

Sure Cross[®] Radio Networks and Host Controller Systems

Instruction Manual

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1 Host Controller Systems

The Host Controller Systems reference guide contains information about using Modbus RTU, Modbus/TCP, and EtherNet/IP commands with the Sure Cross DX80 family of products. This guide includes register maps, control codes, error message handling, supported function codes, and some sample commands to perform specific tasks. This guide also lists control codes and sample commands for configuring I/O parameters by writing to Modbus registers.

The Sure Cross® DX80 Gateway uses Modbus RTU, Modbus/TCP, or EtherNet/IP™ protocols to communicate with host controller systems or external devices.

- The **Modbus Serial Line RTU** protocol is a master-slave protocol typically used for industrial applications. Only one master at any given time is connected to the bus while up to 247 slaves nodes can be connected to the serial bus.
- The **Modbus TCP/IP** protocol is an open standard implementation of Modbus on Internet protocols. Modbus TCP/IP is similar to Modbus RTU but transmits information within TCP/IP data packets.
- **EtherNet/IP** is also an application layer protocol for industrial automation. EtherNet/IP is built on the TCP/IP protocols and uses standard Ethernet hardware.

Modbus is the native protocol for the DX80 wireless system. All wireless devices are organized with a two-byte register for each I/O point. Sixteen registers are allocated for each device, typically eight registers for inputs and eight registers for outputs. In the world of Modbus, these registers are addressed consecutively beginning with the Gateway, then Node 1 through Node N.

EtherNet/IP separates the input registers and output registers into blocks. The two blocks of registers, or instances, are consecutively ordered from the Gateway, then Node 1 through Node 15. The EtherNet/IP interface implementation also allows for 100 extra input and output registers that can be customized for specific applications.

This configuration guide outlines the procedures involved in configuring I/O parameters by writing to registers. Parameter configuration using registers can be done with a host system connected to a Gateway, DXM Wireless Controller, GatewayPro, or Gateway and Ethernet Bridge combination and any supported protocol.

For more information on Modbus, including basic reference guides, please refer to www.modbus.org. For more information on specific Sure Cross components, refer to the data sheets for the Sure Cross devices.

EtherNet/IP is a trademark of ControlNet International, Ltd and Open DeviceNet Vendor Association, Inc.

2 Sure Cross® DX80 Modbus Register Definitions

Modbus distinguishes between inputs and outputs and between bit-addressable and word addressable data items.

For more information, please refer to www.modbus.org. A less documented but commonly used method to separate the data types is using a mapped address structure.

Reference	Description
0xxxx	Read/Write Discrete Output—Drives output data to a discrete output point.
1xxxx	Read Discrete Inputs—Controlled by the corresponding discrete input point.
3xxxx	Read Input Registers—Contains a 16-bit number received from an external source, like an analog signal.
4xxxx	Read/Write Output or Holding Registers—Stores 16-bits of numerical data (binary or decimal), or sends the data to an output point.

The xxxx represents the four-digit address location in user data memory. Because function codes generally denote the leading character, the leading character is omitted from the address specifier for a given function. The leading character also identifies the I/O data type. The Sure Cross DX80 Modbus registers are all holding registers 4xxxx using the mapped address structure.

2.1 Modbus Holding Registers

There are sixteen Modbus holding registers for each SureCross™ device. Calculate the holding register number for each device using the equation: Register number = I/O# + (Node# × 16).

Because the Gateway is always first, at Node 0, the Gateway’s holding registers are registers 1 through 16. Registers for Node 1 are 17 through 32, as shown in the Modbus Holding Register table below. Although only 10 Nodes are shown, the table can continue for as many Nodes as are used in a given network.

Using the equation or the Modbus Holding Registers table, the register number for I/O point 15 for Node 7 is 127.

