DX80 Performance Configuration Software

Instruction Manual

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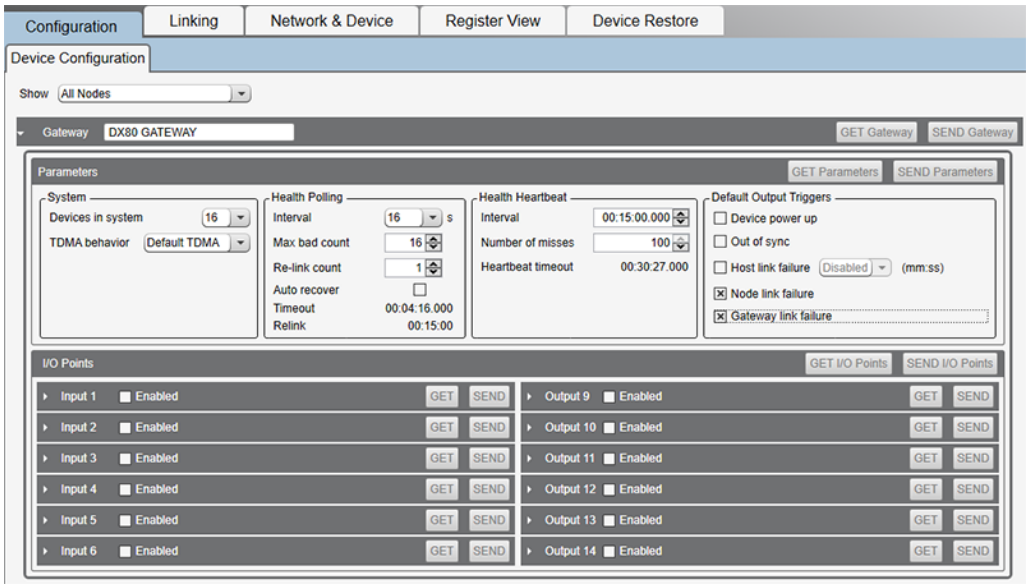
1 Sure Cross® DX80 Performance Configuration Software

The configuration software offers an easy way to link I/O points in your wireless network, view I/O register values, and set system communication parameters when a host system is not part of the wireless network. The software runs on any computer with the Windows Vista, Windows 7, Windows 8, or Windows 10 operating system.

Figure 1. Device Configuration screen



Use a USB to RS-485 adapter cable to connect a standalone DX80 Gateway to the computer. For DXM Controllers with an internal DX80 radio, connect a computer to the DXM Controller using the supplied USB or Ethernet connection. Download the most recent revisions of the configuration software from Banner Engineering's website: https://www.bannerengineering.com/us/en/products/wireless-sensor-networks/reference-library/software.html.

The USB to RS-485 adapter cable is not required for the DXM Controller. For standalone DX80 Gateway devices use:

- USB to RS-485 adapter cable model **BWA-UCT-900** for 1 Watt radios
- USB to RS-485 adapter cable model **BWA-HW-006** for all other radios

2 Quick Start Guide

2.1 Installing the Software

The DX80 Performance Configuration Software uses a USB to RS-485 adapter cable to connect a standalone Sure Cross Gateway to a PC. The DXM Controller connects directly to a PC using a USB or Ethernet cable.

Figure 2. BWA-UCT-900 RS485 to USB Adapter Cable



Before connecting a USB device, first download and run the DX80 Performance Configuration Software from Banner Engineering Corp's website (www.bannerengineering.com/wireless). If the USB device is connected while the software is installing, the driver installation may not finish properly.

To connect a Sure Cross wireless Gateway to a computer:

1. Complete the software installation. The program installs the DX80 Performance Configuration Software and the driver for the Banner USB/485 converter.
2. Connect the USB end of the Banner USB/485 converter to a USB port on the computer. The computer should recognize the Banner USB/485 device.
3. Connect a Banner wireless Gateway to the Euro-style connect end of the Banner USB/485 converter. The Gateway device powers up.[1] When using a third-party USB/485 converter, manually wire the communication and power connections. Refer to Banner's Gateway datasheet for the wiring pinout configurations.
4. Launch the DX80 Performance Configuration Software.
5. Select the correct COMM port for the USB to RS-485 converter.

The DXM Controller ships from the factory with a USB cable to directly connect to a PC. An Ethernet connection is also an option for configuration. Refer to the DXM Controller Instruction Manual (p/n 190037) for more information about defining an IP address for an Ethernet connection.

2.2 Menu Bar

The **File** and **Device** menus select the basic file operations and communication configuration for the DX80 Gateway.

Access the **File** and **Device** menus from the menu bar.

File Menu

Exit—Closes the COMM port and exits the program. Any data that is not saved is lost.

Load—Loads a specific XML configuration file into the tool for editing. This XML configuration file is unique to the DX80 Performance Configuration Software and is not compatible with other configuration tool XML files.

New—Loads blank configuration settings into the tool.

Save—Saves the current settings in the configuration tool under the current XML file name. The program switches to Save As if there is no XML file name assigned.

Save As—Saves the current settings in the configuration tool to a new file name specified by the user.

Device Menu

Traffic Watcher—Views all serial data traffic between the host and the connected radio. The Traffic Watcher logs file loads, error messages, and data transfers.

Connection Settings—Sets the COMM port to communicate with the connected radio. There are four possible connection with the DX80 Performance Configuration Software.

[1] The Gateway will not remain powered up until the computer recognizes and configures the USB port. After plugging the USB/485 converter into the computer's USB port, wait about 10 seconds for the Gateway to be powered (LED 1 solid green).

Serial—Direct connection to the master radio using a RS485 to USB converter cable.
Modbus TCP—Ethernet connection to a DX80 Gateway Pro device.
Serial DXM—Connecting to a DXM internal ISM radio using USB
TCP DXM—Connecting to a DXM internal ISM radio using Ethernet; select the VPN checkbox only when your DXM is connected to the Internet via a VPN

Minimize Data Traffic—Allows the configuration tool to only write data to a Node that has changed. For example, if parameter contents are read from the Node and then the user changes one field, the tool only writes one field back to the Node. Default is ON—the configuration tool minimizes the data traffic.

Use Legacy Commands for Device Communications—Older DX80 devices do not support access to device-level system parameters. Select this option to use of legacy commands to DX80 devices. This slows down communications between the PC and DX80 devices.

Use Site Survey for Node Traffic—Allows the configuration tool to put a Node into site survey mode to increase the data transfer rate between the Gateway and the Node. The communications rate is slower to *Flex*Power Nodes to optimize battery life. Default is ON—the configuration tool turns on Site Survey to increase data rates to FlexPower devices.

2.3 Connection Settings

The configuration software connects directly to a standalone parent radio using the USB to RS-485 adapter cable. When using a DXM Controller, connect to the internal radio through the DXM Controller.

After the software launches, go to **Device** > **Connection Settings** to choose one of the four communication modes: **Serial**, **Modbus over TCP**, **Serial DXM**, or **TCP DXM**.

Figure 3. Connection settings (Serial)

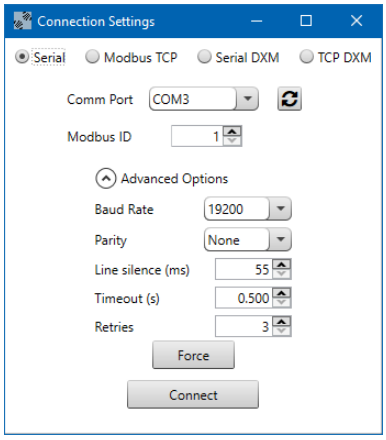
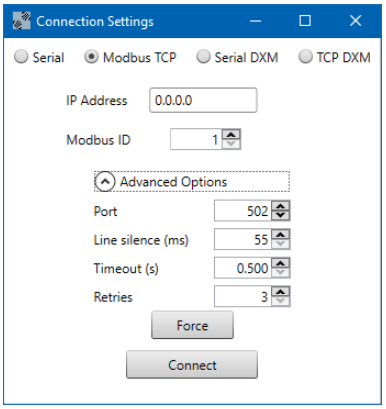


Figure 4. Connection settings (Modbus TCP)



Basic Connection Settings

Comm Port / IP Address—Select the COMM port of the PC or, when using Ethernet, the IP address of the device. Click the refresh button to refresh the COMM ports on the PC.

Connect/Click to Cancel—Click to verify a radio is present by reading back the RF firmware. After a connection is in progress, this button changes to **Click to Cancel**.

Modbus ID—Modbus address ID of the radio.

Modbus TCP—Use when connecting to the parent radio using an Ethernet connection. The IP address must be known to communicate with the device.

Serial—Use when directly connecting to the parent radio using the USB to RS-485 adapter cable.

Serial DXM—Use when configuring an internal radio of the DXM Controller using the USB connection on the DXM Controller.

TCP DXM—Use when configuring the internal radio of the DXM Controller using the Ethernet port. The standard DXM TCP port is 8844.

Advanced Connection Settings

Baud Rate (Serial only)—Defines the baud rate for the serial connection of the USB to RS-485 converter or DXM USB connection. Default of 19200 for the USB to RS-485 converter or 115k for the DXM USB connection.

Force—Click to have the software use the selected parameters and force a connection to a device without validating the device is present.

Line Silence—Specifies the wait time between two consecutive Modbus messages created by the DXM Controller. Too short of a wait time may cause external Modbus devices to miss or create errors on Modbus traffic. A typical setting should be 50 to 100 ms.

Master Ping—For most applications, leave the Master Ping set to 0. To communicate directly with a DXM baseboard, set the value to 2. Using Master Ping allows you to have multiple master radios on a single network. For more information about this advanced setting, contact Banner Engineering Corp and ask to speak to a Wireless applications engineer.

Parity (Serial only)—The default parity setting is None. Optional settings are Even or Odd.

Port (Ethernet only)—Defines the Ethernet port used when communicating via Modbus/TCP or to the DXM Controller. The default is 502.

Retries—The number of times the software resends Modbus messages before it errors out. The minimum number of retries is three.

Timeout—The time allowed for a Modbus message to complete. The default time out is 0.5 seconds for a serial connection and 5 second for a TCP connection. This may need to be extended for battery-powered devices or networks with communications paths that include multiple repeater devices.

3 Software Screens

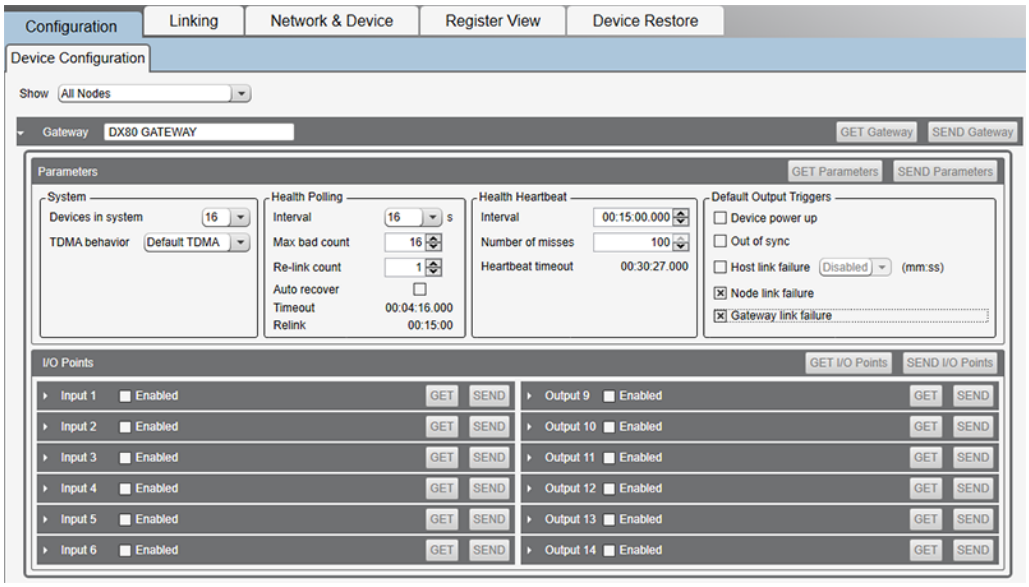
The following sections explain the function of each screen.

3.1 Configuration

Use the **Configuration** screen to configure the Gateway and each Node's input and output parameters. Click on the arrow to the left of the device type to expand the settings for that device.

Devices are listed as a single line that can be expanded to view device level parameters and individual I/O points. Use the drop-down list in the upper left to select how the devices are shown: **All Nodes**, **Nodes with Configuration Data**, or **Nodes Currently in the System**.

Figure 5. Configuration screen



3.1.1 Gateway or Node Parameters

Read or write I/O point data individually using **GET** or **SEND** buttons.

GET or SEND Gateway/Node

Get all the parameter data for a device using **GET Gateway** or **GET Node**.

