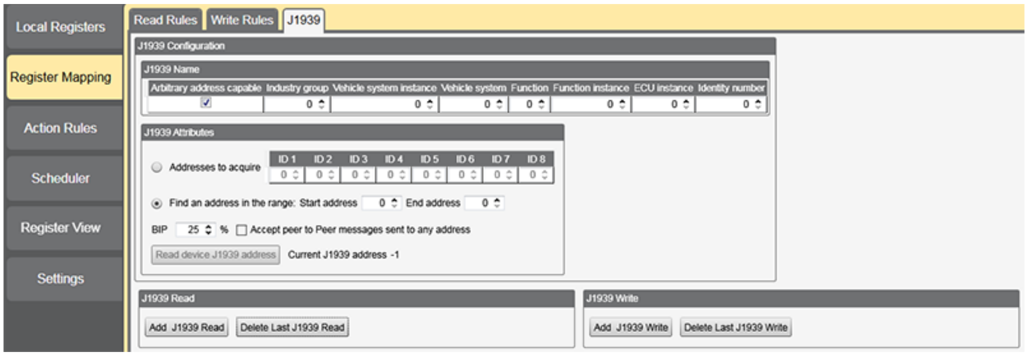
The acceptance criteria for J1939 Read Rules are:

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 ≥ 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 Tool.

## Start Up Guide for the DXM Controller

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



J1939 Name

| Arbitrary address capable | Industry group | Vehicle system instance | Vehicle system | Function | Function instance | ECU instance | Identity number |
|---|---|---|---|---|---|---|---|
| ☑ | 0 | 0 | 0 | 0 | 0 | 0 | 0 |

J1939 Attributes

○ Addresses to acquire

| ID 1 | ID 2 | ID 3 | ID 4 | ID 5 | ID 6 | ID 7 | ID 8 |
|---|---|---|---|---|---|---|---|
| 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |

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

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

Current J1939 address -1

1. On the DXM Controller: 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 Tool and navigate to the Register Mapping > J1939 screen.
3. Configure the J1939 Name for the DXM.

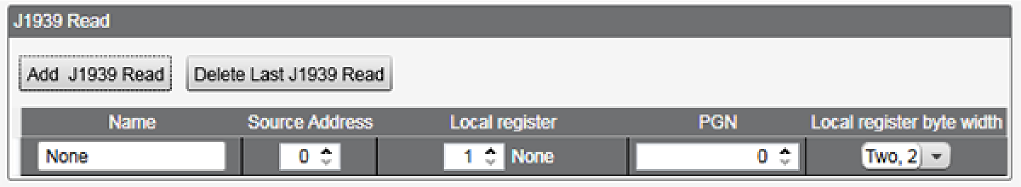
   All sub-fields of the NAME area are user-configurable except the Manufacturer Code, which is permanently set to 758 (decimal) as granted to Banner Engineering by SAE.
4. Specify the preferred addresses for the DXM to claim using one of two methods:
   - Create an explicit list of addresses in the ID1 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 Controller is powered up and connected to a computer running the DXM Configuration Tool.



| Name | Source Address | Local register | PGN | Local register byte width |
|---|---|---|---|---|
| None | 0 | 1 None | 0 | 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 Controller 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.

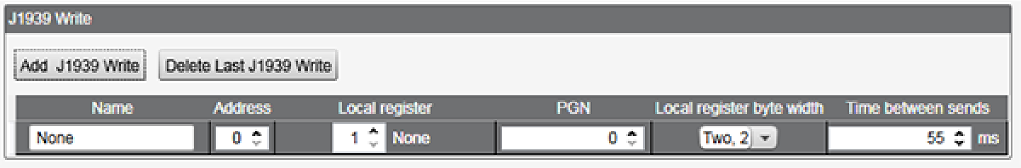
   - If PGN ≥ 0xF000, the PGN is a broadcast rule. The message arrives and passes through the stack as long as the PGN matches the read rule.
   - If PGN < 0xF000, it is a peer-to-peer message. To be received, the lower 8 bits of the PGN must match the bus address claimed by the DXM. (This check can be overridden by selecting Accept peer to peer messages sent to any address.) Because the lower 8 bits of the PGN (also know 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 instruction assume the DXM Controller is powered up and connected to a computer running the DXM Configuration Tool.



| Name | Address | Local register | PGN | Local register byte width | Time between sends |
|---|---|---|---|---|---|
| None | 0 | 1 None | 0 | 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 to 0xFFFF 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 65281d, or 0xFF01.

Because this PGN is in the range 0xFF00–0xFFFF, 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 52212d, or 0xCBF4.

Because this PGN is in the range 0x0000–0xEF00, 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 only. There are two ways to allow the DXM to read this message:
   - Have the DXM claim address 0xF4 =244d 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 Tool. To send these commands, follow these steps.

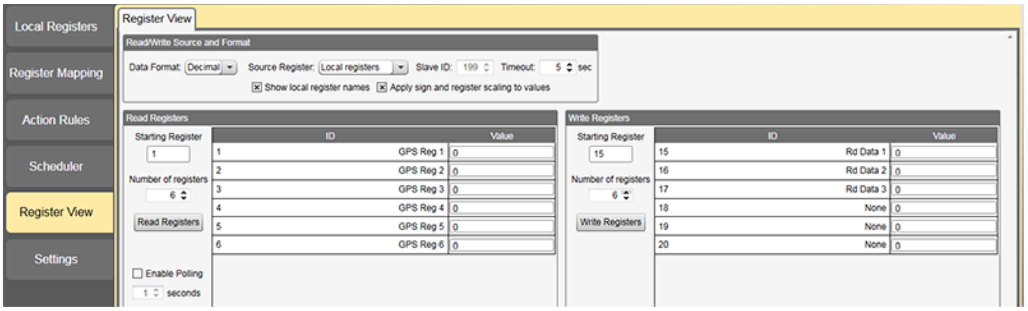
1. Go to the Device > View Serial Activity menu.
   A Traffic on port COMxx window opens.
2. In the single-line text box at the bottom of the window, type a command. Click SEND.
   The resulting serial traffic, including response, will be shown. The successful execution of CMD00xx always results in a 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 | RSP00815A5ADA5EFFFFB4DA | 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 |

## 2.4 Register View

Use the Register View screen to read or write local registers within the DXM Controller or Modbus Slave devices connected to the DXM Controller.

The data format can be decimal or hexadecimal selected by the radio button at the upper left of the page. The selection of using local registers (DXM Controller) or a Modbus Slave ID is found at the upper right of the page. Connect the DXM Controller using USB or Ethernet.



Data Format: Decimal Source Register: Local registers Slave ID: 199 Timeout: 5 sec
☒ Show local register names ☒ Apply sign and register scaling to values

Starting Register 1
Number of registers 6
☐ Enable Polling
1 seconds

| ID | | Value |
|---|---|---|
| 1 | GPS Reg 1 | 0 |
| 2 | GPS Reg 2 | 0 |
| 3 | GPS Reg 3 | 0 |
| 4 | GPS Reg 4 | 0 |
| 5 | GPS Reg 5 | 0 |
| 6 | GPS Reg 6 | 0 |

Starting Register 15
Number of registers 6

| ID | | Value |
|---|---|---|
| 15 | Rd Data 1 | 0 |
| 16 | Rd Data 2 | 0 |
| 17 | Rd Data 3 | 0 |
| 18 | None | 0 |
| 19 | None | 0 |
| 20 | None | 0 |

Data Format—Use the radio button in the upper left to select between the decimal or hexadecimal data format.