Modbus Holding Registers									
I/O Pt.	Gateway	Node 1	Node 2	Node 3	Node 4	Node 5	Node 6	Node 7	Node 8
1	1	17	33	49	65	81	97	113	129
2	2	18	34	50	66	82	98	114	130
3	3	19	35	51	67	83	99	115	131
4	4	20	36	52	68	84	100	116	132
5	5	21	37	53	69	85	101	117	133
6	6	22	38	54	70	86	102	118	134
7	7	23	39	55	71	87	103	119	135
8	8	24	40	56	72	88	104	120	136
9	9	25	41	57	73	89	105	121	137
10	10	26	42	58	74	90	106	122	138
11	11	27	43	59	75	91	107	123	139
12	12	28	44	60	76	92	108	124	140
13	13	29	45	61	77	93	109	125	141
14	14	30	46	62	78	94	110	126	142
15	15	31	47	63	79	95	111	127	143
16	16	32	48	64	80	96	112	128	144

2.2 Alternative Modbus Register Organization

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

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

2.2.1 Input Registers and Outputs Registers

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

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

Refer to your device's datasheet for a list of the active inputs and outputs. Not all inputs or outputs listed in this table may be active for your system.

2.2.2 Discrete Bit-Packed Registers

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

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

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

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

Bit-Packed Device Status Registers

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

Bit-Packed Discrete Input 1

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

Bit-Packed Discrete Output 1

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

Inputs		Outputs	
Modbus Register Address (Decimal)	Description (Inputs)	Modbus Register Address (Decimal)	Description (Outputs)
6601-6603	Status for all devices		
6611-6613	Input 1 from all devices	6691-6693	Output 1 from all devices
6621-6623	Input 2 from all devices	6701-6703	Output 2 from all devices
6631-6633	Input 3 from all devices	6711-6713	Output 3 from all devices
6641-6643	Input 4 from all devices	6721-6723	Output 4 from all devices
6651-6653	Input 5 from all devices	6731-6733	Output 5 from all devices
6661-6663	Input 6 from all devices	6741-6743	Output 6 from all devices
6671-6673	Input 7 from all devices	6751-6753	Output 7 from all devices
6681-6683	Input 8 from all devices		

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

If the device's status register (input 8) contains a 128, a one (1) is written to the Discrete Status Register area, indicating the device is active in the wireless system. If the device's I/O 8 contains any number other than a 128, a zero (0) is written, indicating the device is not active within the wireless network. In this way, an analog value representing the device's status within the wireless network is converted to a discrete value.

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

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

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

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

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

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

The following registers contain analog I/O values for the Gateway and all Nodes. Values are stored first for the Gateway, then for each Node in order of Node address.

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

For example, 6801 contains the input 1 value for the Gateway, 6802 contains the input 1 value for Node 1, and 6848 contains the input 1 value for Node 47.

2.3 Supported Modbus Function Codes

The supported Modbus function codes are 3 (read multiple), 6 (write single), and 16 (write multiple).

All DX80 Modbus registers are defined as 'holding registers' in the 4xxxx address space. Some older PLCs use the register number space of 4xxxx to imply function code 3 for holding registers. For these systems, add 40000 to our register number and the PLC software uses the correct function code 3 to access our registers.

The supported Modbus function codes are defined below. For more information about Modbus, see www.modbus.org.

Function	Description
3	Reads the contents of a contiguous block of holding registers in a remote device. The request specifies the starting register address and the number of registers.
6	Writes a single holding register in a remote device. The request specifies the address of the register to be written and the single register of data.
16	Writes a block of contiguous holding registers in a remote device. The requested written values are specified in the request data field.

2.4 Modbus RTU and Modbus/TCP Register Map

Modbus/TCP and Modbus RTU provide device control and monitoring using holding registers in the 40000 register block.

Each wireless device in the system is allocated 16 holding registers. The Gateway uses the first 16 registers followed by each Node in the network, based on the Node address. For Node 5, the starting Modbus registers are $1 + (\text{Node\#} \times 16) = 1 + (5 \times 16) = 81$, the ending register is 97.