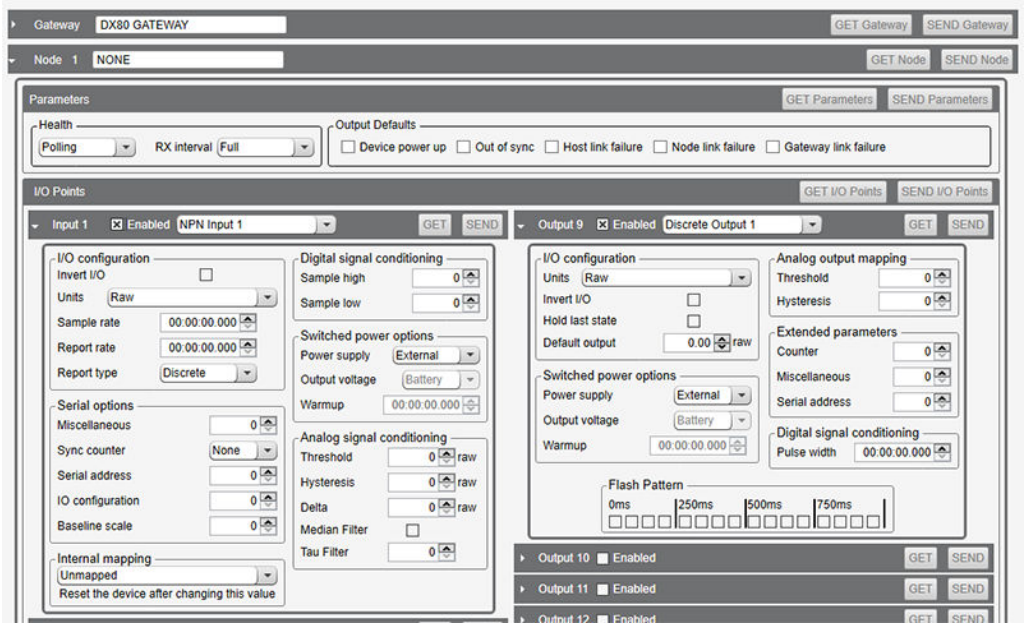
GET or SEND Parameters

Read or write all device-level parameters using **GET Parameters** or **SEND Parameters**.

GET or SEND I/O Points

Read or write I/O data all at once using **GET I/O Points** or **SEND I/O Points**.

Figure 6. Configuration screen with the Node parameters shown



Configure the Gateway or Node Parameters

Follow these steps to configure the Gateway or Node parameters.

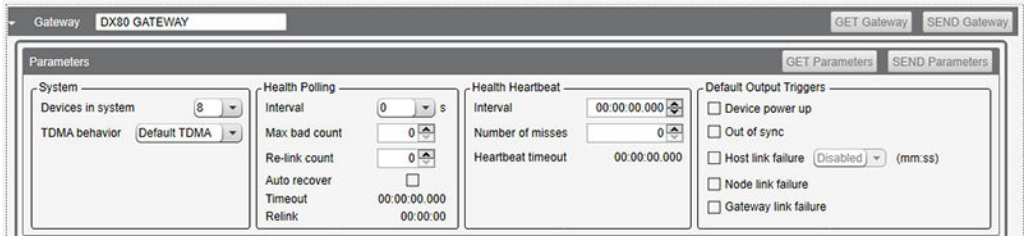
1. Click **GET Gateway** or **GET Node** to get all the parameter data for a device.

   This may take a few minutes and loads all pre-existing configuration into the configuration software.
2. Click the down arrow next to the device name to expand the screen.
3. Expand individual lines of an I/O point by clicking on the down arrow next to the input or output name.
4. Make your desired changes to the configuration.
5. Click **SEND Gateway** or **SEND Node** to send all changes back to the devices.

3.1.2 Gateway Device-Level Parameters

The following are the Gateway-specific device-level parameters. Click on the arrow next to the Gateway to view these parameters.

Figure 7. Gateway device-level parameters



Default Output Triggers

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

Device Power Up—Outputs are set to user-defined states every time the device is powered up.

Out of Sync—Outputs are set to user-defined states when the radio is out of sync with its parent radio.

Host Link Failure—Host link failure is when the defined timeout period has elapsed with no communications between the host system (or Modbus master device) and the DX80 Gateway, typically about four seconds. Outputs are set to user-defined states when a host link failure has been detected.

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

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

Health Heartbeat

Heartbeat mode is typically used for battery-powered devices. This allows for optimal battery performance but will not be a fast deterministic indicator of network health. Typically Heartbeat parameters are configured to detect a network failure in 15-30 minutes. In heartbeat mode, the Nodes send "heartbeat" messages to the Gateway at specific intervals to indicate the radio link is active. The heartbeat is always initiated by the Node and is used only to verify radio communications.

Interval—The interval the Node sends the heartbeat messages to the Gateway. The Gateway needs to receive at least one heartbeat message from the Node within the interval to stay in sync. After the heartbeat is received in that interval, the Node does not send any additional heartbeat messages until the start of the next interval.

Number of Misses—If the Node fails to get its heartbeat message to the Gateway, it immediately retries for the Number of Misses times. The length of time these retries take depends on the maximum number of Nodes in the system. The length of time in which the Gateway listens for a specific Heartbeat message is defined by the Node's Heartbeat Interval + the time to complete the Number of Misses + 1 second buffer. The time to complete the selected Number of Misses depends on the number of Nodes in system.

Health Polling

Polling is the default method to verify device communications status within the network. Banner wireless systems use polling to monitor the status of the RF communications link. If the RF link fails, the system can take precautions to set outputs to defined states. Choose system polling parameters carefully: higher polling intervals create more RF traffic. With multiple wireless systems within range, more RF traffic results in a higher percentage of missed communications.

Auto Recover—A device that is out of sync will automatically rejoin the network when the Auto Recover is enabled. Otherwise, it will require a manual reset of the error condition before the Node is allowed back into the wireless network. Default setting: enabled.

Interval—The Gateway communicates with, or polls, each Node to determine if the radio link is active. The polling rate defines how often the Gateway communicates with each Node. Polling is always initiated by the Gateway and only verifies radio signal communications.

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

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

System

Device In System—Use the drop-down list to select the total number of wireless devices in your wireless network, including the Gateway. The more devices in the network, the slower the overall network performance is.

8 Devices = Nodes communicate every 62.5 milliseconds
16 Devices = Nodes communicate every 128 milliseconds
32 Devices = Nodes communicate every 250 milliseconds
48 Devices = Nodes communicate every 500 milliseconds

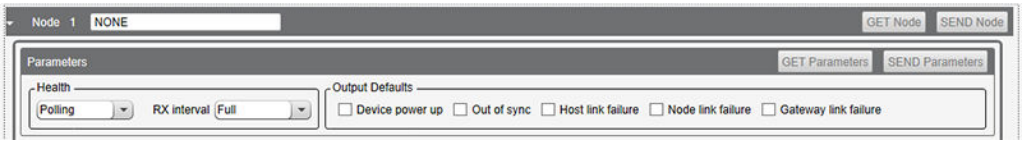
TDMA Behavior—Select the TDMA behavior from the following choices:

Default TDMA—Standard communications with Node devices.
Fast Sync—Allows DX80 Nodes to synchronize to the Gateway much faster, which causes more RF traffic from the Gateway and uses more operating current. We do not recommend using this setting in multiple network environments.
Power Save Gateway—Used for applications that require minimizing the power consumption of the Gateway (battery or solar powered). This setting causes higher latency in the communications between the Gateway and Node.

3.1.3 Node Device-Level Parameters

Click the arrow next to the Node to view the device-level parameters for the selected Node.

Figure 8. Node device-level parameters



There are two parameters that determine the **Health** of a DX80 star architecture wireless network: polling and heartbeat. Both parameters are defined on the Gateway.

- **Polling**—Polling is the default health method for 10 to 30 V DC powered devices. A polling setting of less than one second requires the RX interval to be set to Full.
- **Heartbeat**—Heartbeat is more efficient for battery-powered devices and is the default setting for battery-powered devices.

The **RX interval** is a Node parameter that defines how often a Node will listen for Gateway communications.

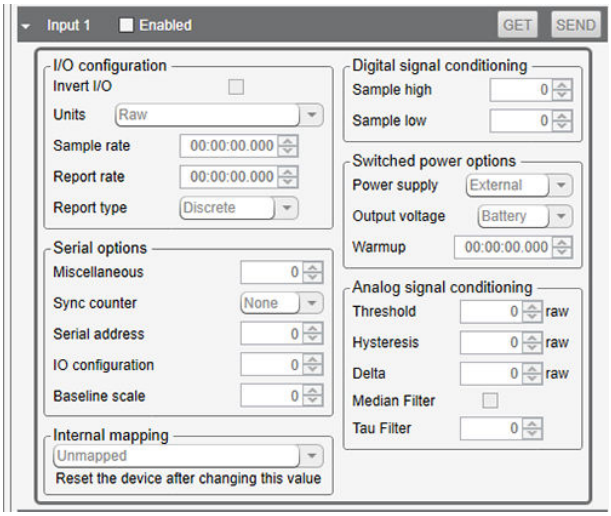
- Full—For 10 to 30 V DC power devices, set the RX interval to FULL to have the Node communicate with the Gateway at the maximum rate. Any Polling or Heartbeat health settings will operate.
- 1 second—For battery-powered devices, set the RX interval to 1 second. This optimizes the battery life for battery-powered devices, but slows down the communication rate with the Gateway.
- 2 seconds to 4 seconds—Some battery-powered devices are set higher than a 1 second receive interval to optimize battery life. Set the DX80 Q45 and M-GAGE device receive intervals to 2 seconds, and set the 900 MHz M-GAGE to 4 seconds. Devices set to 2 or 4 second RX intervals should use the Heartbeat health method. Only Polling health settings greater than 1 second are allowed.

For the **Output Defaults** definitions, see Gateway Device-Level Parameters on p. 8.

3.1.4 Input Parameters

To view or change the input parameters, click on the arrow next to the **Input** number and select **Enabled**. For each input, the following input types are available. Verify with your device datasheet which inputs are configurable and which inputs are set by the factory.

Figure 9. Input parameters



- Accelerometer in
- Accelerometer configuration
- Analog
- Asychronous counter
- Battery voltage
- Bridge
- Constant value
- HART
- Interrupt
- J-type thermocouple
- K-type thermocouple
- Modbus holding registers
- Multiple NPN
- Multiple PNP
- NPN (sinking) or PNP (sourcing) discrete
- Photoelectric
- R-type thermocouple
- Relay
- SDI-12
- Stack light
- Thermistor
- Touch sensor
- Ultrasonic
- 100-ohm RTD
- 10-ohm RTD
- Other thermocouple types

Analog 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.

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.

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.)

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

Digital Signal Conditioning

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

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

I/O Configuration

Report Rate—The report rate defines how often the Node communicates the I/O status to the Gateway. For battery-powered applications, setting the report rate to a slower rate extends the battery life. Set the report rate to 0 to configure for change of state reporting; the input will only report when the value changes from 0 to 1 or 1 to 0. The units are hours:minutes:seconds:milliseconds.

Report Type—The report type defines the data format for the reporting message. A report type of discrete indicates this is a single bit of data. A report type of analog defines the reporting message to be 16-bits of data. A report type of double is 32-bits of data. When setting the Report Type to double, disable the next 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. The units are hours:minutes:seconds:milliseconds.

Units—Select the units of your input from the drop-down list.

Internal Mapping

Maps an input on the Gateway or Node to an output on the same device.

Serial Options

I/O Config—The I/O Config parameter is a configuration parameter for smart sensor devices. This parameter also defines I/O information for the Extended Logic I/O type. (Parameter number 0x14).

Serial Address—The serial address parameter defines the remote serial device address to read. This parameter also defines configuration information for the Extended Logic I/O type. (Parameter number 0x19).

Sync Counter—Select between none, 16-bit, or 32-bit counters.

Switched Power Options

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

Power Supply—Select how the sensor connected to this input is powered: external power supply or switch power 1 through 4. Only devices with switched power outputs can power a sensor. Refer to the device datasheet to see which, if any, switched power outputs are available.

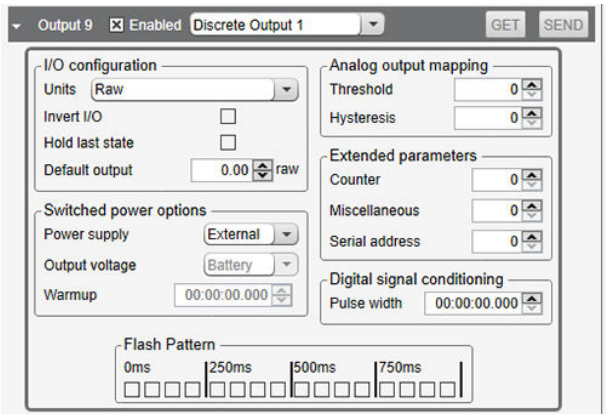
Output Voltage—Select the voltage of your switched power output from the drop-down list.

Warmup—Select the warmup time of your sensor. Units are shown in minutes:seconds. The maximum value is 2:07.5 (two minutes, 7.5 seconds). The minimum time is 0.001 seconds. Set the sensor warmup time to less than the Sample Rate for that input.

3.1.5 Output Parameters

For each output, the following output types are available. Verify with your device datasheet which outputs are configurable and which outputs are set by the factory.

Figure 10. Output parameters



- Analog
- Clear asynchronous counter
- Clear synchronous counter
- Discrete
- Enable RTS
- Force sample and report
- H-bridge
- M-GAGE baseline
- M-GAGE configure
- NMOS
- Relay
- Serial write
- Set thresholds with offsets
- Stack light
- Switch

Analog Output Mapping

The default view shows the **Threshold** and **Hysteresis** parameters. These parameters are used in certain configuration modes of the output. When Linking is defined, these parameters change names to Start and End parameters.

The Start and End parameters define the beginning and ending window when mapping an analog input range to an analog output range. The output range is always defined as the output capability: 4–20 mA, 0–20 mA, or 0–10 V. The Start and End parameters define the input range.

For example, a temperature input on a Node is linked to the 4–20 mA analog output on a Gateway. If we want to link a temperature range of 32 to 90 degrees to 4–20mA, the Start parameter is set to 32 degrees and the End parameter is set to 90 degrees. The parameters will be grayed out until an input to output linking is defined.

Digital Signal Conditioning

Pulse Width—The number of 62.5 ms intervals a digital output is active (1) before returning to zero. Zero disables the pulse width feature and any value on an output point remains indefinitely. Maximum pulse width is about 16 seconds. Value range: 0 (disable, default) through 255. (Parameter number 0x0A).