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. Select how often to read the registers by selecting Enable Polling and entering the time. Click Read Registers to view the register values as they display just below the Read Registers section.

Source Register—Use the radio button in the upper right to select between using the local registers or the Modbus Registers of a specific Modbus Slave.

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.

## 2.5 Scheduler

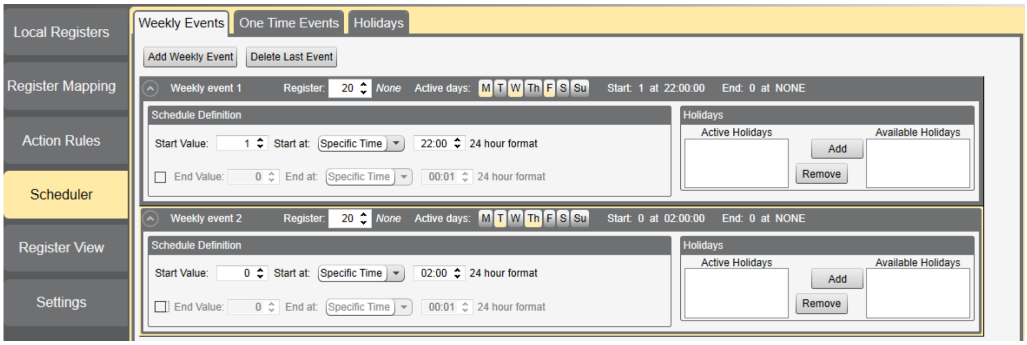
Use the Scheduler screens to create a calendar schedule for local register changes, including defining the days of the week, start time, stop time, and register values. Schedules are stored in the XML configuration file, which is loaded to the DXM Controller. Reboot the DXM Controller to activate a new schedule.

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

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

### 2.5.1 Create a Weekly Event

To define weekly events, use the Scheduler > Weekly Events screen.



Weekly event 1 Register: 20 None Active days: M T W Th F S Su Start: 1 at 22:00:00 End: 0 at NONE

Schedule Definition

Start Value: 1 Start at: Specific Time 22:00 24 hour format

□ End Value: 0 End at: Specific Time 00:01 24 hour format

Holidays

Active Holidays Available Holidays

Weekly event 2 Register: 20 None Active days: M T W Th F S Su Start: 0 at 02:00:00 End: 0 at NONE

Schedule Definition

Start Value: 0 Start at: Specific Time 02:00 24 hour format

□ End Value: 0 End at: Specific Time 00:01 24 hour format

Holidays

Active Holidays Available Holidays

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

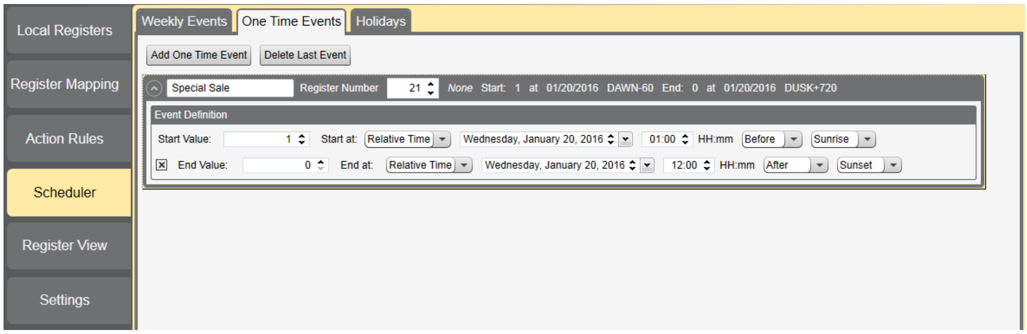
Register updates can be changed up to two times per day for each rule. Each rule can be set for any number of days in the week by clicking the buttons M, T, W, Th, F, S, or Su.

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

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

### 2.5.2 Create a One-Time Event

Define one-time events to update registers at any time within a calendar year. Similar to Weekly events, the times can be specific or relative to sunrise or sunset. Define one-time events using the Scheduler > One Time Events screen.



Special Sale Register Number 21 *None* Start: 1 at 01/20/2016 DAWN-60 End: 0 at 01/20/2016 DUSK+720

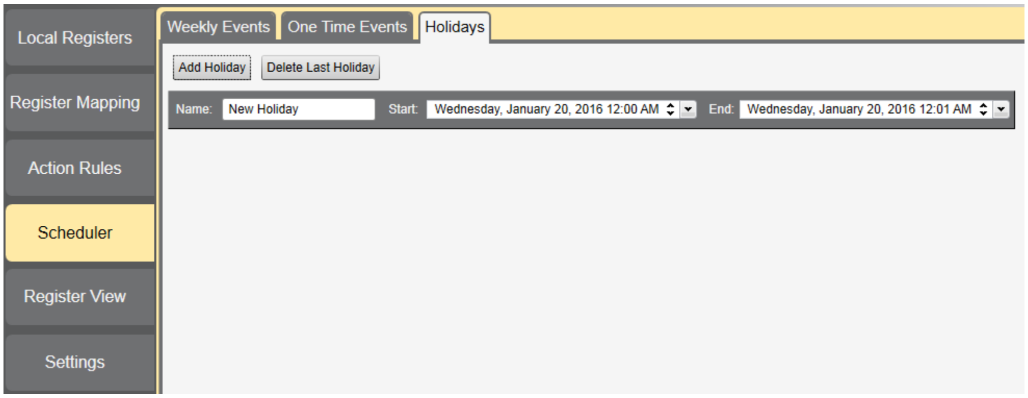
Start Value: 1 Start at: Relative Time Wednesday, January 20, 2016 01:00 HH:mm Before Sunrise

☒ End Value: 0 End at: Relative Time Wednesday, January 20, 2016 12:00 HH:mm After Sunset

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.

## 2.5.3 Create a Holiday Event

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



Name: New Holiday Start: Wednesday, January 20, 2016 12:00 AM End: Wednesday, January 20, 2016 12:01 AM

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.

## 2.5.4 Create a Dynamic Schedule

The Dynamic Scheduler allows the user to adjust the running event schedule without reloading a full configuration file. This allows the user to save multiple event schedules and load the schedules as needed.

To enable the dynamic scheduler, go to the Scheduler > Dynamic Update screen and select Enable Dynamic Scheduler. When the DXM Controller is sent a new scheduler XML file, it replaces the existing schedule configuration with the new schedule configuration.

To create a default configuration and dynamic schedule, follow these steps.

1. Create the default configuration.
   a) On the Scheduler > Dynamic Update screen, select Enable Dynamic Scheduler.
   b) Create a default DXM configuration file.
   c) Save the XML file and upload it to the DXM Controller.

2. Create a dynamic schedule.
    a) On the Scheduler > Weekly Events screen, create a new schedule of events.
    b) On the Scheduler > Dynamic Update screen, save the new schedule by clicking on Save Scheduler update **file**.
3. Load the dynamic schedule.
    a) Connect the DXM Controller to your computer using an Ethernet or USB cable.
    b) Click Load scheduler update **file**.

    The dynamic schedule uploads to the DXM Controller and takes effect without the device rebooting.