I/O Point	Gateway Modbus Holding Register	Node Modbus Register
1	1	$1 + (\text{Node\#} \times 16)$
2	2	$2 + (\text{Node\#} \times 16)$
3	3	$3 + (\text{Node\#} \times 16)$
4	4	$4 + (\text{Node\#} \times 16)$
5	5	$5 + (\text{Node\#} \times 16)$
6	6	$6 + (\text{Node\#} \times 16)$
7	7	$7 + (\text{Node\#} \times 16)$
8	8	$8 + (\text{Node\#} \times 16)$
9	9	$9 + (\text{Node\#} \times 16)$
10	10	$10 + (\text{Node\#} \times 16)$
11	11	$11 + (\text{Node\#} \times 16)$
12	12	$12 + (\text{Node\#} \times 16)$
13	13	$13 + (\text{Node\#} \times 16)$
14	14	$14 + (\text{Node\#} \times 16)$
15	15	$15 + (\text{Node\#} \times 16)$
16	16	$16 + (\text{Node\#} \times 16)$

For example:

Registers	Device and Input Connections	Register	Device and Input Connections	Register	Device and Input Connections
1	Gateway I/O 1	17	Node 01 I/O 1	33	Node 02 I/O 1
2	Gateway I/O 2	18	Node 01 I/O 2	34	Node 02 I/O 2
3	Gateway I/O 3	19	Node 01 I/O 3	35	Node 02 I/O 3
4	Gateway I/O 4	20	Node 01 I/O 4	...	...
5	Gateway I/O 5	21	Node 01 I/O 5	...	...
6	Gateway I/O 6	22	Node 01 I/O 6	...	...
7	Gateway I/O 7	23	Node 01 I/O 7	...	...
8	Gateway I/O 8	24	Node 01 I/O 8	...	...
9	Gateway I/O 9	25	Node 01 I/O 9	761	Node 47 I/O 9
10	Gateway I/O 10	26	Node 01 I/O 10	762	Node 47 I/O 10
11	Gateway I/O 11	27	Node 01 I/O 11	763	Node 47 I/O 11
12	Gateway I/O 12	28	Node 01 I/O 12	764	Node 47 I/O 12
13	Gateway I/O 13	29	Node 01 I/O 13	765	Node 47 I/O 13
14	Gateway I/O 14	30	Node 01 I/O 14	766	Node 47 I/O 14

Registers	Device and Input Connections	Register	Device and Input Connections	Register	Device and Input Connections
15	Gateway I/O 15	31	Node 01 I/O 15	767	Node 47 I/O 15
16	Gateway I/O 16	32	Node 01 I/O 16	768	Node 47 I/O 16

3 DXM Series

The DXM products are industrial wireless controllers that facilitate Ethernet connectivity and Industrial Internet of Things (IIoT) applications, including:

- Predictive Maintenance Monitoring: monitor equipment to detect problems early and avoid additional damage and unplanned downtime
- Environmental Monitoring: minimize material loss by monitoring temperature and humidity in climate-controlled areas
- Productivity Solutions: create call-for-parts/service and pick-to-light systems to increase productivity and reduce error

The DXM1x0-Bx models can provide visual indication, email or text notifications, and collect and transmit data to a host system or to the cloud. As a communications gateway, the DXM100-Bx and DXM150-Bx series interfaces local serial ports, local I/O ports, and local ISM radio devices to the internet using either a cellular connection or a wired Ethernet network connection.

The DXM100-Sx and DXM150-Sx Modbus Slaves can connect directly to an RS-485 serial bus or to a wireless ISM network as a remote Modbus Slave device.

3.1 Device Setup

3.1.1 Apply 12–30 V DC to the DXM100 Controller

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

Equipment used:

- **DXM100-B1R1** Wireless Controller
- **MQDMC-501** 0.3 m (1 ft) cordset with a 5-pin M12/Euro-style quick disconnect fitting
- **PS24W** Wall plug power supply; 24 V dc, 1 A



Important: Verify the antenna has been installed before applying power to any DX80 product.

1. Connect the brown wire from the **MQDMC-501** cordset to the DXM100's terminal 2 (PWR).
2. Connect the blue wire from the **MQDMC-501** cordset to the DXM100's terminal 3 (GND).
3. Connect the **PS24W** power supply to the **MQDMC-501** cordset.
4. Plug in the **PSD24W** wall plug power supply.
On the DXM, the orange LED near the power terminals turns on and the LCD turns on after about 10 seconds.

3.1.2 Binding and Conducting a Site Survey with the ISM Radio

The DXM100 internal ISM radio will either be a MultiHop master radio or a DX80 Gateway radio.