Extended Parameters

Counter—Select between none, 16-bit, or 32-bit counters.

Serial Address— The serial address parameter defines the remote serial device address to read. This parameter also defines configuration information for the Extended Logic I/O type. (Parameter number 0x19).

Flash Pattern

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

I/O Configuration

Default Output—If a default output is selected, this is the value placed in this register when radio communications are lost between the Gateway and this Node or when any of the selected Default Output Triggers under the Parameter Settings are active.

Hold Last State—If this checkbox is selected, this register retains the last sampled state when radio communications are lost between the Gateway and this Node.

Switched Power Options

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

Power Supply—Select how the sensor connected to this input is powered: external power supply or switch power 1 through 4. Only devices with switched power outputs can power a sensor. Refer to the device datasheet to see which, if any, switched power outputs are available.

Output Voltage—Select the voltage of your switched power output.

Warmup—Select the warm up time of your sensor.

3.2 Linking

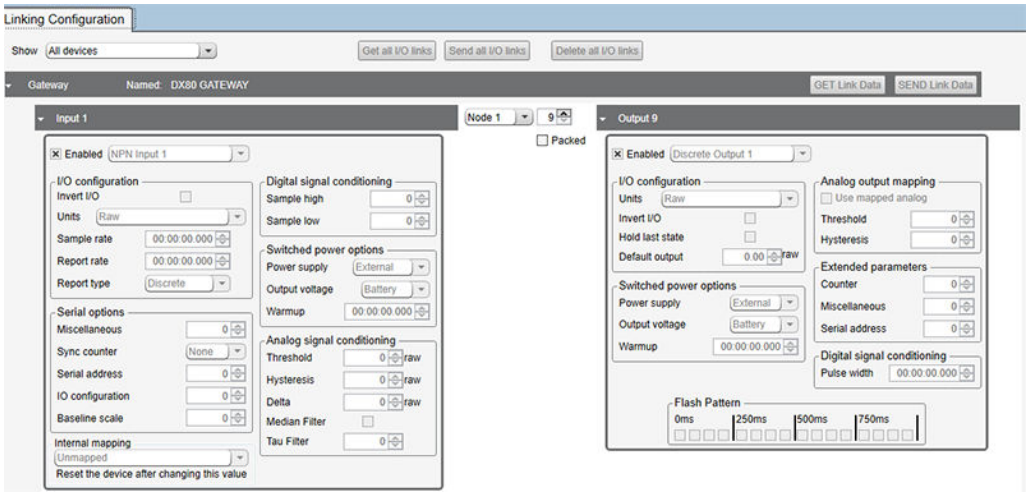
Use the **Linking** screen to link one Sure Cross device's inputs to another Sure Cross device's outputs, as long as both devices are part of the same wireless network.

Do not use the linking capability if an external host system will be reading and writing Modbus data registers in the Gateway. The **Linking** screen lists each device on a line.

Use the **Show** drop-down list to select whether to display all devices, all the devices with links, or all devices currently within your network.

For each displayed device, click on the arrow to expand that device's parameters. Inputs are on the left, outputs are on the right.

Figure 11. Linking screen



Click **Get All I/O Links** to retrieve any existing links in the entire wireless network.

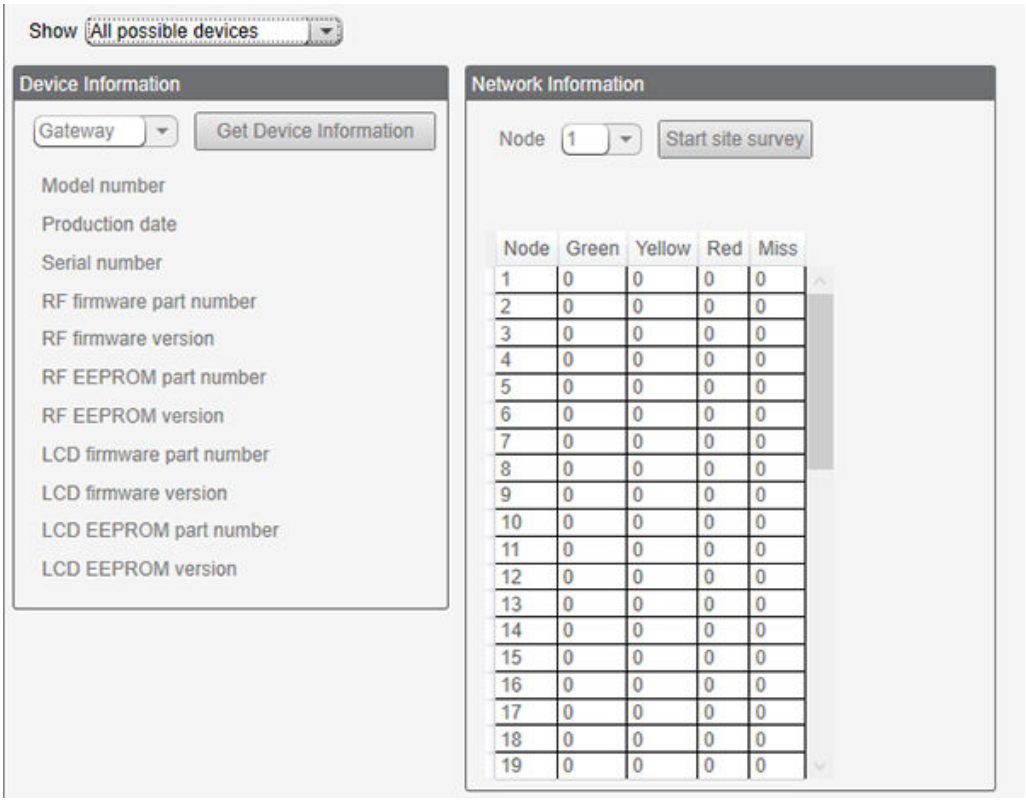
After the linking is defined, click **Send All I/O Links** to write all linking data. To erase all linking data, click **Delete All I/O Links**.

For each device, click **GET Link Data** to retrieve any existing linking information specific to that device. Click **SEND Link Data** to send any new linking data for that device to the network.

3.3 Network and Device

Use the **Network & Device** screen to view factory information about your wireless network devices and to view the Site Survey results.

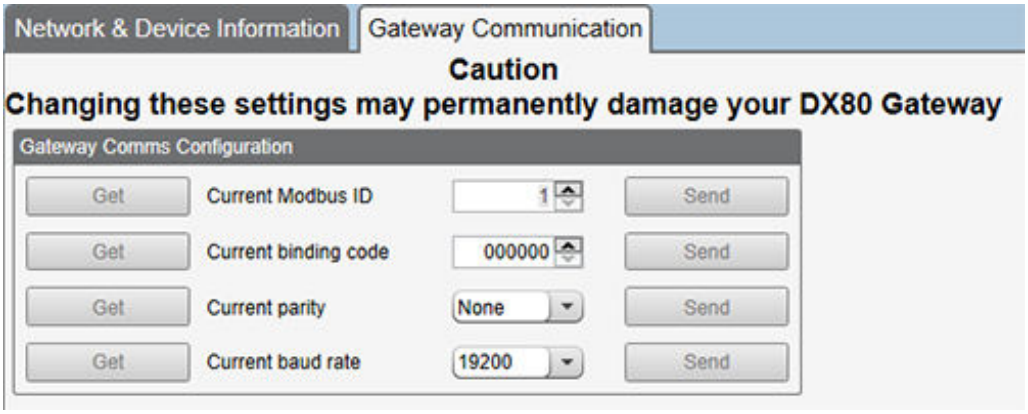
Figure 12. Network and Device Information screen



Factory information about a device includes the model number, production date, serial number, and various firmware and EEPROM versions. To view all the device's factory information:

1. From the **Device Information** drop-down list, select a device.
2. Click **Get Device Information**. The program retrieves all version and manufacturing data from the device and displays it on the screen.

Figure 13. Gateway Communication screen



The Gateway Communications screen allows you to change the Gateway's serial communication settings and network binding code. After you change these settings, you must re-connect to the configuration software.

Current Modbus ID

Displays the current Modbus ID of the Gateway

Current Binding Code

Displays the current binding code for the network

Current Parity

Displays the current parity of the Gateway for serial communications

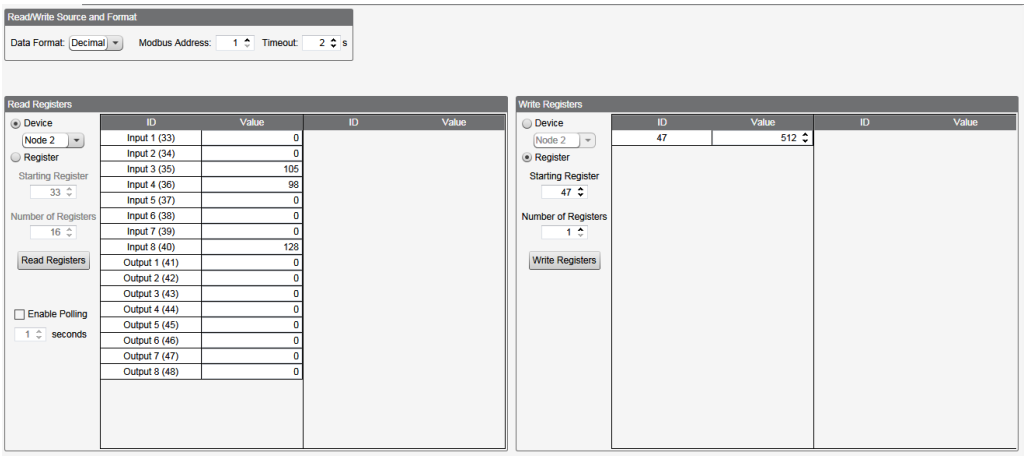
Current Baud Rate

Displays the current baud rate of the Gateway for serial communications

3.4 Register View

The **Register View** screen creates a Modbus master utility to read or write any Modbus register within the DX80 Gateway. Use the **Register View** screen to read or write specified device I/O values.

Figure 14. Register View screen



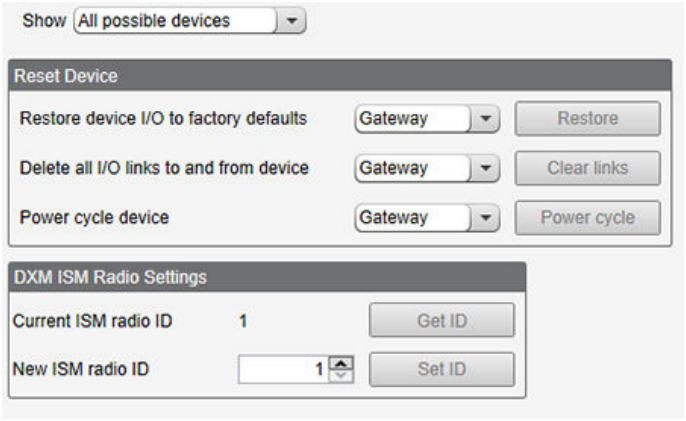
Data Format—From the drop-down list, select the which data format to view the register values in: decimal or hex.

Modbus Address—Enter the Modbus address of the wireless network's Gateway.

Timeout—Enter the timeout value, in seconds, for communications. If the Node does not respond to a command within the timeout window, an error message occurs. Increase the timeout if the radio signal strength between the Gateway and Node is poor.

3.5 Device Restore

Figure 15. Device Restore screen



Reset device I/O to factory default—To restore the factory default settings to a selected device, select the device from the drop-down list and click **Restore**.

Delete all I/O links to and from device— To erase all I/O links to or from the selected device, select the device and click **Clear links**.

Power cycle device—To cycle power to a device after you have changed any of the settings of that device, select the device and click **Power cycle**.

Current ISM radio ID—Defines the current network ID for the Gateway. The default value is an ID of 1.

New ISM radio ID—Change this value to modify the network ID for the Gateway. This value is generally not used except to avoid data packet collisions with high-density networks.

4 Configuration Instructions

4.1 Inputs and Outputs

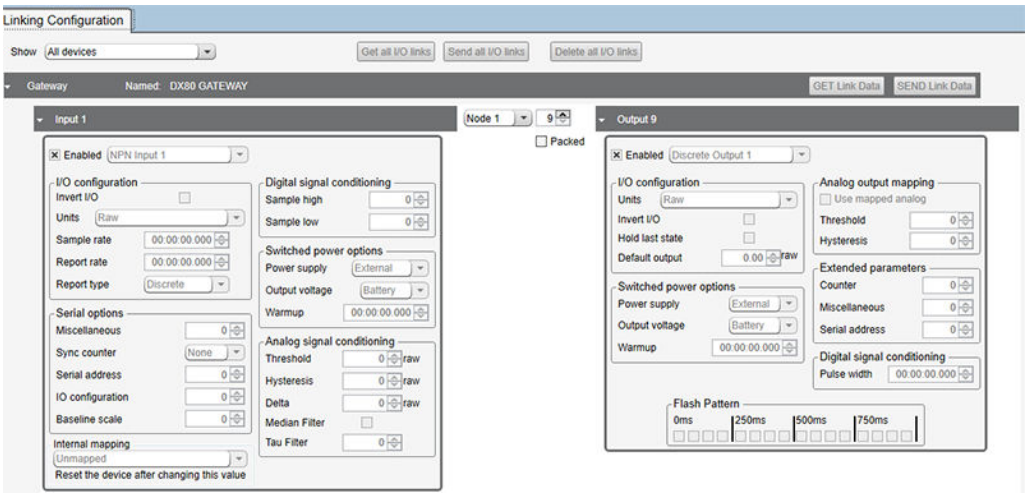
4.1.1 Link the Gateway and Node Inputs and Outputs

Follow these instructions to link the inputs and outputs of the Gateway and any Nodes within your wireless network.