## 2.6 **Settings**

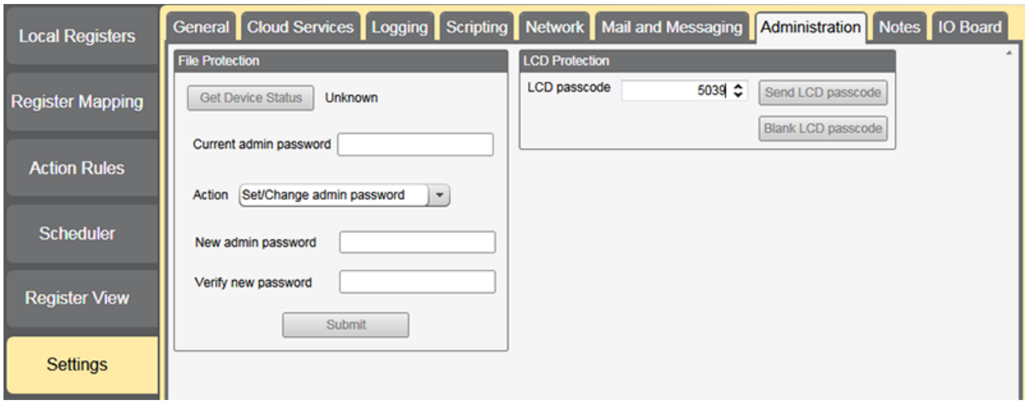
The settings tab defines general parameters, cloud services settings, logging parameters, Script Basic settings, networking and e-mail/SMS messages settings.

### 2.6.1 **Administration**

The DXM Controller manages two passwords that are defined on the **Settings** > **Adminstration** 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 Controller. The LCD protection password requires the user to enter a password on the DXM LCD to unlock the LCD display of the DXM Controller.

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 Controller and requires the DXM Controller 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.



Get Device Status: Unknown

Action: Set/Change admin password

LCD passcode: 5039

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.

### Reset the Controller if the Password is Lost

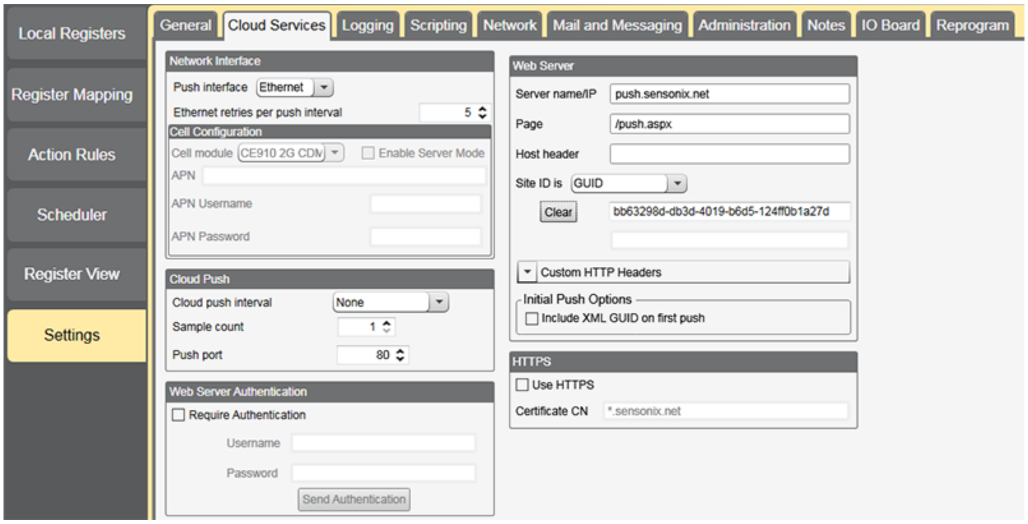
If the device is locked and the password is lost, go to the DXM Controller to clear the password. Clearing the password from the controller also erases the configuration file and all ScriptBasic programs. To clear the password:

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.

## 2.6.2 Cloud Services

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



Network Interface
Push interface: Ethernet
Ethernet retries per push interval: 5
Cell Configuration
Cell module: CE910 2G CDM ☐ Enable Server Mode
APN
APN Username
APN Password

Cloud Push
Cloud push interval: None
Sample count: 1
Push port: 80

Web Server Authentication
☐ Require Authentication
Username
Password

Web Server
Server name/IP: push.sensonix.net
Page: /push.aspx
Host header
Site ID is: GUID
bb63298d-db3d-4019-b6d5-124ff0b1a27d
Custom HTTP Headers
Initial Push Options
☐ Include XML GUID on first push

HTTPS
☐ Use HTTPS
Certificate CN: *.sensonix.net

### Cell **Configuration**

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

- CE910 2G CDMA—A Telit CE910 CDMA cellular modem card that operates on the Verizon wireless network.
- HE910 3G GSM/HSPA—A Telit HE910 3G GSM cellular modem card that operates on various carriers worldwide. The modem supports 2G GSM if 3G is not available.
- LE910 4G LTE—A Telit LE910 4G LTE cellular modem card that operates on the Verizon LTE network. The modem does not have a fall back to 3G network.

APN, APN Username, and APN Password are user-defined fields.

### Cloud Push

The 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.

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.

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

The 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.

### HTTPS

Selecting HTTPS indicates to the DXM Controller 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.

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 Sensonix certificate CN is a wildcard certificate; *.sensonix.net. If nothing is entered into this field, the Sensonix CN will be used; *.sensonix.net.

The DXM Controller uses the Network Interface settings to determine where to send cyclic report data, alert messages, or log files. Selecting Ethernet or Cell also requires setting up the parameters under the **Settings** > Network tab.

When Cellular is selected, the optional VPN (Virtual Private Network) is available. This requires the private cellular plan and allows for direct point-to-point communication between the DXM Controller and host system. Enabling VPN forces the DXM Controller to constantly listen for messages from a host system.

## Network Interface

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 interface—Select Ethernet or Cell from the drop-down list.

## Web Server

Under the Web Server section, 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 will be the server name. The Sensonix website does not require this field.

The Server Name/IP is the webserver address used by the DXM Controller when pushing data to the cloud. Enter the domain name, `demopush.sensonix.net` or the IP address `54.218.39.109` for the Sensonix website. The DXM Controller 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.

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

From the Site 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 in the DXM configuration tool.

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.

When Include XML GUID on **first** push is selected, the first initial push to the web server includes the configuration file GUID (Global Unique IDentifier) number. The web server can then verify that the XML configuration file that is loaded into the DXM Controller is the same as what is loaded into the web server.