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

The LCD and the processor applications share the external Modbus connection. If the processor is configured to constantly interact with Modbus, it may cause issues with the LCD attempting to use the functions of the ISM radio. To alleviate the contention do one of these things:

- Load a DXM configuration file that slows down the read/write rules.
- Disable the DXM configuration file from loading into the processor by setting DIP switch 4 to ON (on the processor board). Reboot the device. When the processor reboots, it will not load the configuration file and remains idle. See the DXM100 Controller Instructional Manual (190037) for the processor DIP switch location.

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

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

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

2. Assign the Node address to the Node.
 - For Nodes without rotary dials: Use the DXM arrow keys to select the Node address to assign to the DX80 Node about to enter binding mode. The DXM assigns this Node address to the next Node that enters binding mode. Only bind one Node at a time.
 - For Nodes with rotary dials: Use the Node's rotary dials to assign a valid decimal Node Address (between 01 and 47). The left rotary dial represents the tens digit (0 through 4) and the right dial represents the ones digit (0 through 9) of the Node Address.
3. Start binding mode on the DXM radio by clicking **ENTER** on the DXM radio.
4. Enter binding mode on the DX80 Node.
 - For housed radios, triple-click button 2.
 - For board-level radios, triple-click the button.
 - For Nodes without buttons, refer to the Node's datasheet for instructions on entering binding mode.

The left and right red LEDs flash alternately and the Node searches for a Gateway in binding mode. After the Node binds, the LEDs stay solid momentarily, then they flash together four times. The Node exits binding mode.
5. Label the Node with the assigned address number for future reference.
6. Click **BACK** on the DXM to exit binding for that specific Node address.
7. Repeat steps 2 through 5, for as many DX80 Nodes as are needed for your network.
8. When you are finished binding, click **BACK** on the DXM until you return to the main menu.

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

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

1. Enter binding mode on the DXM radio:
 - a) Use the arrow keys select the **ISM Radio** menu on the LCD and click **ENTER**.
 - b) Highlight the **Binding** menu and click **ENTER**.
2. Assign the device address to the repeater or slave radios.
 - For MultiHop radios without rotary dials: Use the DXM arrow keys to select the device ID to assign to the MultiHop radio about to enter binding mode. The DXM assigns this device ID to the next radio that enters binding mode. Only bind one slave radio at a time.
 - For MultiHop radios with rotary dials: Use the repeater or slave's rotary dials to assign a valid decimal device ID (11 through 60). The left rotary dial represents the tens digit (1 through 6) and the right dial represents the ones digit (0 through 9) of the device ID.
3. Start binding mode on the DXM radio by clicking **ENTER** on the DXM radio.
4. After entering binding mode on the DXM100, put the MultiHop repeater or slave radio into binding mode.
 - For housed radios, triple-click button 2.
 - For board-level radios, triple-click the button.
 - For radios without buttons, refer to the radio's datasheet for instructions on entering binding mode.

After binding is completed, the MultiHop slave automatically exits binding mode and begins operation.
5. Click **BACK** on the DXM to exit binding for that specific device address.
6. Label the MultiHop slave radio with the assigned address number for future reference.
7. Repeat steps 2 through 6, changing the device address for as many MultiHop slaves as are needed for your network.
8. When you are finished binding, click **BACK** on the DXM until you return to the main menu.

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

Conduct a Site Survey

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

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

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

1. From the **ISM Radio** menu, use the down arrow to highlight the **Site Survey** menu. Click **ENTER**.

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

3.1.3 Set the IP Address

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

Equipment needed:

- DXM100-B1R1 Wireless Controller

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

Entering IP Addresses using the LCD menu system overrides the IP addresses in the XML configuration files. To use the IP addresses set in the XML configuration file, clear the IP addresses from the menu system.

1. On the DXM, use the arrows and move to the **System Config** menu. Press **Enter**.
2. Use the arrow keys to select the **Ethernet** menu. Press **Enter**.
3. Use the arrow keys to select **IP**. Press **Enter**.
The octet of the IP address displays.
4. Use the up and down arrows to change the IP address. Press **Enter** to move to the next octet.
5. Press **Enter** on the final octet to accept the changes.
6. Cycle power to the DXM100.
The changes are saved on the DXM100 and the new IP address will be used.