The source device may be the Gateway or any of the Nodes physically present in the network. Device I/O 1 through 8 are inputs on most DX80 wireless models. Device I/O 9 through 14 are outputs on all DX80 wireless models.

Refer to the device's datasheet for exact input and output configurations. The source type field displays the input structure for that given input. Sample input structures include discrete, 0–20 mA, 4–20 mA, 0–10V DC, degrees C, degrees F, and raw.

Figure 16. Linking the Gateway and Node I/O



1. From the **Linking** > **Linking Configuration** screen, click **GET Gateway** to retrieve the Gateway's I/O configuration.
   The Gateway's I/O configuration is displayed within the software.
2. Click **GET Node** for all Nodes in your wireless network to retrieve the Nodes' configuration.
   The Node's I/O configuration is displayed in the software.
3. Select the Gateway and click on the arrow to the left of its name.
   A list of that device's inputs are shown.
4. To map each input to an output, change the **Not Linked** entry on the drop-down menu to the appropriate device for the output.
   The selected Node's output 9 is selected.
5. Using the drop-down list, select the output register you want to link this input to.
6. Define each input-to-output linking for this device.
7. Click **SEND Link Data**.

For simple register linking, you are not required to define the detailed parameters of an input or output (using **GET** or **SEND** on the I/O). If required, I/O can be configured using the **Configuration** screen. For complex linking from an input scale to a different output scale, define **Analog Output Mapping** parameters to set the start and end of the output scale.

4.1.2 Example Configuration -- Analog Inputs

To configure Analog IN 1 for a specific sample rate, report rate, and switch power output voltage, follow these steps.

Although this example uses a DX80N9X2S-P1 Performance Node, configuring other Node models is the same except that the input point associated with Analog IN 1 may be different.

To use the software to configure your Node, first set the Node's DIP switch to be Host Configured. This overrides all other DIP switch settings and relies on the host system or software to configure the device. Consult your Node's datasheet to determine which DIP switch selects between Host Configured (ignores DIP switches) and DIP switch configuration.

Determine which analog input you are configuring. For this example, we are configuring Analog IN 1 of a P1 Node (input 3).

1. On the configuration software, go to the **Configuration** > **Device Configuration** screen.
2. Select the P1 Node from the list and click the arrow to the left of the Node name to open those device parameters.

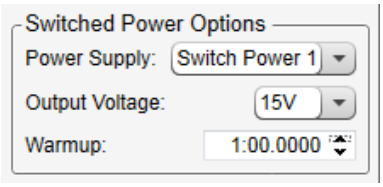
3. Click **GET Node** to load the existing settings into the configuration software.
4. Click the arrow next to Input 3 to open the parameters for that input.
5. Enable Input 3.
6. From the drop-down, select Analog Input 1.
7. From the Units drop-down list, select 0-20mA, 4-20mA, or 0-10V, whichever is appropriate.

Configure the Switched Power Options

To configure the switch power, you must set the power supply, switch power voltage, and warm-up parameters. These parameters must be assigned to the same I/O point as the analog input you are configuring, in this example this is I/O point 3 (Analog IN 1).

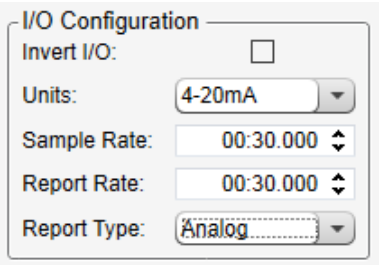
After configuring each parameter, click the **Send** button associated with this input to send the configuration changes to the Gateway's configuration file.

1. Set the power supply parameter. In this example, we are associating SP1 with Analog IN 1 (I/O point 3 on the -P1 Performance Node).
2. Set the switch power voltage parameter. In the example, we are setting the switch power voltage to 15 V and the switch power voltage is associated with I/O point 3 (Analog IN 1 for the -P1 Performance Node).
3. Set the warm-up parameter. In this example, we are setting the switch power warm-up time to one (1) 62.5 millisecond interval, or 62.5 milliseconds.
4. Click **Send** to send this setting to the Gateway's configuration file.



Configure the Sample and Report Rates

1. From the Units drop-down list, select the units for your analog input.
2. Set the sample rate of input 3 (Analog IN 1) to 30 minutes.
3. Set the report rate of input 3 (Analog IN 1) to 30 minutes.
4. Click **Send** to send this setting to the Gateway's configuration file.
5. From the Report Type drop-down list, select the report type.



4.2 Communication

4.2.1 How Do You Monitor System Health?

The Gateway monitors the radio link status in a DX80 system using one of two methods: polling or heartbeat. Each method has different properties and is useful in different system configurations. Some system configurations may require both methods to be used. Independent of the method, the status indication is stored in each device's Modbus register eight.

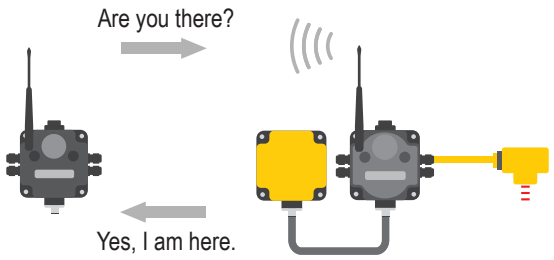
Polling

A polling message originates from the Gateway to Nodes. When a Node receives a polling message, it is expected to immediately respond to the Gateway, indicating the link is operational.

There are no retries on a polling message, just a single attempt of communication between the Gateway and Node. If the message fails, the Gateway increments a missed message counter. A successfully received message resets the missed message counter back to zero. When the maximum number of missed messages is reached, the link is considered bad.

The length of time to determine a radio link error is: **Health Polling Interval × Maximum Bad Count**.

Figure 17. A Gateway polling a Node



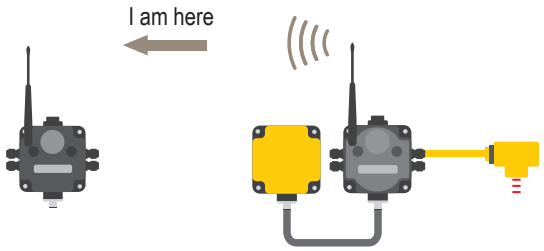
Heartbeat

Heartbeat mode is driven by the Node. The Node sends a heartbeat message to the Gateway based on a specific time interval.

The Node resends the message when the message is not acknowledged by the Gateway. Use the configuration software to define the heartbeat interval for each Node in the network using the Node's parameters.

The Gateway is programmed to expect a message from each Node within the Node Heartbeat RX interval. If the Gateway determines that a Node has not checked in within a specified interval and within the defined number of misses, the radio link is considered to be bad. The maximum time an error is detected will be between one and two heartbeat intervals.

Figure 18. A Gateway and Node exchanging heartbeat signals



Do I Use Heartbeat Mode or Polling?

By default, the DX80 wireless network uses Polling to determine network health in 10-30 V DC powered devices and Heartbeat mode for battery-powered devices.

Polling is the most flexible method for a variety of 10–30 V DC powered applications. Polling can be programmed to be fast or slow, but it will drain battery-powered devices quickly when the polling interval is not set to 16 seconds or longer.

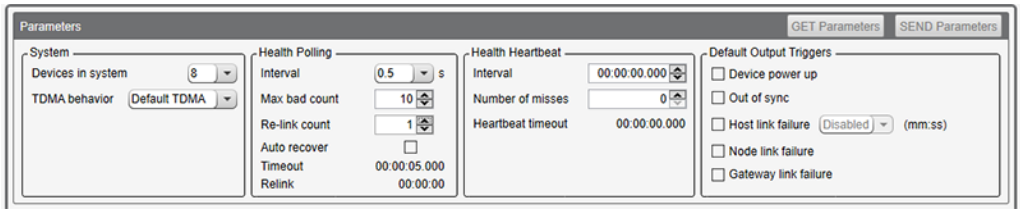
The Heartbeat method is engineered to be more efficient for battery devices. Although radio link failures may not be determined as quickly as with Polling, Heartbeat Mode is more efficient for most battery-powered networks.

For networks containing both battery-powered and 10–30 V DC powered devices, both Polling and Heartbeat modes are used to determine the radio link status. Using both methods results in a programmable error detection time for 10–30 V DC devices and a more efficient interaction (and increased battery life) for battery-powered devices.

Using the latest version of the configuration software:

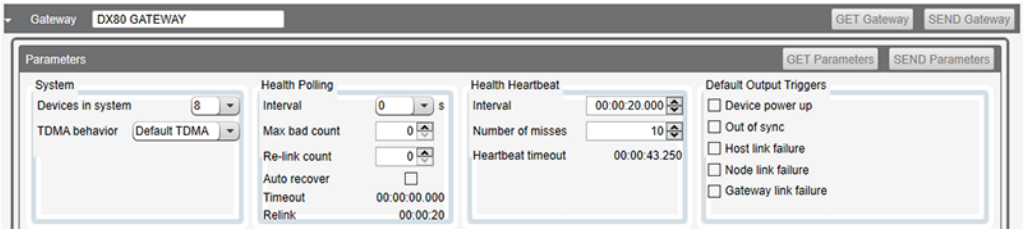
1. Go to the **Configuration** > **Device Configuration** screen.
2. Click the arrow next to the **Gateway** device to display the **Parameters**.
3. Set either the **Health Polling** or **Health Heartbeat** parameters.
    - **Polling**—For 10–30 V DC powered devices, set the **Health Polling interval** to 4 seconds with a **Max bad count** of 16. This allows the system to detect a bad radio link within 64 seconds.

Figure 19. Health polling interval settings



- **Heartbeat**—Set the Health **Heartbeat Interval** to 2 minutes and 30 seconds and the **Number of misses** to 16 to get a **Heartbeat Timeout** of 5 minutes and 4 seconds. The **Heartbeat Timeout** interval is calculated using the **Heartbeat Interval**, the **Number of misses**, and the speed of the device. Using these settings, a bad radio link for battery-powered devices would be detected within 5 minutes and 4 seconds.

Figure 20. Health heartbeat settings



To set the ISM radio settings on a DXM Wireless Controller, you must use the DX80 Performance Configuration Software.

4.2.2 Set the Report or Sample Rate

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

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.

1. Go to the **Configuration** > **Device Configuration** screen.
2. Click the arrow next to the Node you would like to configure.
   The inputs and outputs for that Node display.
3. Click **GET Node** to retrieve any existing configuration settings for the selected Node.
   The existing configuration settings for the selected Node display on the screen.
4. Click the arrow next to the input you would like to configure.
   The parameters for that input display.
5. Select **Enabled** for the input if it is not already enabled.
   The parameters for the selected input are configurable.
6. Set the **Sample rate** in hh:mm:ss.sss.
7. Set the **Report rate** in hh:mm:ss.sss. Set the **Report rate** value to 0 to select change of state reporting.
8. Click **SEND** for each input (only sends that input's settings) or click **SEND Node** to send all the Node's settings, including the **Parameters**.
9. Repeat these steps for all the Nodes and/or inputs you'd like to configure.

4.2.3 What is Sampling on Demand?

Sample on demand allows a host system to send a Modbus command to any register and require the inputs to immediately sample the sensor and report readings back to the host system. Sampling on demand can be used between the normal periodic reporting.

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

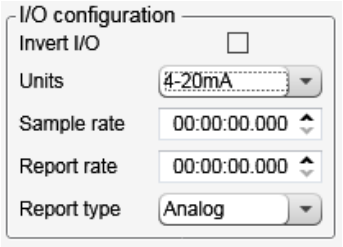
Configure for Sample on Demand

To configure a Node to use Sample on Demand, use the configuration software to change the Sample Rate of each I/O point to 0.

Changing the sample rate to 0 shuts off the periodic sampling and configures the I/O point to only sample when the host system demands a sampling.

Setting the sample rate set to a non-zero value configures the input to sample the inputs periodically or when the host system demands a sampling.

1. Connect the Gateway to a computer with the configuration software installed and launch the software.
2. On the **Configuration** > **Device Configuration** screen, click on the arrow next to the Node you'd like to sample on demand.
3. Click on the arrow next to that Node's input number to expand the input's parameters.
4. Change the **Sample rate** and the **Report rate** to zero (00:00:00.000).



5. Click **SEND** to send the changes to the network.
   This input will now only report sensor readings when demanded to by the host system.

Sample an Input Using a Host System

To sample the input, have the Host System write to the Node's register 15. To calculate which register this is for your Node, use this equation: 15 + (Node # × 16).

1. From the host system, write 0x13xx to the Node's register 15, where xx defines the input you want to sample.

For Input	Write Value (in hex)	Write Value (in decimal)
1	0x1301	4865
2	0x1302	4866
3	0x1304	4868
4	0x1308	4872
5	0x1310	4880
6	0x1320	4896
All Inputs	0x133F	4927

2. To send the Sample on Demand command to more than one input, add together the binary representation values.
   For example, to demand a sampling of inputs 1, 2, and 3, the Hex command is 0x1307.

4.3 Conduct a Site Survey

To conduct a site survey analysis from the DX80 Performance Configuration Software, follow these instructions.

1. From the **Network & Device** > **Network & Device Information** screen, select the Node number from the drop-down menu.
2. Click **Start site survey**.
   The Gateway begins to conduct a site survey analysis with the selected Node. After the software has collected enough data, the results for the selected Node display. Leaving this screen before the site survey finishes ends the Site Survey.

4.3.1 Interpreting the Site Survey Results

Site Survey results are listed as a percentage of data packets received and indicate the signal strength of the received signal.