## Web Server **Authentication**

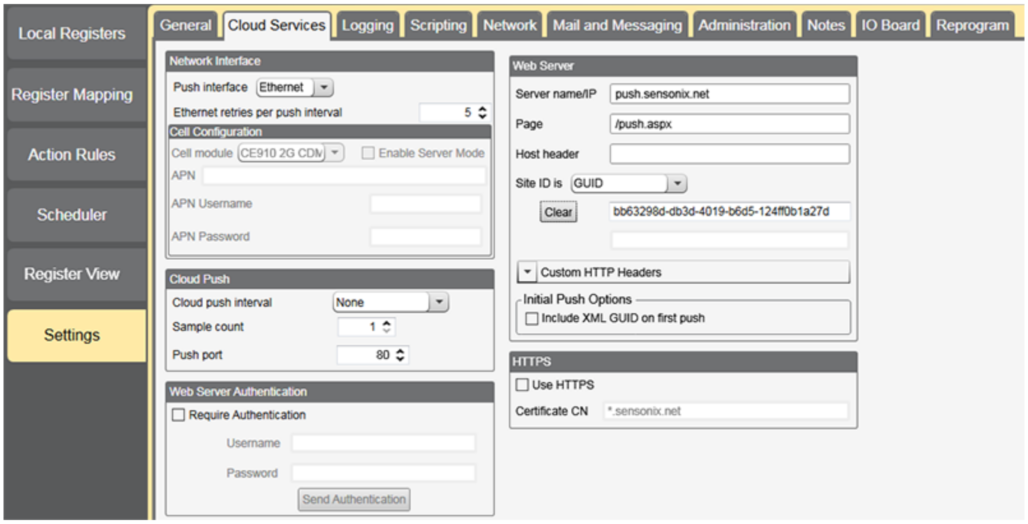
Webserver **Authentication** defines a username and password to be sent to the webserver with every push data set to validate the sending device before storing any data in the database. If the webserver is expecting login credentials, the DXM Controller must be programmed with the username and password.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

The DXM Controller must be connected to the computer. Select Require **Authentication**, then enter a username and password. Select Send **Authentication** to send the username and password to the DXM Controller to be stored in non-volatile memory. Manually cycle power to the DXM Controller after the username and password are written to it. The credentials cannot be read from the DXM Controller.

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

### **Configure** the Cloud **Settings**

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



Network Interface
Push interface: Ethernet
Ethernet retries per push interval: 5

Cell Configuration
Cell module: CE910 2G CDM
□ Enable Server Mode
APN:
APN Username:
APN Password:

Cloud Push
Cloud push interval: None
Sample count: 1
Push port: 80

Web Server Authentication
□ Require Authentication
Username:
Password:

Web Server
Server name/IP: push.sensonix.net
Page: /push.aspx
Host header:
Site ID is: GUID
bb63298d-db3d-4019-b6d5-124ff0b1a27d

Initial Push Options
□ Include XML GUID on first push

HTTPS
□ Use HTTPS
Certificate CN: *.sensonix.net

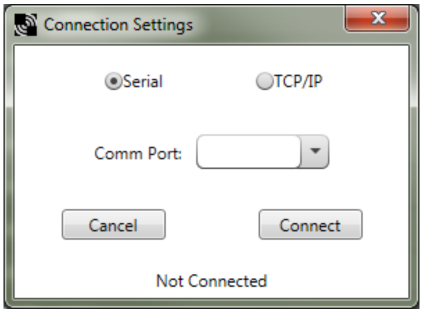
2. Copy and paste the Site ID.

   The Site ID is that long string of numbers and letters from the Sensonix Web Services site.
3. Verify the Server Name/IP is set to `push.sensonix.net` and the Page is set to `/push.aspx` for sending to the Sensonix Web Services site.
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 10 minutes or longer, while Ethernet connections can push at an interval of 1 minute or longer. The Logging Interval specifies how often data is gathered by the device.

   For example, if the Cloud Push Interval was set to 15 minutes and the Logging Interval was set to 5 minutes, then during each data push (every 15 minutes) three sets of data would be pushed to the web.
5. Save the configuration file by going to File > Save.

   No spaces or special characters are permitted in file names.
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.

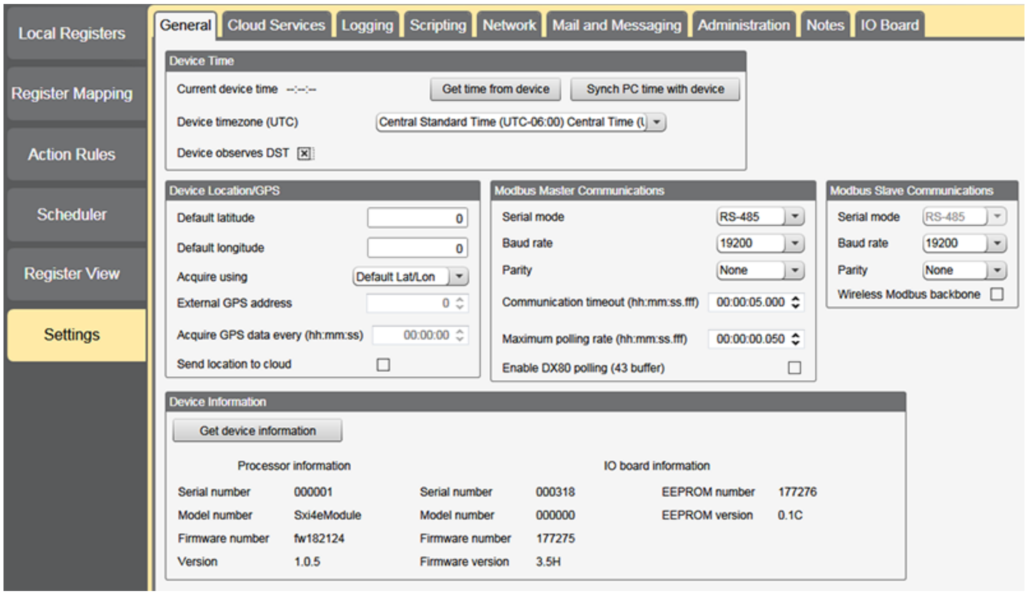


● Serial ○ TCP/IP
Comm Port:
Not Connected

   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.

## 2.6.3 General

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



Device Time

Current device time --:--:--

Device timezone (UTC) Central Standard Time (UTC-06:00) Central Time (U

Device observes DST ☒

Device Location/GPS

Default latitude 0

Default longitude 0

Acquire using Default Lat/Lon

External GPS address 0

Acquire GPS data every (hh:mm:ss) 00:00:00

Send location to cloud ☐

Modbus Master Communications

Serial mode RS-485

Baud rate 19200

Parity None

Communication timeout (hh:mm:ss.fff) 00:00:05.000

Maximum polling rate (hh:mm:ss.fff) 00:00:00.050

Enable DX80 polling (43 buffer) ☐

Modbus Slave Communications

Serial mode RS-485

Baud rate 19200

Parity None

Wireless Modbus backbone ☐

Device Information

| Processor information | | IO board information | | | |
|---|---|---|---|---|---|
| Serial number | 000001 | Serial number | 000318 | EEPROM number | 177276 |
| Model number | Sxi4eModule | Model number | 000000 | EEPROM version | 0.1C |
| Firmware number | fw182124 | Firmware number | 177275 | | |
| Version | 1.0.5 | Firmware version | 3.5H | | |

Device **Information**—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.

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

GPS **Location**—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 RS485 bus. Select Send **Location** to Cloud to report this information to the Web site.

Modbus Master **Communications**—Defines the Modbus Master serial port settings on the device (main RS-485 port). The default communications settings are 19200 baud, no parity, RS485. When changing the communications settings on the DXM Controller, 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 Tool for DX80/Performance radios or the MultiHop Configuration Tool for MultiHop radios.