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

3.2 DXM Configuration Tool

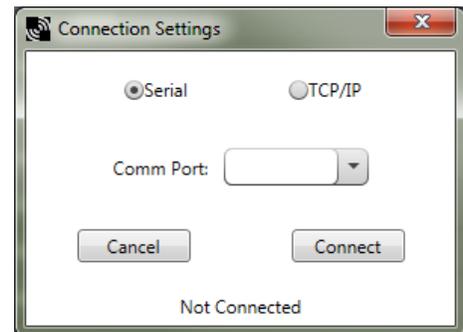
Configure the DXM100 using the DXM Configuration Tool. The DXM Configuration Tool can be used stand-alone or connected to the controller using USB or Ethernet. The tool creates an XML file defined for the DXM100 and can be used at the website level for configuration.

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

Use the DXM Configuration Tool either while connected to a DXM100 or as a standalone configuration software.

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

- Use the **File** menu to manage the loading and saving of the XML configuration file created by the DXM Configuration Tool.
- Use the **Device** menu to handle the connection settings to the DXM100 as well as upload or download the XML configuration files. Also part of the **Device** menu is the communications tools used to view data traffic on the serial bus, useful in ScriptBasic programming.



Connect to the DXM100 by selecting the **Device > Connection Settings** menu. Connect via USB or Ethernet. Before attempting an Ethernet connection, first connect using USB so you can configure the Ethernet parameters before you connect to a live network.

Banner recommends disconnecting the COMM port through the **Device** menu before turning off power or disconnecting the USB cable. Use **Device > Reboot** to restart the DXM100 if needed; the tool automatically disconnects the COMM port, then reconnect it again.

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

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

3.3 DXM100 Documentation

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

- DXM Wireless Controller Sell Sheet, p/n [194063](#)
- DXM100-B1 Wireless Controller Datasheet, p/n [186724](#)
- DXM100-B2 Wireless Controller Datasheet, p/n [195232](#)
- DXM100-Bx Wireless Controller Instruction Manual, p/n [190037](#)
- DXM100-S1 Modbus Slave Datasheet, p/n [195454](#)
- DXM100-S2 Modbus Slave Datasheet, p/n [195231](#)
- DXM100-Sx Modbus Slave Instruction Manual, p/n [188231](#)
- DXM ScriptBasic Instruction Manual, p/n [191745](#)
- DXM Controller Configuration Quick Start, p/n [191247](#)
- DXM Configuration Tool software (p/n [b_4447978](#))
- DXM Configuration Tool Instruction Manual, p/n [158447](#)
- DXM EDS [Configuration file](#) for Allen-Bradley PLCs
- EIP Configuration File for DXM 1xx-BxR1 and R3 models (p/n [194730](#))
- Activating a Cellular Modem (p/n [b_4419353](#))
- Additional technical notes and videos

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

3.4 DXM150 Documentation List

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

- DXM Wireless Controller Sell Sheet, p/n [194063](#)
- DXM150-B1 Wireless Controller Datasheet, p/n [178136](#)
- DXM150-B2 Wireless Controller Datasheet, p/n [195952](#)
- DXM150-Bx Wireless Controller Instruction Manual, p/n [190038](#)
- DXM150-S1 Modbus Slave Datasheet, p/n [160171](#)
- DXM150-S2 Modbus Slave Datasheet, p/n [200634](#)
- DXM150-Sx Modbus Slave Instruction Manual, p/n [195455](#)
- DXM ScriptBasic Instruction Manual, p/n [191745](#)
- DXM Controller Configuration Quick Start, p/n [191247](#)
- DXM Configuration Tool software (p/n [b_4447978](#))
- DXM Configuration Tool Instruction Manual, p/n [158447](#)
- DXM EDS [Configuration file](#) for Allen-Bradley PLCs
- EIP Configuration File for DXM 1xx-BxR1 and R3 models (p/n [194730](#))
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- Additional technical notes and videos

Technical notes, configuration examples, and ScriptBasic program examples are available at <http://www.bannerengineering.com>.

4 Message Registers (I/O 7 and 8)

Informational messages are warning or error conditions that include a message code and data field.