Table 1: Site survey results

	Result	Description
	Green	Packets received at a strong signal strength. A strong signal strength is greater than −90 dBm at the receiver.
	Yellow	Packets received at a good signal strength. A good signal is between −90 and −100 dBm at the receiver.
	Red	Packets received at a weak signal strength. A weak signal is less than −100 dBm at the receiver.

	Result	Description
	Missed	Packets not received on the first transmission and requiring a retry.

Judging if the reliability of a network's signal meets the needs of the application is not just a matter of green, yellow, and red packets received. In normal operating mode, when data packets are not received, the transmitter re-sends the packet until all data is received.

For slow monitoring applications such as a tank farm, where data is required in terms of seconds or minutes, receiving most of the data in the 'red' range, indicating a weak but reliable signal, transmits enough data for accurate monitoring. Nodes positioned near the outside range of the radio signal may have 90% of the data packets received in the red zone, again indicating a weak, but reliable signal.

4.4 Set the Number of Devices in the System

Define the number of devices (including the Gateway) in the wireless network using the **Device Configuration** screen. The more devices in the network, the slower the overall network performance is.

1. Go to the **Configuration** > **Device Configuration** screen.
2. Click the arrow next to the Gateway.
   The Gateway-specific parameters display.
3. In the **System** section, use the **Devices in system** drop-down list to select the maximum number of devices in your wireless network. Select the smallest number of devices to increase the communication speed.

   8 Devices = Nodes communicate every 62.5 milliseconds
   16 Devices = Nodes communicate every 128 milliseconds
   32 Devices = Nodes communicate every 250 milliseconds
   48 Devices = Nodes communicate every 500 milliseconds
4. Click **SEND Parameters** to send the changed parameters to the Gateway or click **SEND Gateway** to send all changes made to the Gateway's parameters, including I/O changes.

4.5 Continuous or Host-Controlled Switch Power

Switch power outputs on a Sure Cross® device are variable power supply outputs that can be used to power external devices. The switch power outputs are typically used in short bursts to turn on a sensor, sample the sensor output, and turn off the sensor, which is accomplished by a Sure Cross device powered by a 3.6 volt battery and specific timing parameters.

Some applications want to control the switched power outputs from the host or would like to always have the switched power output active. This technical note shows how to activate the switched power outputs on power-up or have the host system turn on or off the switch power outputs (SP1-SP4).

To provide continuous switch power or host system controlled switch power, follow these steps to configure your FlexPower Node.

1. Set the hardware DIP switches for host controlled mode (DIP switches 6, 7, and 8 set to ON, ON, OFF) to allow parameters to be changed from the configuration software. If you do not set the DIP switches for host controlled mode, any configuration changes are erased when the power is turned off.
2. Change the factory default setting to disable inputs from using the switch power. For example, the DX80 FlexPower Node with Boost associated switch power 1 to I/O 1 (in discrete mode) or I/O 3 (in analog mode). DIP switch 2 selects between Discrete Mode or Analog Mode.
3. Use an unused output (I/O 14) to define the switch power control and voltage. For host-controlled switch power, all settings are the same except for the final default condition setting.

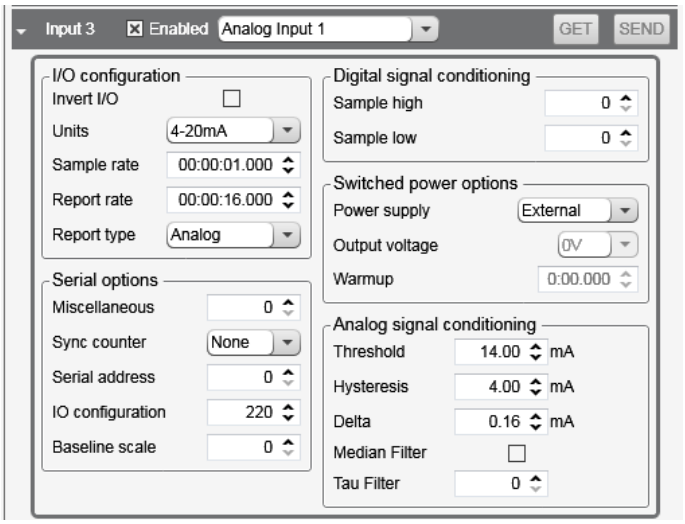
4.5.1 Configure the Switch Power

Select an unused output for define for continuous switch power. For this example, we will be using I/O 14.

1. Disconnect the DX80 Node from its power.
2. Follow the instructions in the datasheet to access the DIP switches. Set the DIP switches for host-controlled mode: DIP switch 6 (ON), 7 (ON), and 8 (OFF).
3. Apply power to the Node and allow it to connect to its Gateway.
4. Connect the Gateway to a computer with the configuration software installed and launch the software.
5. Go to the **Configuration** screen and click **GET I/O Points** to retrieve the network configuration.

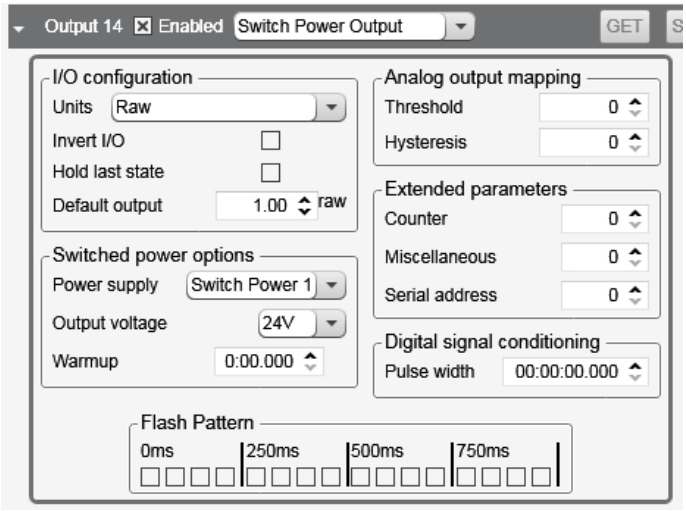
6. Click on the arrow next to the analog input you'd like to associate with the continuous switch power. In this example, we are using input 3.
7. Under the **Switch power options** section, select **External** from the **Power supply** drop-down list.

Figure 21. Setting the switch power parameters for Input 3



8. On the Output side, enable Output 14.

Figure 22. Output 14 parameters



9. From the output type drop-down list, select **Switch Power Output**.
10. In the **Switched power options** section, select **Switch Power 1** from the drop-down list.
11. Select the output voltage from the drop-down list and set the warm-up time. Refer to the device/sensor datasheet for the appropriate output voltage and warm-up time.
12. Under the **I/O configuration** section, set the default output to 1.
13. Decide if you want continuous switch power or host-controlled switch power.
    - For continuous switch power—In the **Output Default** section (top of the screen), set the default output condition to **Device power up**
    - For host-controlled switch power—Do not set the **Device power up** Output Default condition. The host system turns on the switch power by setting I/O 14 to 1 and turns it off by setting I/O 14 to 0.
14. After all changes have been made, click **SEND I/O Points** to update the network configuration.
15. When asked to reset the device, select **Yes**.

4.6 Parameter Definitions and Numbers

The following parameters can be changed using the configuration software or by sending register commands from your host system.

Counter Enable—An enable byte that turns any input point into a synchronous counter. Set to 0 to turn off (default). Set to 1 to enable the 16-bit counter (report type must be set to analog). Set to 2 to enable the 32-bit counter (report type must be set to double). (Parameter number 0x18). The counter value is stored in the Modbus registers. For a 32-bit counter type, Modbus registers N and N+1 are used.

Default Value (bits 15:0)—Defines the default state for each output on all devices. This parameter only applies to outputs. A value of 65535, or 0xFFFF, sets the default value to the last known state. (Parameter number 0x11). There are five conditions that cause the output points to be set:

- Bit 1. Power-up. If enabled, output points are set to the default state when the device powers up. When disabled, outputs are set to 0 when the device powers up.
- Bit 2. Node Out-of-Sync. If enabled, the output points are set to the default state when a Node determines it is out of sync with the Gateway (7 to 10 sec). When disabled, no action takes place for the output points when an out-of-sync condition is detected.
- Bit 3. Host Link Failure. A Modbus user-defined timeout period expired. If enabled, a host link failure forces all device outputs to the user-defined default state. Each device can be enabled/disabled for this feature.
- Bit 4. Gateway Link Failure. The Gateway has detected a problem with a Node in the system. If enabled, any Node outputs linked to the failing device are set to the default state when a Gateway link failure is detected. Each device can be enabled or disabled to use this feature.
- Bit 5. Node Link Failure. The Node detected a problem communicating with the Gateway. If enabled, the Node sets all outputs to the user-defined default state when a Node link failure is detected. Each device can be enabled or disabled to used this feature.

Delta (bits 15:0)—Defines the amount of change required between two successive analog input sample points to trigger a report condition. To disable (default), set to 0. (Parameter number 0x0F).

Duty Cycle (Outputs only) (bits 15:0)—This parameter defines the proportion of time the output is active. Using the 16-bit field, each “on” bit represents 1/16 seconds. For example, 0000 0000 0000 1111 (0x000F) sets the duty cycle to 1/4 seconds; 0000 0000 0000 0011 (0x0003) sets the duty cycle to 1/8 seconds. (Parameter number 0x04).

Enable Flag (bit 0)—Enables (1) or disables (0, default) the I/O point. (Parameter number 0x01).

Hysteresis (bits 15:0)—Works with the active threshold parameter to define when to disable event reporting of an analog input. The hysteresis parameter defines how much below the active threshold the analog input is required to be before the analog input is considered to be off. Value range: 0 (disable, default) through 65535 (two-byte value). (Parameter number 0x09).

I/O Config—The I/O Config parameter is a configuration parameter for smart sensor devices. This parameter also defines I/O information for the Extended Logic I/O type. (Parameter number 0x14).

I/O Type (bits 7:0)—Defines the operations required to operate this I/O point. Every enabled I/O point must have a defined I/O type. (Parameter number 0x02). This parameter is hardware specific and is not typically changed from the factory settings. (See input and output type tables after this section.)

Invert Flag (bit 0)—Complements the polarity of the sensed I/O point. A value of 1 becomes 0. An analog value is not changed, but an analog value with a threshold and hysteresis is complemented. Value range: 0 (inactive) to 1 (active). (Parameter number 0x10).

Low Pass Filter—This parameter defines the operation digital filters for standard analog inputs. Setting parameter bit 7 enables a median filter. Parameter bits [2:0] define the output filtering magnitude. (Parameter number 0x12).

Power Supply # (bits 7:0)—Turns on a local power supply to supply power to an external device. A parameter value of 0 indicates no power supply. A parameter value of 1, 2, 3, or 4 enables that particular internal supply connection. (Parameter number 0x0D).

Value range: 0 (external power supply, default), 1 (selects SP1), 2 (selects SP2), 3 (selects SP3), and 4 (selects SP4).

Three parameters define a power supply connection: power supply selection, voltage, and warm-up time. The voltage parameter defines the supply voltage. The warm-up parameter defines the time the power supply is on before evaluating the input point.

Pulse Width (Outputs Only; bits 7:0)—The number of 62.5 ms intervals a digital output is active (1) before returning to zero. Zero disables the pulse width feature and any value on an output point remains indefinitely. Maximum pulse width is about 16 seconds. Value range: 0 (disable, default) through 255. (Parameter number 0x0A).

Report Rate (bits 15:0)—The report rate defines the rate that the I/O status is reported back to the Gateway. The value represents the number of 62.5 ms increments. Report rates can be from 0 to 4095 seconds. A non-zero report rate guarantees a report on a periodic basis AND at change of state. When set to zero, there will only be a report at change of state. Value range: 0 through 65535. (Parameter number 0x04).

Report Type (bits 1:0)—Defines the internal data structure and reporting definition for an I/O point. If a discrete point changes state, all I/O points are reported to the Gateway in discrete values. An analog input can be treated as a digital value using the Threshold and Hysteresis parameters. (Parameter number 0x0E).

- Discrete/bit report type = 0. Use for discrete values.
- Analog report type = 1 (default). Use for all analog values (two bytes).
- Double report type = 2. Use for 32-bit counter values (four bytes).

Samples High (bits 7:0)—The number of samples an I/O point must be detected high (1) before it is a change of state. This parameter can be applied to a discrete input or a analog input using the threshold parameter. Value range: 0 (disable, default) through 255. (Parameter number 0x06).

Samples Low (bits 7:0)—The number of samples an I/O point must be detected low (0) before it is a change of state. This parameter can be applied to a discrete input or a analog input using the threshold parameter. Value range: 0 (disable, default) through 255. (Parameter number 0x07).

Sample Rate (bits 15:0)—The rate at which the I/O point is sampled. The value represents the number of 62.5 ms increments. The sample rate/interval can be from 1 (0.0625 seconds, default) to 65535 (4095 seconds). Set to 0 to Sample on Demand. (Parameter number 0x03).

Sample on demand allows a host system to send a Modbus command to any register and require the inputs to immediately sample the sensor and report readings back to the host system. Sampling on demand can be used between the normal periodic reporting.

Serial Address—The serial address parameter defines the remote serial device address to read. This parameter also defines configuration information for the Extended Logic I/O type. (Parameter number 0x19).

Switch Power Voltage (bits 7:0)—Used for I/O points supplying power to external devices. Use the lowest operating voltage of the external device when supplying power from a battery-powered DX80. Value range: 0 (default) through 255. (Parameter number 0x0B).