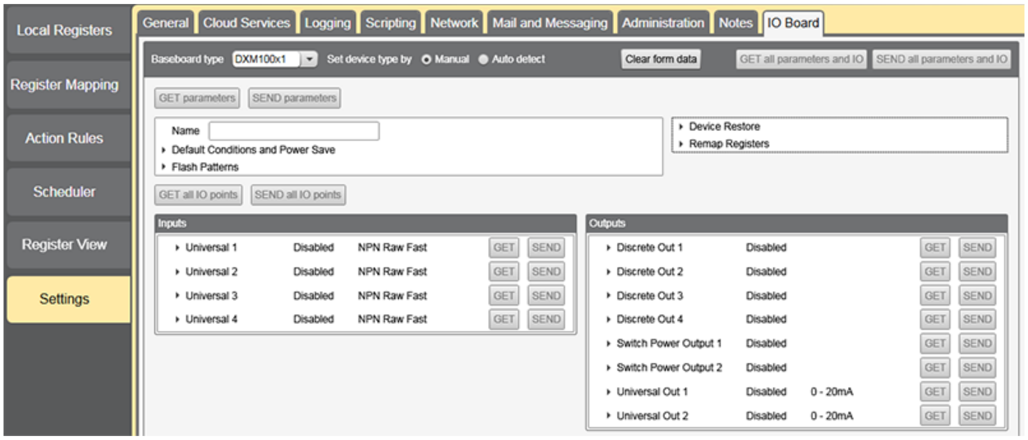
- The **Communication timeout** field defines the length of time (hours:minutes:seconds) reserved for each Modbus master command to complete. The factory default of 5 seconds should be adequate for most Modbus slave devices and DX80 star wireless networks. This may need to be lengthened for MultiHop networks with battery powered devices or networks with many chained repeaters.
- The Maximum polling rate field defines the time interval (hours:minutes:seconds) between Modbus messages. The default is set to 50 milliseconds. Some Modbus devices cannot communicate at this rate and may require greater than 50 milliseconds.
- Enabling DX80 polling automatically defines DXM Local Registers to be allocated as the DX80 Modbus registers. The DXM Controller runs a routine to request only changes that the Gateway has received from the Nodes in the system. Any input changes are saved in the corresponding DXM Local Registers. To write DXM Local Register data to the Gateway radio, create Write Rules.

The Gateway uses local registers 1 through16 and Node 1 uses local registers 17 through 32, etc.

Modbus Slave **Communications**—Defines the Modbus Slave communications parameters and Modbus Slave ID when the RS-232 flow control signals are configured as a secondary Modbus serial port. Select Wireless Modbus Backbone to enable the Modbus slave port to come through a MultiHop HE5 module plugged into the SAM4 processor board (DXM150-S1R2P model only).

## 2.6.4 I/O Board

The DXM Controller 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.



Baseboard type DXM100x1 Set device type by ● Manual ● Auto detect

Name

Inputs

- Universal 1 Disabled NPN Raw Fast
- Universal 2 Disabled NPN Raw Fast
- Universal 3 Disabled NPN Raw Fast
- Universal 4 Disabled NPN Raw Fast

Outputs

- Discrete Out 1 Disabled
- Discrete Out 2 Disabled
- Discrete Out 3 Disabled
- Discrete Out 4 Disabled
- Switch Power Output 1 Disabled
- Switch Power Output 2 Disabled
- Universal Out 1 Disabled 0 - 20mA
- Universal Out 2 Disabled 0 - 20mA

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.

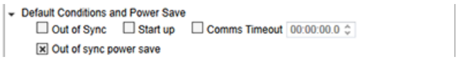
The Name must be less than 18 characters and contain only the standard alpha-numeric characters, the following standard ASCII characters: *, +, -, /, <, >, or a space.

After making any changes, click SEND parameters to write the changes. The status bar at the bottom of the screen indicates the status of the process. Green (Communication Status Ready) indicates the process is complete. Red (error) indicates an error. Yellow (Getting Data) indicates the network is retrieving the requested data.

After making any changes, click SEND parameters to write the changes. The status bar at the bottom of the screen indicates when the process is complete.

## Default **Conditions**

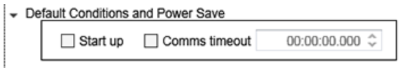
Default conditions are the conditions under which outputs are sent to their defined default state. These conditions apply to all outputs.



Default Conditions and Power Save

☐ Out of Sync ☐ Start up ☐ Comms Timeout 00:00:00.0

☒ Out of sync power save



Default Conditions and Power Save

☐ Start up ☐ Comms timeout 00:00:00.000

When a radio is Out of Sync, it is not communicating with its parent radio. Selecting the Out of Sync condition sets all outputs (on this device) to their specific default values when this radio has lost its communication link with its parent radio. The default output values are selected under each of the output parameter sections of this screen.

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 MultiHop 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.

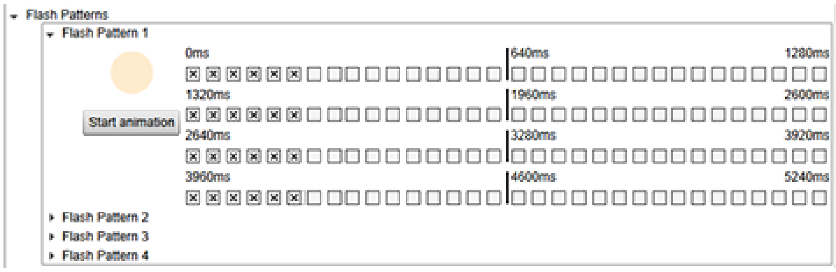
Selecting Out of sync power save sets the radio to low power mode if the radio is out of sync for more than 5 minutes. The radio wakes up every 5 minutes to search for a parent radio. This setting is recommended for battery-powered devices.

After making any changes, click SEND parameters to write the changes. The status bar at the bottom of the screen indicates the status of the process. Green (Communication Status Ready) indicates the process is complete. Red (error) indicates an error. Yellow (Getting Data) indicates the network is retrieving the requested data.

After making any changes, click SEND parameters to write the changes. The status bar at the bottom of the screen indicates when the process is complete.

## Flash **Patterns**

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



Define Flash **Patterns** by selecting specific 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. Each slot represents one frame size, which may vary from radio to radio. The default frame is 40 milliseconds. Users may configure up to four different flash patterns per radio device.

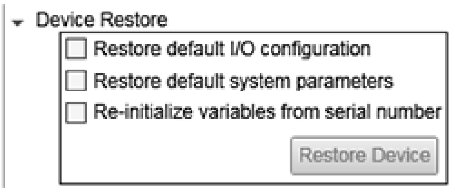
In the example shown, Flash Pattern 1 is configured to turn on the EZ-LIGHT for 240 milliseconds, then turn off the light for 1040 milliseconds. To preview the flash pattern, click on the Start **Animation** button. The EZ-LIGHT graphic flashes on and off in the programmed flash pattern.

After making any changes, click SEND parameters to write the changes. The status bar at the bottom of the screen indicates the status of the process. Green (Communication Status Ready) indicates the process is complete. Red (error) indicates an error. Yellow (Getting Data) indicates the network is retrieving the requested data.

After making any changes, click SEND parameters to write the changes. The status bar at the bottom of the screen indicates when the process is complete.

## Device Restore

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



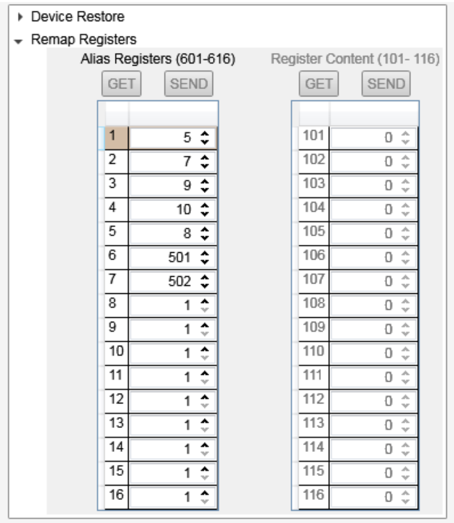
□ Restore default I/O configuration
□ Restore default system parameters
□ Re-initialize variables from serial number

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.
   - **Re-Initialize** Variables from Serial Number. Restores the default values of all variables calculated from the serial number. This is not typically recommended.
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.



| Alias Registers (601-616) | | Register Content (101- 116) | |
|---|---|---|---|
| 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.