The type of warning or error condition is encoded in the message code while the data field contains additional information for some message codes.

Each DX80 model reserves four registers (defined I/O points) to provide information or control an operation. The reserved registers (I/O points) are 7, 8, 15, and 16. Informational messages are transmitted using Modbus I/O 8 register; control messages are transmitted using register I/O 15. Registers 7 and 16 have special functions depending on the action requested.

4.1 Error Handling Message Codes

All device errors are captured and sent to the Gateway for storage in the devices' register for I/O point 8.

All messages are sent to the Gateway regardless of the priority, and redundant messages are not sent more than once. For example, if a communications timeout is detected 10 times in a row, the device sends the timeout message only once.

The Gateway stores only the highest priority message in the register. A 0x00 message will not be saved unless there is a 0x0 in the I/O point register. All non-zero messages must be cleared by the user. A value of 254 in the register for I/O point 8 disables all error reporting.

To clear any I/O point 8 device message, use the Gateway's front panel menu system. A host connection can also choose to clear or disable Modbus I/O 8 registers. A Node device ignores error messages; errors must be cleared from either the Gateway or the host. The auto-recover feature allows for automatic erasing of errors for a Node if the error condition 'heals' itself. For example, an RF communications link disrupted by a temporary obstacle 'heals' itself when the obstruction is removed. Auto recovery is enabled by factory default and is the recommended setting.

Any new error/warning messages interrupt the active front panel. Once the user has confirmed receipt of the message, the user can clear, disable, or ignore the error/warning message. If the user ignores the message, additional messages from that Node will be collected if they are of a higher priority and will interrupt the display only for new messages. If the user chooses to disable error messages, which is not recommended, the Gateway discards all messages from the Node.

4.2 Modbus Message Codes for Register 8

Register I/O 8 is reserved for device messages or Site Survey data when in Site Survey mode.

Conditions are detected as they occur and are reported to the Gateway. After the message is sent to the Gateway, the Node does not resend the message until the condition changes or there is a higher priority message. The higher the message code, the higher the priority. For more information about how Site Survey data is stored in registers 7 and 8, refer to [Conducting a Site Survey \(Gateway and Nodes\)](#).

The following are the Modbus message codes, shown in hex, that may appear on the Sure Cross devices' I/O 8 Modbus register.

Message Code [15:8]	Data Field [7:0]	Description
00	80	Normal operation. Device message register contents 0x0080 indicate the Node is synchronized to the Gateway. (Decimal value 128.) A value of zero (0) indicates there is no device present.
01	00-FF	Unknown message. The message was received correctly (correct checksum), but it is not a recognized command. This type of message is usually caused by devices with poor radio links or collocated networks that are not uniquely separated by binding codes and Network IDs. Network performance is not affected. (Decimal values 256 through 511.)
35	01	Radio Device (polling/heartbeat) Timeout. (Decimal value 13569.) A Node dropped out of the wireless network based on the polling or heartbeat parameters. Refer to the User Configuration Tool documentation for polling or heartbeat parameters and the timeout operation. When the least significant bit is on (1), an error condition exists. <ul style="list-style-type: none"> Run a site survey to determine the quality of the radio link. If no communication exists between the Gateway and Node, verify the power at the Node and all antenna connections. Blocked radio communications may also be a result of recently changed environmental conditions. Replace the battery of a battery-powered Node. Although the LCD and device may appear functional, the battery may not have enough capacity to handle radio communication.
36	01	Modbus time-out. A Gateway timeout (inactivity on the serial channel) was detected. (Decimal value 13825.) When the least significant bit is on (1), an error condition exists.

Message Code [15:8]	Data Field [7:0]	Description
FE	--	Modbus register 8 device messages are disabled. The Modbus register 8 clears or disables messages using the Gateway's Modbus register 15. (Decimal values 65024 through 65279.)

5 Control Registers (I/O 15)

Use control messages to start device-level actions.

Each DX80 device allocates 16 registers, with registers one through six reserved for inputs and nine through 14 reserved for outputs. Registers 7, 8, 15, and 16 are reserved for warnings, error messages, and control operations. The control messages use the device's register 15. Some control messages are device specific, depending on the action required.