Output Voltage	Parameter (decimal)	Parameter (hex)
5 V	204	CC
7 V	125	7D
10 V	69	45
15 V	32	20
20 V	12	0C
24 V	03	03

Threshold (bits 15:0)—The trigger point or threshold for an analog input. When an analog input is greater than or equal to the threshold value, a ON or 1 event is reported (if not inverted). If the analog input does not reach the active threshold value, no change of state is reported. If the threshold parameter is 0, there is no threshold and the analog input will report based on the delta rate. Value range: 0 (disable, default) through 65535 (two-byte value). (Parameter number 0x08).

Units (bits 7:0)—The parameter defines the range and/or type of value associated with the I/O point. The devices use this parameter to correctly interpret the I/O point data. (Parameter number 0x0C). (See units tables after this section.)

Warm-up Time (bits 7:0)—Values 01 through 127 set the number of 62.5 millisecond increments. Values 129 through 255 set the number of 250 microsecond increments, with 129 representing 250 microseconds, 130 representing two 250 microsecond increments (500 microseconds, and 255 representing 127 250 microsecond increments (or 31 milliseconds). When the device supplies power to external sensors, this parameter defines how long power is applied before the input point is examined for changes. When running multiple I/O point using switched power, only use values 0–127 (62.5 ms to 7.9 seconds). Value range: 00 (off, default) through 255. (Parameter number 0x05).

Internal Output Mapping—Reserved. Do not use. (Parameter number 0x1A).

Miscellaneous—Reserved. (Parameter number 0x17).

4.6 M-GAGE Parameters

M-GAGE Report Rate (Inputs) —The report rate defines how often the Node communicates the I/O status to the Gateway. For battery-powered applications, setting the report rate to a slower rate extends the battery life.

M-GAGE Sample High and M-GAGE 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. This parameter can be applied to a discrete input or a analog input using the threshold parameter.

M-GAGE 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.

M-GAGE Threshold and M-GAGE Hysteresis— Threshold and hysteresis work together to establish the ON and OFF points of an analog input. The threshold defines a trigger point or reporting threshold (ON point) for a sensor input. When the input value is higher than the threshold, the input is ON. Hysteresis defines how far below the threshold the analog input is required to be before the input is considered OFF. A typical hysteresis value is 10% to 20% of the unit's range.

The M-GAGE Node's threshold and hysteresis ranges are 0 to 65,535. The factory default threshold setting is 100 and default hysteresis is 30 (the sensor detects an OFF condition at threshold minus hysteresis, or 100 - 30 = 70). With the default settings, once the magnetic field reading is above 100, an ON or "1" is stored in the lowest significant bit (LSB) in the Modbus register. When the M-GAGE reading drops below the OFF point (threshold minus hysteresis), the LSB of the Modbus register is set to "0." To determine your threshold, take M-GAGE readings of the test objects at the distance they are likely to be from the sensor. For example, if a car reads 100, a bicycle 15, and a truck reads 200, setting the threshold to 150 will detect only trucks of a specific size. Magnetic field fluctuations vary based on the amount of ferrous metal present and the distance from the sensor.

If the threshold parameter is 0, there is no threshold and the analog input will report based on the delta rate. Value range: 0 (disable, default) through 65535 (two-byte value).

The following filter parameters are advanced configuration parameters and are for engineering use only:

- **M-GAGE Baseline Threshold/Filter**—Under normal conditions, the ambient magnetic field fluctuates. When the magnetic field readings drift below a threshold setting, the baseline or drift filter uses an algorithm to slowly match the radio device's baseline to the ambient magnetic field. The baseline threshold/filter parameter sets a baseline threshold and filter activation time on M-GAGE devices. When M-GAGE input readings are below the selected baseline threshold setting, the filter algorithm slowly lowers the magnetic baseline reading to zero to remove small changes in the magnetic field over time.
- **M-GAGE Low Pass Filter**—The filters T0 through T6 are parameter settings that define the degree of input digital signal filtering for analog inputs. T0 is the least amount of filtering. T6 is the highest filter setting and has the least amount of fluctuation between readings.
- **Compensation Filter Adjustment**—Set the compensation filter adjustement using the **Serial address** field within the configuration software.

4.6.1 I/O Types (Parameter 0x02)

The following inputs and output types are set using **Device Config** > **Device Parameters** screen of the configuration software. You may also configure the I/O by sending Modbus commands from your host system.

Important: All devices have unique and predetermined physical I/O types. The I/O settings in the software must match the physical I/O that the devices contain for compatibility. For example, a PNP input type cannot be changed into an NPN input type if the physical I/O is not compatible.

Table 2: General Input Types

Type #		Description	Type #		Description	Type #		Description
Hex	Dec		Hex	Dec		Hex	Dec	
0x30	48	Analog IN 1	0x01	1	NPN IN 1	0x19	25	Multiple Discrete NPN
0x31	49	Analog IN 2	0x03	3	NPN IN 2	0x1A	26	Multiple Discrete PNP
0x32	50	Analog IN 3	0x05	5	NPN IN 3	0x3B	59	SDI 12 COMMs
0x33	51	Analog IN 4	0x07	7	NPN IN 4	0xB1	177	Serial Read
			0x1B	27	NPN IN 5	0xB2	178	Serial Write
0x0D	13	Async Counter 1	0x1D	29	NPN IN 6	0x37	55	Battery voltage
0x0E	14	Async Counter 2	0x1F	31	NPN IN 7	0xF0	240	Constant
0x0F	15	Async Counter 3	0x21	33	NPN IN 8	0xB3	179	Force sample/report
0x10	16	Async Counter 4	0x02	2	PNP IN 1	0xB4	180	Set threshold with offset
			0x04	4	PNP IN 2	0xA3	163	Frequency read
0x4B	75	Bridge IN 1	0x06	6	PNP IN 3	0xA0	160	M-GAGE
0x4C	76	Bridge IN 2	0x08	8	PNP IN 4	0xA1	161	M-GAGE baseline
			0x1C	28	PNP IN 5	0xA7	167	M-GAGE configure
0x09	9	Pulse Input 1	0x1E	30	PNP IN 6	0xA4	164	M-GAGE X-Axis
0x0A	10	Pulse Input 2	0x20	32	PNP IN 7	0xA5	165	M-GAGE Y-Axis

Type #		Description	Type #		Description	Type #		Description
Hex	Dec		Hex	Dec		Hex	Dec	
			0x22	34	PNP IN 8	0xA6	166	M-GAGE Z-Axis
0xB0	176	Clear async counter				0xB5	181	Extended Input Logic
0xAF	175	Clear sync counter				0xA2	162	Enable RTS

Table 3: Temperature Input Types

Type #		Description	Type #		Description	Type #		Description
Hex	Dec		Hex	Dec		Hex	Dec	
0x47	71	10 Ohm RTD (3-wire) IN 1	0xC5	197	Thermocouple E1	0xD1	209	Thermocouple N1
0x48	72	10 Ohm RTD (3-wire) IN 2	0xC6	198	Thermocouple E2	0xD2	210	Thermocouple N2
0x49	73	10 Ohm RTD (3-wire) IN 3	0xC7	199	Thermocouple E3	0xD3	211	Thermocouple N3
0x4A	74	10 Ohm RTD (3-wire) IN 4	0x53	83	Thermocouple E4	0x57	87	Thermocouple N4
0x40	64	100 Ohm RTD (3-wire) IN 1	0xC8	200	Thermocouple G1	0xD4	212	Thermocouple P1
0x41	65	100 Ohm RTD (3-wire) IN 2	0xC9	201	Thermocouple G2	0xD5	213	Thermocouple P2
0x42	66	100 Ohm RTD (3-wire) IN 3	0xCA	202	Thermocouple G3	0xD6	214	Thermocouple P3
0x43	67	100 Ohm RTD (3-wire) IN 4	0x54	84	Thermocouple G4	0x58	88	Thermocouple P4
0x3C	60	Thermistor IN 1	0x34	52	Thermocouple J1	0x44	68	Thermocouple R1
0x3D	61	Thermistor IN 2	0x35	53	Thermocouple J2	0x45	69	Thermocouple R2
0x3E	62	Thermistor IN 3	0x36	54	Thermocouple J3	0x46	70	Thermocouple R3
0x3F	63	Thermistor IN 4	0x4D	77	Thermocouple J4	0x47	71	Thermocouple R4
0x5C	92	Thermistor IN 5	0x38	56	Thermocouple K1	0xD7	215	Thermocouple S1
0xBC	188	Thermocouple B1	0x39	57	Thermocouple K2	0xD8	216	Thermocouple S2
0xBD	189	Thermocouple B2	0x3A	58	Thermocouple K3	0xD9	217	Thermocouple S3
0xBE	190	Thermocouple B3	0x4E	78	Thermocouple K4	0x59	89	Thermocouple S4
0x50	80	Thermocouple B4	0xCB	203	Thermocouple L1	0xDA	218	Thermocouple T1
0xBF	191	Thermocouple C1	0xCC	204	Thermocouple L2	0xDB	219	Thermocouple T2
0xC0	192	Thermocouple C2	0xCD	205	Thermocouple L3	0xDC	220	Thermocouple T3
0xC1	193	Thermocouple C3	0x55	85	Thermocouple L4	0x5A	90	Thermocouple T4
0x51	81	Thermocouple C4	0xCE	206	Thermocouple M1	0xDD	221	Thermocouple U1
0xC2	194	Thermocouple D1	0xCF	207	Thermocouple M3	0xDE	222	Thermocouple U2
0xC3	195	Thermocouple D2	0xD0	208	Thermocouple M3	0xDF	223	Thermocouple U3
0xC4	196	Thermocouple D3	0x56	86	Thermocouple M4	0x5B	91	Thermocouple U4

Table 4: Output Types

Type #		Description	Type #		Description	Type #		Description
Hex	Dec		Hex	Dec		Hex	Dec	
0x80	128	Analog OUT 1	0x60	96	Discrete OUT 1	0x64	100	Discrete OUT NMOS 1
0x81	129	Analog OUT 2	0x61	97	Discrete OUT 2	0x65	101	Discrete OUT NMOS 2
0x82	130	Analog OUT 3	0x62	98	Discrete OUT 3	0x6C	108	Discrete OUT NMOS 3
0x83	131	Analog OUT 4	0x63	99	Discrete OUT 4	0x6D	109	Discrete OUT NMOS 4

Type #		Description	Type #		Description	Type #		Description
Hex	Dec		Hex	Dec		Hex	Dec	
			0x67	103	Discrete OUT 5			
0x6B	107	Switch Power Output	0x68	104	Discrete OUT 6	0x66	102	Multiple Discrete OUT
			0x69	105	Discrete OUT 7			
			0x6A	106	Discrete OUT 8			

4.7 Defining the Units

The units parameter defines the range and/or type of data value associated with an input or output.

Selecting **Units** from within any configuration tool changes the units definition of several parameters, including threshold, hysteresis, and delta. For example, if the units are 0 to 20 mA, the threshold, hysteresis, and delta values are entered as milliampere values. Selecting Temp °C changes the threshold, hysteresis, and delta units to degrees Celsius.

Signed values range from −32768 to +32767 and allow for the measurement of negative values. Signed values are typically used for measuring temperatures. Signed values are stored as two's complement values.

Unsigned values range from 0 to 65535 and are used to measure values that do not go below zero, such as 4 to 20 mA, distance, or a counter.

4.7.1 Input Units

Table 5: Defining the input units

Units	Description	Definition	LCD
0	Raw	Displays the raw A/D conversion data with data ranges from 0 to 65535. This units type is typically used only for factory calibration.	Raw A/D hex value
1	4 to 20 mA	Analog unit. Modbus register contents are scaled such that 0 represents 4 mA and 65535 represents 20 mA.	4.00mA–20.00mA
2	0 to 20 mA	Default analog input unit. Modbus register contents are scaled such that 0 represents 0 mA and 65535 represents 20 mA.	0.00mA–20.00mA
3	Discrete (ON/OFF)	Default discrete input unit.	ON/OFF
4	0 to 10 V (Volts)	Analog input using 0 to 10 V instead of current. Modbus register contents are scaled such that 0 represents 0V and 65535 represents 10V.	0.00V–10.00V
6	Temp °C	Celsius, high resolution. Analog input for temperature devices such as thermocouples, RTD, and thermistors. In high resolution mode, temperature = (Modbus register value) ÷ 20.	0000.0C
7	Temp °F	Fahrenheit, high resolution. Analog input for temperature devices such as thermocouples, RTD, and thermistors. In high resolution mode, temperature = (Modbus register value) ÷ 20.	0000.0F
8	Temp °C (Low Res)	Celsius, low resolution. To measure a greater temperature range, use the low resolution unit. In low resolution mode, temperature = (Modbus register value) ÷ 2.	0000.0C
9	Temp °F (Low Res)	Fahrenheit, low resolution. To measure a greater temperature range, use the low resolution unit. In low resolution mode, temperature = (Modbus register value) ÷ 2.	0000.0F
10	Asynchronous Counter, 32-bit	The 32-bit counter value records counts up to 4.29 billion.	0000 0000
11	Asynchronous Counter, 16-bit	The 16-bit counter value records counts up to 65535.	0000