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.

Count on rising values—Select to count on a rising transition.

Count on falling values—Select to count on a falling transition.

### Analog **Configuration**

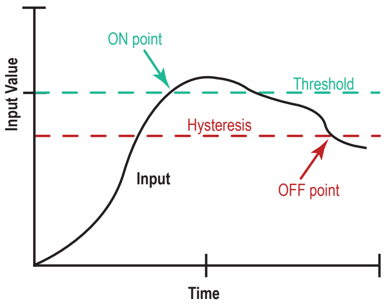
Enable push on change of state—Enables push registers for this input. When the discrete input changes state, the register value is pushed to the master radio if this register is configured to be a push register. For analog inputs, use the threshold and hysteresis parameters to define "on" and "off" points.

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.

## 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).

Use Flash **Pattern**—To use a programmed flash pattern, set the Enable Flash Pattern to ON, then select the appropriate flash pattern from the drop-down list. The flash patterns are defined in the Device Parameters section of this screen. Select from one of the four user-defined flash patterns. Set the flash patterns in the Device Parameters section of this screen.

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

### 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 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 Flash **Pattern**—To use a programmed flash pattern, set the Enable Flash Pattern to ON, then select the appropriate flash pattern from the drop-down list. The flash patterns are defined in the Device Parameters section of this screen. Select from one of the four user-defined flash patterns. Set the flash 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.

Use Flash **Pattern**—To use a programmed flash pattern, set the Enable Flash Pattern to ON, then select the appropriate flash pattern from the drop-down list. The flash patterns are defined in the Device Parameters section of this screen. Select from one of the four user-defined flash patterns. Set the flash patterns in the Device Parameters section of this screen.

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

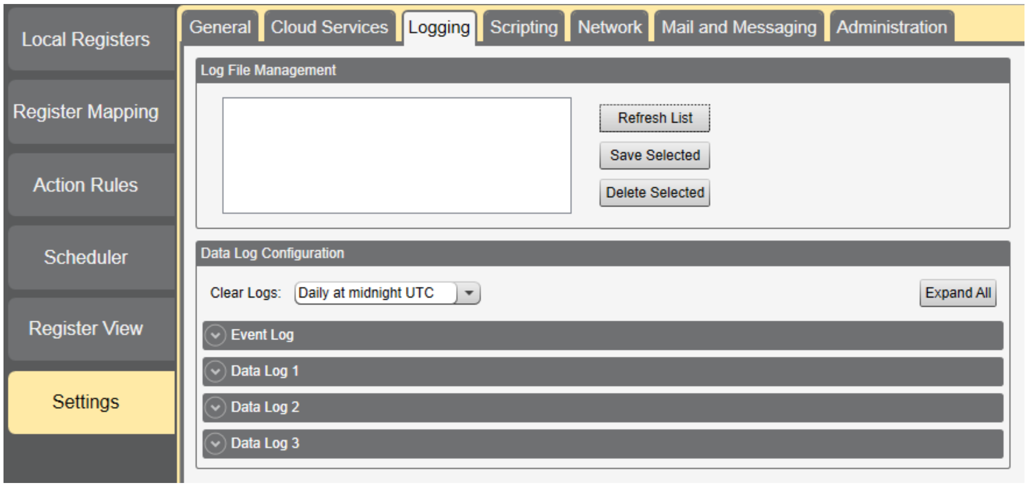
Cap warmup **time** (hours:minutes:seconds)—Similar to the switch power warm-up time, the h-bridge capacitor warm-up time is the time allotted to charge the capacitor used to activate the h-bridge and latching solenoid.

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

## 2.6.5 Logging

Use **Settings** > Logging to define the local logging setup for the on-board SD card of the DXM Controller. 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.

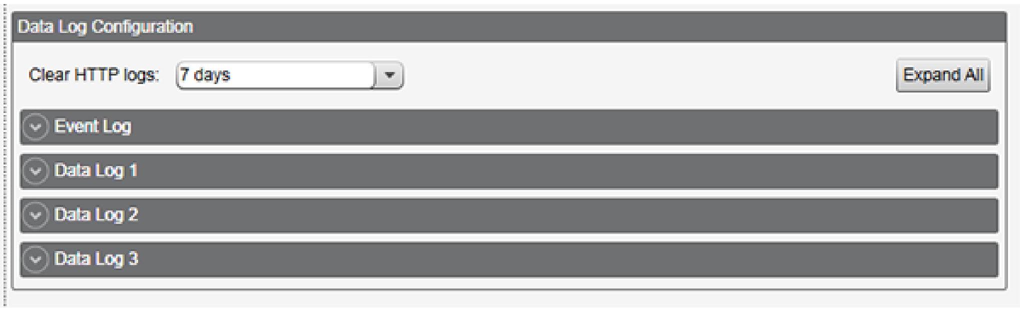


Clear Logs: Daily at midnight UTC

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 Controller needs to be connected to a PC for these features to operate.

HTTP log files are saved to the SD card to save data when the connection is down and the DXM Controller cannot connect to the webserver. If Enable Log is not selected, the DXM Controller will not save any data in failed transmissions. By default, Clear HTTP Logs is set to erase the HTTP log files daily to limit the number of log files saved to the SD card.