4.7.2 Output Units

Table 6: Defining the output units

Units	Description	Definition	LCD
0	Raw	Displays the raw A/D conversion data with data ranges from 0 to 65535. This units type is typically used only for factory calibration.	Raw A/D hex value
1	4 to 20 mA	Analog unit. Modbus register contents are scaled such that 0 represents 4 mA and 65535 represents 20 mA.	4.00mA–20.00mA
2	0 to 20 mA	Default analog input unit. Modbus register contents are scaled such that 0 represents 0 mA and 65535 represents 20 mA.	0.00mA–20.00mA
3	Discrete (ON/OFF)	Default discrete unit.	ON/OFF
4	0 to 10 V (Volts)	Analog unit using 0 to 10 V instead of current. Modbus register contents are scaled such that 0 represents 0 V and 65535 represents 10 V.	0.00V–10.00V
5	Signed Analog, 0 to 10 V	For a signed value, such as temperature, that is to be converted to a voltage out value. Use null to set the start point and span to define the range. The null value is the starting temperature to be associated with 0 V. The span is the entire temperature range that is to be associated with 0 to 10 V.	0.00V–10.00V
6	Signed Analog, 0 to 20 mA	For a signed value, such as temperature, that is to be converted to a mA out value. Use null to set the start point and span to define the range. The null value is the starting temperature to be associated with 0 mA. The span is the entire temperature range that is to be associated with 0 to 20 mA.	0.00mA–20.00mA
7	Unsigned Analog, 0 to 20 mA	For unsigned values, such as a counter, that is to be converted to a mA out value. Use the null to set the start point and span to define the range. The null value is the distance to be associated with 0 mA. The span is the entire distance range that is to be associated with 0 to 20 mA.	0.00mA–20.00mA
8	Signed Analog, 4 to 20 mA (A)	In older models, this units type is for degree Celsius conversions only. Use null to set the start point and span to define the range. The null value is the starting temperature to be associated with 4 mA. The span is the entire temperature range that is to be associated with 4 to 20 mA. For newer firmware models, type codes 8 and 9 are treated the same.	4.00mA–20.00mA
9	Signed Analog, 4 to 20 mA (B)	In older models, this units type is for degree Fahrenheit conversions only. Use null to set the start point and span to define the range. The null value is the starting temperature to be associated with 4 mA. The span is the entire temperature range that is to be associated with 4 to 20 mA. For newer firmware models, type codes 8 and 9 are treated the same.	4.00mA–20.00mA
10	Unsigned Analog, 0 to 10 V	For an unsigned value, such as 0 to 20 mA, that is to be converted to a voltage out value. Use the null to set the start point and span to define the range. The null value is the distance to be associated with 0V. The span is the entire distance range that is to be associated with 0 to 10 V.	0.00V–10.00V
11	Counter, 16-bit	The 16-bit counter value records counts up to 65535.	0000
12	Unsigned Analog, 4 to 20 mA	For an unsigned value, such as 0 to 10 V, that is to be converted to a mA out value. Use the null to set the start point and span to define the range. The null value is the distance to be associated with 4 mA. The span is the entire distance range that is to be associated with 4 to 20 mA.	4.00mA–20.00mA

4.7.3 Interpreting Register Values in the Banner Wireless System

The units conversion table defines the type and range of values for each type of I/O.

The wireless devices have many different units of measure for inputs including: milliamp (mA), voltage (V), temperature (°C or °F), humidity (RH), or a raw 16-bit or 32-bit value. Outputs can be either current (4 to 20 mA, 0 to 20 mA) or voltage (0 to 10 V DC). All values stored in Modbus registers are unsigned numbers, except for temperature readings. The temperature readings are stored as signed numbers (two's complement).

The following table defines the range of values and descriptions for input units.

Table 7: Register values

Input Type	I/O Range		Holding Register Representation		Data Conversion	Description
	Min.	Max.	Min.	Max.		
Discrete	0	1	0	1	-	-

Input Type	I/O Range		Holding Register Representation		Data Conversion	Description
	Min.	Max.	Min.	Max.		
0 to 20 mA	0.0 mA	20.0 mA	0	65535	(20 mA ÷ 65535) × Reg Value = mA	Linear mapping of unsigned register value to current
4 to 20 mA	4.0 mA	20.0 mA	0	65535	((16 mA ÷ 65535) × Reg Value) + 4 = mA	Linear mapping of unsigned register value to current
0 to 10 V dc	0.0 V DC	10.0 V DC	0	65535	(10 V ÷ 65535) × Reg Value = V	Linear mapping of unsigned register value to voltage
Temp C/F (high resolution)	–1638.3	+1638.4	0	65535	(Converted Reg Value) ÷ 20 = Temp	Signed Values
Counter	0	65535	0	65535	-	-
16-bit T30UF	0 mm	65535 mm	0	65535	None; stored as millimeter value	Unsigned
Humidity	0% RH	100% RH	0	10000	(Reg Value) ÷ 100 = Relative Humidity (RH)	Unsigned

Temperature Measurements:

- In high resolution mode, the temperature = (Modbus register value) ÷ 20. For high resolution temperature input, 0 in the register is interpreted as 0° and 65535 in the register (0xFFFF) is interpreted as −1 ÷ 20 = −0.05°.
- In low resolution mode, the temperature is (Modbus register value) ÷ 2. For low resolution temperature input, 0 in the register is interpreted as 0° and 65535 in the register (0xFFFF) is interpreted as −1 ÷ 2 = −0.5°. The I/O range values are –16383 through 16384.

When using a 4 to 20 mA sensor with a 0 to 20 mA input, the sensor uses the 4 to 20 mA section of the total range. Using a 4 to 20 mA with a 0 to 20 mA input allows you to determine when you have an error condition with the sensor. A normal input reading between 4 and 20 mA indicates a functioning sensor whereas a value below 4 mA indicates an error condition, such as a broken wire or loose connection. Some Sure Cross devices allow you to configure the analog inputs and outputs to use either 0 to 20 mA or 4 to 20 mA.

4.7.4 Signed Numbers

Temperature values are stored in Modbus registers as two's complement signed numbers. Using two's complement allows negative numbers to be stored in Modbus registers.

Although not technically a sign bit, the most significant bit (MSB) indicates a negative number when the value is set to one (1). When the most significant bit is zero (0), the value is greater than or equal to zero.

Modbus register values of 32768 through 65535 (decimal) represent negative temperatures. These numbers in binary form are: 1000 0000 0000 0000 through 1111 1111 1111 1111.

To convert to a negative temperature value from a Modbus register value, first convert the value from the two's complement number. To convert from a two's complement number in binary form, invert all the bits (0 changes to 1, 1 changes to a 0), then add 1. Convert this binary value to a decimal value and divide by either 20 (high resolution mode) or 2 (low resolution mode) to calculate the negative temperature.

Table 8: Defining the signed numbers

Register Value		Converted Decimal	Calculated Temperature (Converted Decimal ÷ 20)
Two's Complement Value	Decimal Value		
0000 0000 0000 0101	5	5	0.25
0000 0000 0000 0100	4	4	0.20
0000 0000 0000 0011	3	3	0.15
0000 0000 0000 0010	2	2	0.10
0000 0000 0000 0001	1	1	0.05
0000 0000 0000 0000	0	0	0
1111 1111 1111 1111	65535	-1	-0.05
1111 1111 1111 1110	65534	-2	-0.10
1111 1111 1111 1101	65533	-3	-0.15

Register Value		Converted Decimal	Calculated Temperature (Converted Decimal ÷ 20)
Two's Complement Value	Decimal Value		
1111 1111 1111 1100	65532	-4	-.20
1111 1111 1111 1011	65531	-5	-0.25
1111 1100 0001 1000	64536	-1000	-50

4.7.5 Mapping Unit Types

Using signed or unsigned value types allows the user to generically map any input to any output. The signed and unsigned values read the null and span parameters to create the linear translation between one scale and another. The output type is set to mA or V.

Output = (Fullscale/Span)(InputValue − Null) + Offset

Table 9: Defining the mapping unit types

Output Scale	Fullscale (range)	Offset
0 to 20 mA	20 mA	0 mA
4 to 20 mA	16 mA	4 mA
0 to 10 V	10 V	0 V

Fullscale

Defined in the table; the output range.

Input Value

The value mapped to the output.

Null

The starting point for the output scale.

Offset

Defined in the table; the starting output value.

Span

The total range of values mapped to the output.

Example: Mapping a Temperature

Map a temperature input from a Node to a 4 to 20 mA output. The starting temperature is −20 °F and the last temperature will be 50 °F (4 mA = −20 °F, 20 mA = 50 °F). This defines the null as −20 °F and the span as 70.

With an input temperature value of −5 °F, the output value will be:

Output = (Fullscale ÷ Span)(InValue − Null) + Offset
(Fullscale ÷ Span) = 16 ÷ 70 = 0.22857
(Value − Null) = −5 − (−20) = 15
Offset = 4
Output = 0.22857 × 15 + 4 = 7.42 mA

Example: Mapping a Distance

Map a distance input from a Node to a 0 to 10 V output. The starting distance is 200 mm and the last distance will be 2000 mm (4 mA = 200 mm and 20 mA = 2000 mm). This defines the null as 200 and the span as 1800.

With an input distance reading of 1560 mm, the output value will be:

Output = (Fullscale ÷ Span)(InValue − Null) + Offset
(Fullscale ÷ Span) = 10 ÷ 1800 = 0.00555
(Value − Null) = 1560 − 200 = 1360
Offset = 0
Output = 0.00555 × 1360 + 0 = 7.54 V

Alarm Conditions. The standard alarm conditions are as follows:

Unsigned Alarm = 0xFFFF
Signed Alarm = 0x7FFF

If special alarm conditions are needed, consult the factory for details.

5 Troubleshooting

5.1 Restore the Device to the Factory Default Settings

To restore the device to its factory default settings, clear the I/O links, or reboot the device, follow these steps.

1. Go to the **Device Restore** screen.
2. Select the device from the drop-down list.
3. Reset the device to factory defaults, erase the I/O linking, or reboot the device as needed.
   - To reset the device back to its factory default settings, click **Restore**.
   - To clear the I/O links from a device, click **Clear Links**. This erases any I/O links to or from the selected device.
   - To reboot or cycle power to a device, click **Power Cycle**. Cycle power to a device after you have changed any of the settings of that device.

5.2 Read (or Write) Registers

To read (or write) registers, use the **Register View** screen.

1. To read registers:
   a) Select the device from which to read registers from the drop-down list or select a starting register and the number of registers to read.
   b) Click **Read Registers**. The register values are displayed for the selected device.

   Select **Enable Polling** and enter a time in seconds to enable constant polling from the Gateway. The **Read Registers** button changes to **Begin Polling**. Click **Begin Polling** to start polling at the defined rate.
2. To write to specific registers:
   a) Select a device to write to from the drop-down list or select the starting register and the number of registers to write to.
   b) Enter a value into the value column for the specific register you want to write to.
   c) Click **Write Registers**.

6 Product Support

6.1 Contact Us

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

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6.3 Glossary of Wireless Terminology

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

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active threshold	An active threshold is a trigger point or reporting threshold for an analog input.
a/d converter	An analog to digital converter converts varying sinusoidal signals from instruments into binary code for a computer.
address mode	The Sure Cross® wireless devices may use one of two types of addressing modes: rotary dial addressing or extended addressing. In **rotary dial** address mode, the left rotary dial establishes the network ID (NID) and the right rotary dial sets the device address. **Extended** address mode uses a security code to "bind" Nodes to a specific Gateway. Bound Nodes can only send and receive information from the Gateway they are bound to.
antenna	Antennas transmit radio signals by converting radio frequency electrical currents into electromagnetic waves. Antennas receive the signals by converting the electromagnetic waves back into radio frequency electrical currents.
attenuation	Attenuation is the radio signal loss occurring as signals travel through the medium. Radio signal attenuation may also be referred to as free space loss. The higher the frequency, the faster the signal strength decreases. For example, 2.4 GHz signals attenuate faster than 900 MHz signals.
baseline filter (M-GAGE)	Under normal conditions, the ambient magnetic field fluctuates. When the magnetic field readings drift below a threshold setting, the baseline or drift filter uses an algorithm to slowly match the radio device's baseline to the ambient magnetic field.
binding (DX80 star networks)	Binding Nodes to a Gateway ensures the Nodes only exchange data with the Gateway they are bound to. After a Gateway enters binding mode, the Gateway automatically generates and transmits a unique extended addressing (XADR), or binding, code to all Nodes within range that are also in binding mode.

The extended addressing (binding) code defines the network, and all radios within a network must use the same code.

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

binding (MultiHop networks)

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

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

binding (serial data radio networks)

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

bit packing i/o

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

booster (boost voltage)

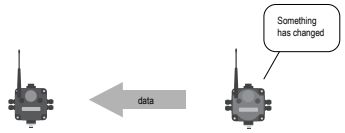
A booster is an electronic circuit that increases a battery-level voltage input (3.6V) to a sensor operating voltage output (5 to 20 V).

CE

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

change of state

Change of state reporting is a report initiated by the Node when a change to the sensor's input state is detected. If the input does not change, nothing is reported to the Gateway.



channel

A channel may be either a path for communications or a range of radio frequencies used by a transceiver during communication.

collision

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

collocated networks

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

contention architecture

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

counter - event

The event counter counts the total number of times an input signal changes to the high/ON/1 state. The counter increments on the falling edge of an input signal when the signal level crosses the threshold.

Event counters can be used to measure the total operational cycles of a spinning shaft or the total number of items traveling down a conveyor.

counter - frequency

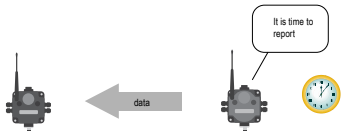
The frequency counter calculates the frequency of the input signal, in Hz.

Frequency counters can be used to measure flow rates, such as measuring the flow rate of items on a conveyor or the speed at which a windmill spins.

courtesy power outputs

Courtesy power outputs provide continuous power and cannot be turned on or off.

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



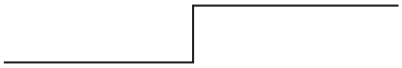
debounce When a signal changes state using a mechanical switch or relay, the signal can oscillate briefly before stabilizing to the new state. The debounce filter examines the signal's transitions to determine the signal's state.