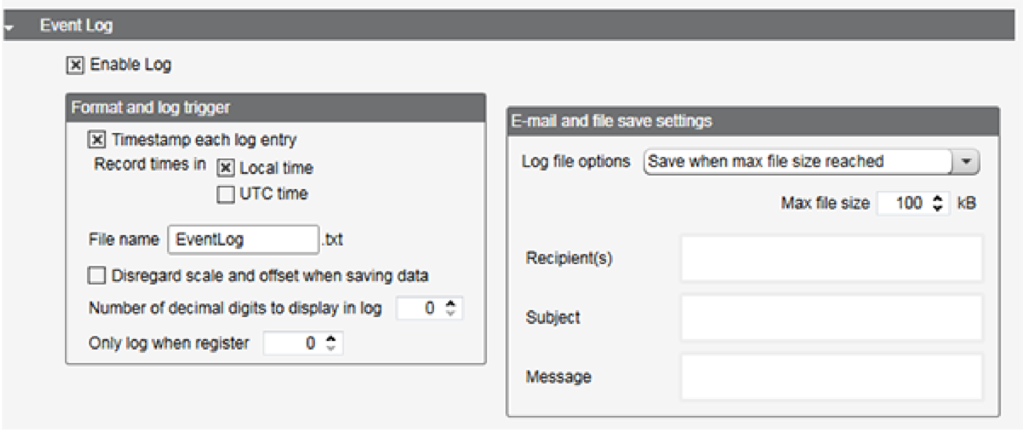


Data Log Configuration

Clear HTTP logs: 7 days

## 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.



Event Log

☒ Enable Log

Format and log trigger

☒ Timestamp each log entry

Record times in ☒ Local time ☐ UTC time

File name EventLog .txt

☐ Disregard scale and offset when saving data

Number of decimal digits to display in log 0

Only log when register 0

E-mail and file save settings

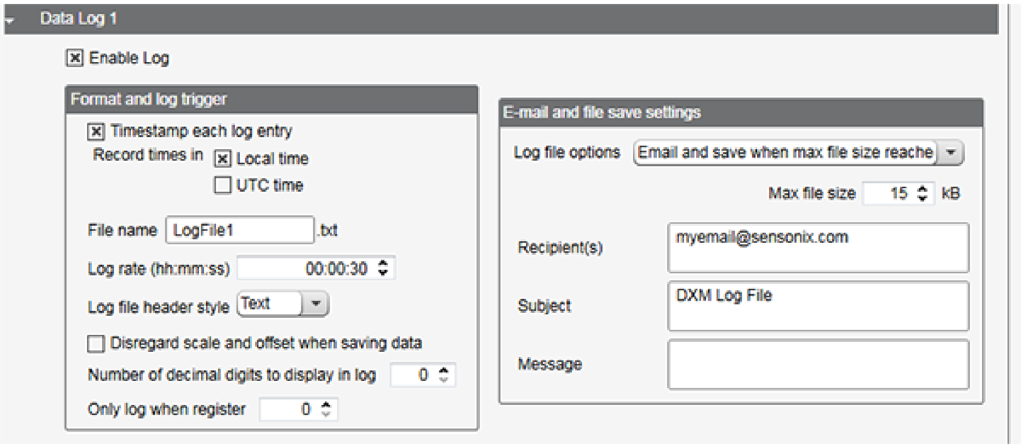
Log file options Save when max file size reached

Max file size 100 kB

Recipient(s)

Subject

Message



Data Log 1

☒ Enable Log

Format and log trigger

☒ Timestamp each log entry

Record times in ☒ Local time ☐ UTC time

File name LogFile1 .txt

Log rate (hh:mm:ss) 00:00:30

Log file header style Text

☐ Disregard scale and offset when saving data

Number of decimal digits to display in log 0

Only log when register 0

E-mail and file save settings

Log file options Email and save when max file size reache

Max file size 15 kB

Recipient(s) myemail@sensonix.com

Subject DXM Log File

Message

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.

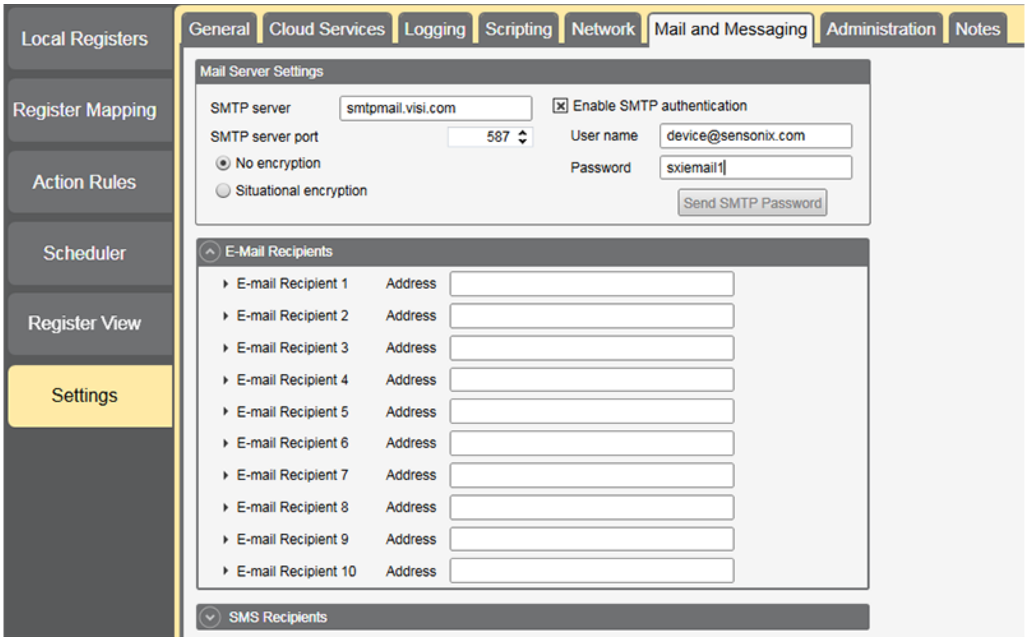
   The local time is determined from the device's time zone selection under on the **Settings** > General screen.
3. Name your Event or Data Log.
   A date/time stamp is added to the end of the user-defined File Name then stored on the Micro SD card. New files will be created with a new date/time stamp.
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 Controller 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.

### 2.6.6 Mail and Messaging

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



Mail Server Settings

SMTP server: smtpmail.visi.com

SMTP server port: 587

● No encryption

○ Situational encryption

☒ Enable SMTP authentication

User name: device@sensonix.com

Password: sxiemail1

E-Mail Recipients

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

E-Mail Recipients—Enter the list of email addresses to send message and alerts to. Include the subject line and message.

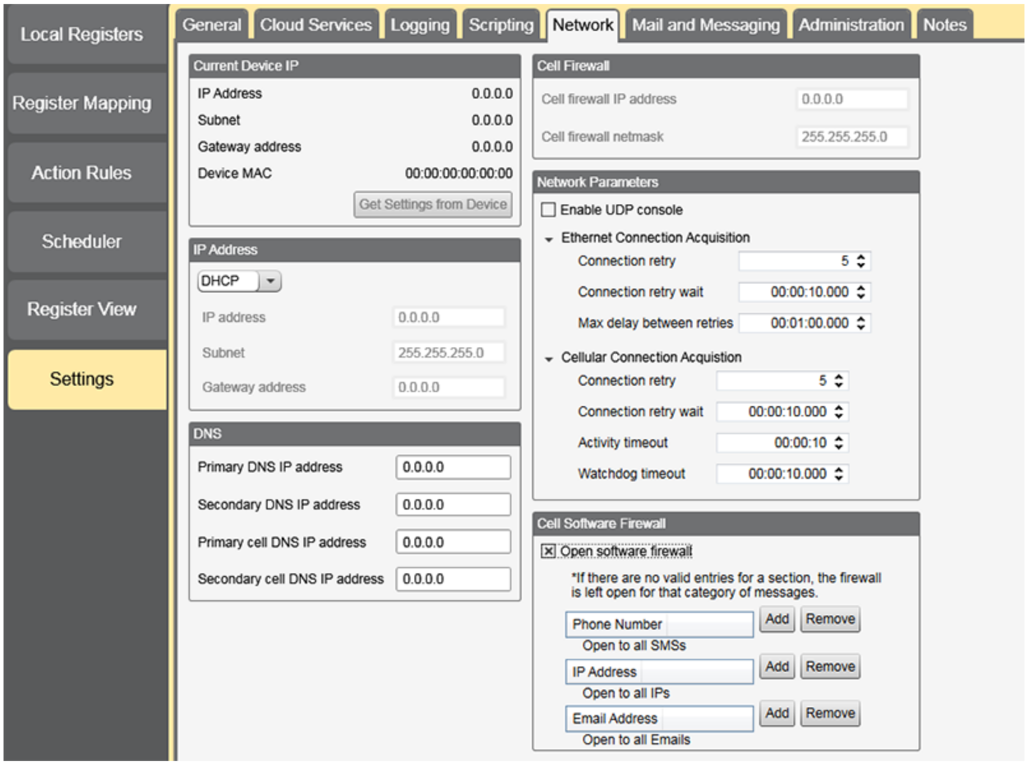
Mail Server **Settings**—The server settings specify a SMTP (Simple Mail Transfer Protocol) server as well as provide the login credentials to the SMTP mail server. The SMTP server port defines where to send the e-mail message for submission. Port 25 or 587 is for typical sending e-mail. Some servers 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. The user can define three email recipients. 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.

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.

## 2.6.7 Network

Use the Network screen to define the Ethernet connectivity settings, Cellular firewall settings (for VPN), and DNS settings.

Any network parameters adjusted using the LCD Display screen override the settings in the XML configuration file. The user must reset the network LCD setting on the LCD display before the network parameters in the XML configuration will be used.



Current Device IP

| | |
|---|---|
| IP Address | 0.0.0.0 |
| Subnet | 0.0.0.0 |
| Gateway address | 0.0.0.0 |
| Device MAC | 00:00:00:00:00:00 |

IP Address

DHCP

| | |
|---|---|
| IP address | 0.0.0.0 |
| Subnet | 255.255.255.0 |
| Gateway address | 0.0.0.0 |

DNS

| | |
|---|---|
| Primary DNS IP address | 0.0.0.0 |
| Secondary DNS IP address | 0.0.0.0 |
| Primary cell DNS IP address | 0.0.0.0 |
| Secondary cell DNS IP address | 0.0.0.0 |

Cell Firewall

| | |
|---|---|
| Cell firewall IP address | 0.0.0.0 |
| Cell firewall netmask | 255.255.255.0 |

Network Parameters

☐ Enable UDP console

Ethernet Connection Acquisition

| | |
|---|---|
| Connection retry | 5 |
| Connection retry wait | 00:00:10.000 |
| Max delay between retries | 00:01:00.000 |

Cellular Connection Acquistion

| | |
|---|---|
| Connection retry | 5 |
| Connection retry wait | 00:00:10.000 |
| Activity timeout | 00:00:10 |
| Watchdog timeout | 00:00:10.000 |

Cell Software Firewall

☒ Open software firewall

*If there are no valid entries for a section, the firewall is left open for that category of messages.

Phone Number
Open to all SMSs

IP Address
Open to all IPs

Email Address
Open to all Emails

### Cellular Firewall and Cellular **Software** Firewall

The cellular modem has a built-in firewall to restrict which host(s) communicates with the DXM Controller using a private network. Define an IP address for a single host connection or use the netmask to create multiple IP connections (0.0.0.0 is open to any IP address).

Select Open **software firewall** to accept incoming messages on a cellular connection. If Open **software firewall** is selected and there are no entries present, the software firewall allows all traffic. Entries within the firewall settings will only allow the devices specified to communicate with the DXM Controller.

### 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.

### DNS

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

### 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 Controller'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.

### Network Parameters

The Network Parameters define certain aspects of the user selected network, cellular or Ethernet, within the DXM Controller. In most cases, the factory default parameters are sufficient for typical applications and do not need to be changed.

Ethernet **Connection Acquisition**—These parameters govern the operation of the DXM when it tries to connect to an Ethernet network.

- **Connection** Retry—Defines the number of attempts to join an Ethernet network (default 5). Only use this parameter with DXM Controller firmware later than version 1.0. Typical settings are 0 through 5 seconds.
- **Connection** Retry Wait—Defines the amount of time in seconds to wait between the first and seconds retries. For every failed attempt to connect to the network the wait time increases by a multiple of the wait time. For example, if the wait time is 5 seconds, the delay between the first and second retry will be 5 seconds. The next delay is 10 seconds, then 15 seconds, then 20 seconds, up to the maximum time specified. Only use with DXM Controller firmware later than version 1.0. Typical settings are 0 through 5 seconds.
- Max Delay between Retries—Defines the maximum amount of time to wait between retries. After every failed attempt, the wait time is increased by the original retry wait time until it reaches the Max Delay between Retries.

Cellular **Connection Acquisition**—Defines the interaction with the wireless network when trying to establish a connection. The default parameters should not need to be changed.

- **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.

The following Cellular Server Mode parameters only apply to DXM Controllers using a cellular network connection in Server Mode. Server Mode turns on the cellular modem continuously to allow for connections from a host system to the DXM Controller. Do not configure the DXM Controller to send push data automatically in Server Mode.

- **Activity** Timeout—An internal setting on the cellular modem that watches the incoming activity. If there isn't activity coming into the cellular modem for the specified amount of time, the connection closes and the device returns to listening mode. This catches the issue with the host system dropping a connection but the cell modem not aware of the dropped connection. Always set the Activity Timeout parameter to a time longer than the expected polling rate. If the polling rate is 1 hour this setting should be greater than 1 hour (e.g. 4000 seconds). The factory default setting is disabled (0).
- Watchdog Timeout—Used in an application routine running in the DXM processor. If there is no incoming cellular traffic within the watchdog time period, the cell modem resets. The Watchdog Timeout should be greater than the Activity Timeout; the watchdog routine is a failsafe mechanism to detect if the cellular modem is left in a bad state from the wireless network. The factory default setting is disabled (0).

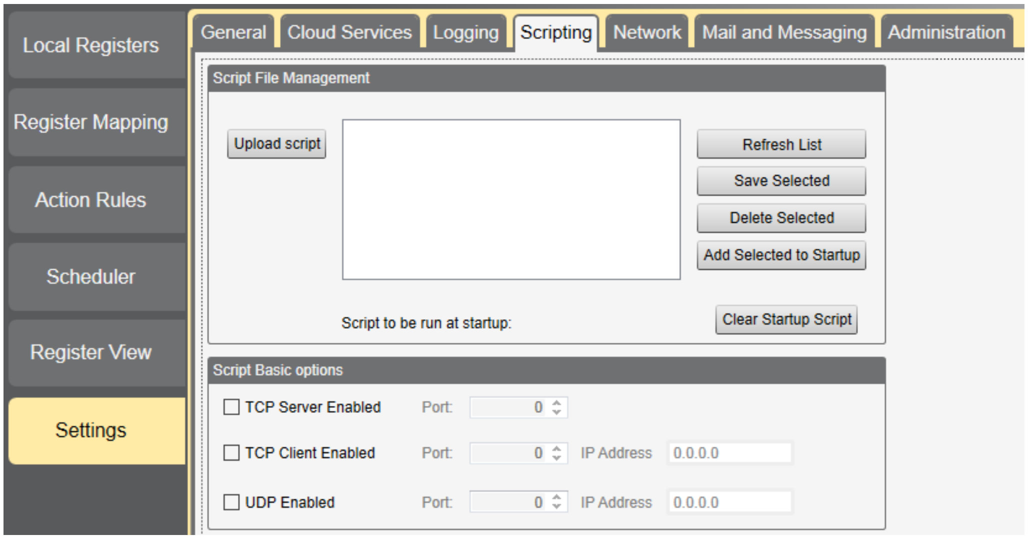
## 2.6.8 Notes

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.

## 2.6.9 **Scripting**

The DXM Controller can run one ScriptBasic program.



☐ TCP Server Enabled Port: 0

☐ TCP Client Enabled Port: 0 IP Address 0.0.0.0

☐ UDP Enabled Port: 0 IP Address 0.0.0.0

Under the **Scripting** tab, save, load or delete script files on the DXM Controller. 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 box appears.
2. Select the pull-down menu to select the file types: .sb, .esb or *.*.

# 3 Additional Information

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