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



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



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

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

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

Equation: $PmW = 10^{x/10}$ where x is the transmitted power in dBm, or dBm = 10 log(PmW)

Another decibel rating, dBi, is defined as an antenna's forward gain compared to an idealized isotropic antenna. Typically, dBm = dBi = dBd + 2.15 where dBi refers to an isotropic decibel, dBd is a dipole decibel, and dBm is relative to milliwatts.

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

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

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

Device Power Up—Outputs are set to user-defined states every time the device is powered up.

Out of Sync—Outputs are set to user-defined states when the radio is out of sync with its parent radio.

Host Link Failure—Host link failure is when the defined timeout period has elapsed with no communications between the host system (or Modbus master device) and the DX80 Gateway, typically about four seconds. Outputs are set to user-defined states when a host link failure has been detected.

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

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

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

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

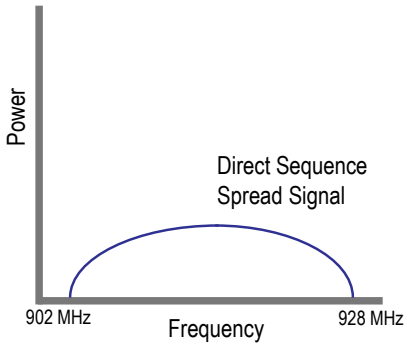
determinism A deterministic system defines how network endpoints behave during the loss of communications. The network identifies when the communications link is lost and sets relevant outputs to user-defined conditions. Once the radio signal is re-established, the network returns to normal operation.

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

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



Direct Sequence Spread Spectrum (DSSS) Direct Sequence Spread Spectrum is a method for generating spread spectrum transmissions where the transmitted signal is sent at a much higher frequency than the original signal, spreading the energy over a much wider band. The receiver is able to de-spread the transmission and filter the original message. DSSS is useful for sending large amounts of data in low to medium interference environments.



DX83 Ethernet Bridge The Ethernet Bridge acts as a communications bridge between the Modbus RTU network (Gateway) and Modbus/TCP or EtherNet/IP host systems and includes the ability to configure the network using a Web browser interface.

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

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

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

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

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

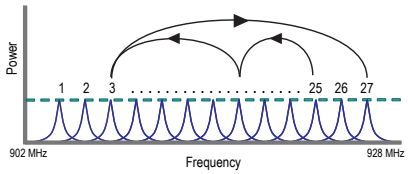
***Flex*Power** Banner's *Flex*Power® technology allows for a true wireless solution by allowing the device to operate using either 10 to 30 V DC, 3.6 V lithium D cell batteries, or solar power. This unique power management system can operate a *Flex*Power Node and an optimized sensing device for up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

free space loss (FSL) The radio signal loss occurring as the signal radiates through free space. Free Space Loss = 20 Log (4(3.1416)d/λ) where d is in meters. Remembering that $\lambda f = c = 300 \times 10^6$ m/s, the equations reduce down to:

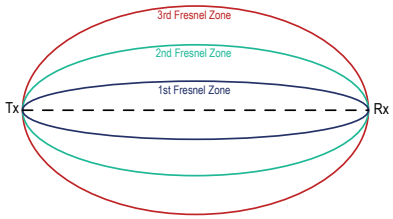
For the 900 MHz radio band: FSL = 31.5 + 20 Log d (where d is in meters).

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

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



Fresnel zone Fresnel zones are the three-dimensional elliptical zones of radio signals between the transmitter and receiver. Because the signal strength is strongest in the first zone and decreases in each successive zone, obstacles within the first Fresnel zone cause the greatest amount of destructive interference.



gain Gain represents how well the antenna focuses the signal power. A 3 dB gain increase doubles the effective transmitting power while every 6 dB increase doubles the distance the signal travels. Increasing the gain sacrifices the vertical height of the signal for horizontal distance increases. The signal is 'squashed' down to concentrate the signal strength along the horizontal plane.

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

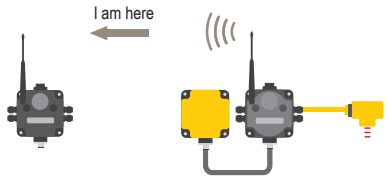
Gateway A Sure Cross® Gateway is the wireless sensor network master device used to control network timing and schedule communication traffic. Similar to how a gateway device on a wired network acts as a "portal" between networks, the Sure Cross Gateway acts as the portal between the wireless network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

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

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

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

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



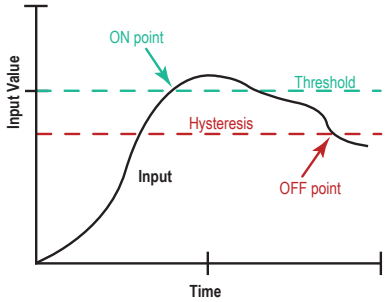
hibernation/ storage mode While in **storage mode**, the radio does not operate. To put any integrated battery Sure Cross radio into storage mode, press and hold button 1 for five seconds. To wake the device, press and hold button 1 for five seconds. The radio is in storage mode when the LEDs stop blinking, but in some models, the LCD remains on for an additional minute after the radio enters storage mode. After a device has entered storage mode, you must wait one minute before waking it.

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

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

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

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



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

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

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



line of sight Line of sight is the unobstructed path between radio antennas.

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

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

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

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

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

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

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

median filter When the median filter is turned on, three samples are taken for each analog sensor reading. The high and low values are discarded and the middle value is used as the analog value. Set to zero (0) to turn off the median filter. Set to one (1) to turn on the median filter.

Modbus Modbus is a master-slave communications protocol typically used for industrial applications.

Modbus/TCP Modbus/TCP is an open standard protocol very similar to Modbus RTU except that it uses standard Internet communication protocols.

MultiHop MultiHop networks are made up of one master radio and many repeater and slave radios. The MultiHop networks are self-forming and self-healing networks constructed around a parent-child communication relationship. A MultiHop Radio is either a master radio, a repeater radio, or a slave radio.

The master radio controls the overall timing of the network and is always the parent device for other MultiHop radios. The host system connects to this master radio. Repeater radios extend the range of the wireless network and slave radios are the end point of the wireless network.

For more information, refer to the Sure Cross MultiHop Radios Instruction Manual (p/n 151317).

multipath fade Obstructions in the radio path reflect or scatter the transmitted signal, causing multiple copies of a signal to reach the receiver through different paths. Multipath fade is the signal degradation caused by these obstructions.

network ID The Network ID (NID) is a unique identifier you assign to each wireless network to minimizes the chances of two collocated networks interfering with each other. Assigning different NIDs to different networks improves collocation performance in dense installations.

node A node is any communications point within a network.

Node Nodes are remote I/O slave devices within Banner's wireless sensor networks. Sensors and other devices connect to the Node's inputs or outputs, allowing the Node to collect sensor data and wirelessly transmit it to the Gateway. Every Sure Cross device is a transceiver, meaning it can transmit and receive data.

noise Noise is any unwanted electromagnetic disturbances from within the RF equipment, especially the receiver. Noise is more of a concern when signal levels are low.

omni-directional antenna Omni-directional antennas transmit and receive radio signals equally in all directions.

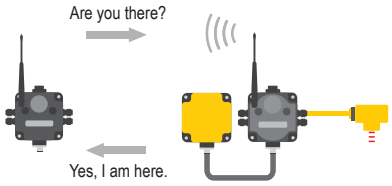
out of sync/link loss (loss of radio signal) The Sure Cross wireless devices use a deterministic link time-out method to address RF link interruption or failure. When a radio link fails, all pertinent wired outputs are sent to the selected default value/state until the link is recovered, ensuring that disruptions in the communications link result in predictable system behavior. Following a time-out, all outputs linked to the Node in question are set to 0, 1, or hold the last stable state depending on the value selected.

path loss Path loss describes attenuation as a function of the wavelength of the operating frequency and the distance between the transmitter and receiver.

path loss (or link loss) calculations Link loss calculations determine the capabilities of a radio system by calculating the total gain or loss for a system. If the total gain/loss is within a specific range, the radio signal will be received by the radio. **Total Gain = Effective output + Free space loss + Total received power** . Because the transmitter and receiver gains are positive numbers and the free space loss is a larger negative number, the total gain of a system should be negative. A link loss calculation may also be called a link budget calculation.

peer to peer network Peer-to-peer is a model for a communication protocol in which any device in the network can send or receive data. Any device can act as a Master to initiate communication.

polling interval/ rate The Gateway communicates with, or polls, each Node to determine if the radio link is active. The polling rate defines how often the Gateway communicates with each Node. Polling is always initiated by the Gateway and only verifies radio signal communications.



polling interval/ rate and maximum misses The Gateway communicates with, or polls, each Node to determine if the radio link is active. The polling rate, or interval, defines how often the Gateway communicates with each Node. Polling is always initiated by the Gateway and only verifies radio signal communications. Nodes that fail to respond are counted against the ‘Maximum Misses’ for that Node. If the ‘Maximum Misses’ is exceeded for any Node, the Gateway generates an RF timeout error in the Modbus I/O register 8 of the appropriate Node. The ‘Maximum Misses’ is defined as the number of consecutive polling messages that the Node fails to respond to.

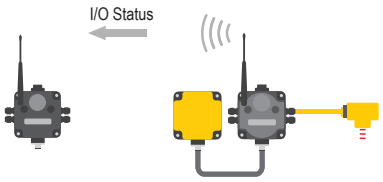
radiation pattern An antenna's radiation pattern is the area over which the antenna broadcasts an easily received signal. The radiation pattern/shape changes based on the antenna type and gain.

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

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

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

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



Change of state reporting sets the system to report only when the value crosses the threshold setting.

rotary dial address mode — See: *address mode*

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

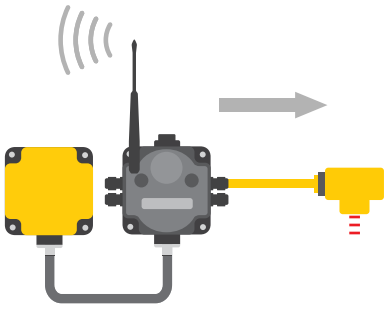
resistance temperature detector (RTD) — An RTD is a temperature measurement device that measures the electrical resistance across a pure metal. The most commonly used metal is platinum because of its temperature range, accuracy, and stability.

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

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

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

sample interval/ rate — The sample interval, or rate, defines how often the Sure Cross device samples the input. For battery-powered applications, setting a slower rate extends the battery life.



sample on demand — Sample on demand allows a host system to send a Modbus command to any register and require the inputs to immediately sample the sensor and report readings back to the host system. Sampling on demand can be used between the normal periodic reporting.

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

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

The equations for calculating SNR are:

SNR = 20 × log (Vs/Vn) where Vs is the signal voltage and Vn is the noise voltage;
SNR = 20 × log (As/An) where As is the signal amplitude and An is the noise amplitude; or
SNR = 10 × log (Ps/Pn) where Ps is the signal power and Pn is the noise power.

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

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

slave ID The slave ID is an identifying number used for devices within a Modbus system. When using more than one Modbus slave, assign each slave a unique ID number.

By default, Gateways are set to Modbus Slave ID 1.

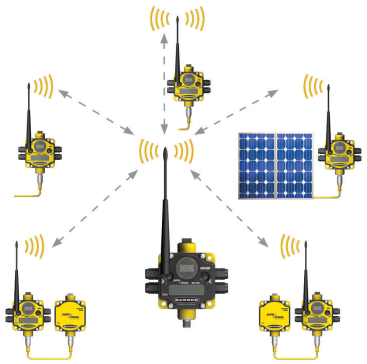
sleep mode During normal operation, the Sure Cross radio devices enter **sleep mode** after 15 minutes of operation. The radio continues to function, but the LCD goes blank. To wake the device, press any button.

slow scan mode (All internal battery models)In slow scan mode, the device enters a deeper sleep mode to conserve battery power after the device loses its communication link with its parent or master radio. The device wakes up periodically to search for its parent radio. If a parent or master radio is not found, the device goes back to sleep for another sleep cycle. If the parent or master radio is detected, the device exits slow scan mode. To manually exit slow scan mode, press the binding button.

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

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

star networks A star topology network is a point to multipoint network that places the network master radio in a center or hub position. Slave radios only transmit messages to the master radio, not to each other. These network layouts can be very flexible and typically operate relatively quickly. Slave radios acknowledge receipt of messages transmitted from the master radio.



For more information on Banner's star network products, refer to the Sure Cross Performance DX80 Wireless I/O Network Instruction Manual (p/n 132607)

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

system operating margin (fade margin) The system operating margin, or fade margin, is the difference between the received signal level (in dBm) and the receiver sensitivity (also in dBm) required for reliable reception. It is recommended that the receiver sensitivity be more than 10 dBm less than the received signal level. For example, if the

signal is about –65 dB after traveling through the air and the radio receiver is rated for -85 dB, the operating margin is 20 dB — an excellent margin.

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

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

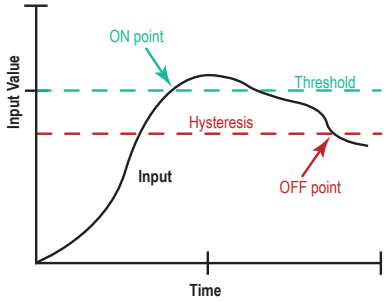
time-division multiple access (TDMA) TDMA is a wireless network communication architecture that provides a given slot of time for each device on the network, providing a guaranteed opportunity for each device to transmit to the wireless network master device.

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

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

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

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



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

Setting threshold and hysteresis points prevents inputs from oscillating between ‘on’ and ‘off’ when the input remains close to the threshold point.

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

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

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

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

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



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