Typically, control messages are used to start a device level action, like 'reset device' (0x0100). The 0x1000 command code sent to an M-GAGE™ device register 15 performs a baseline function on that M-GAGE.

5.1 Control Codes

The register word is made up of two parts, the control code in the upper byte and the data field in the lower byte. Some control codes do not have a data field. For these control codes, use 0x00 as the data field.

Node Reg 15	Control Code [15:8]	Data Field [7:0]
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I/O 15 Control Messages				
Control Code in Hex (Dec)	Data Field in Hex (Dec)	Control Code and Data Field in Decimal	Restrictions	Description
0x00 (00)	0x00	0000		No operation.
0x01 (01)	0x00	256		Reset Micro. Force a restart condition, like power-up. A reset function to the Gateway forces all devices out of sync. A reset function to a Node device only affects that Node. A reset function may cause the Gateway to detect a timeout condition and will temporarily cause a loss of control of the device outputs. The outputs may turn either on or off. Do not reset the device while connected to a running control system
0x02 (02)	0x00	512		Restore system and device defaults from the EEPROM. This command restores all factory default conditions for the system settings.
0x03 (03)	0x00	768	Applies only to the 64 processor	Restore I/O defaults from EEPROM. This command restores all factory default conditions for all the device's I/O points.
0x04 (04)	Node 0x00 through 0x38 (1-56)	1024+Node#	Gateway Only	Reset the error of the specified Node defined by the data field. The control code is available only on the Gateway I/O 15 register and results in a 0x00 placed in the Modbus register I/O 8 of the appropriate Node.
0x05 (05)	Node 0x00 through 0x38 (1-56)	1280+Node#	Gateway Only	Ignore the error of the specified Node defined by the data field. The control code is available only on the Gateway I/O 15 register.
0x06 (06)	Node 0x00 through 0x38 (1-56)	1536+Node#	Gateway Only	Disable the error of the Node defined by the data field. Control code available only on the Gateway I/O 15 register (This results in a 0xFE placed in the Modbus register I/O 8 of the appropriate Node). Reset using the Reset Error function (0x04)
0x07 (07)	00	1792	Gateway Only	Clear I/O linking in EEPROM. The I/O link table will be written with zeros.
0x08 (08)	00	2048	Gateway Only	Abort Channel Search. If this command is received when channel search is in progress, the change search mode is aborted.
0x10 (16)	00	4096	M-GAGE Nodes Only	Baseline M-GAGE™.
0x11 (17)	Bit Mask, see description	4352	0 = all bits off 63 = all bits on	Gateway Link failure. Set the outputs to default states based on Bit Mask. Bit0 in the data field = I/O 9, bit1 = I/O 10, etc. The Gateway Link Failure flag must be set to enable this feature.

I/O 15 Control Messages				
Control Code in Hex (Dec)	Data Field in Hex (Dec)	Control Code and Data Field in Decimal	Restrictions	Description
0x12 (18)	00	4608		Host Communication Timeout. Set all outputs on this device to default states. The Host Link Failure flag must be set to enable this feature.
0x13 (19)	Bit Mask	4864		Force device sample and report of selected enabled inputs. The bit mask defines which I/O point will be sampled. Bit 0 = I/O 1, Bit 1 = I/O 2, etc. A value of 0x3F (63) selects all inputs.
0x20 (32)	Node 0x00 through 0x38 (1-56)	8192+Node#	Gateway Only	Enable Site Survey between Gateway and Node defined by the data field. All error messages from the Gateway are ignored when running Site Survey. Only one Node can participate in Site Survey at any given time. To disable the Site Survey, use control code 0x20 with Node 0. A Node must be enabled to run the Site Survey, then disabled before selecting the next Node.
0x30 (48)	0x00 through 0x18	12288-12312	FlexPower® Devices only	Enable all switched power outputs. The data field selects the voltages. 0x00 = turn off 0x05 = 5V 0x07 = 7V 0x0F = 15V 0x14 = 20V 0x18 = 24V
0x31 (49)		12544-12586		Enable switched power #1, data field selects the voltage (See above)
0x32 (50)		12800-12824		Enable switched power #2, data field selects the voltage (See above)
0x33 (51)		13056-13080		Enable switched power #3, data field selects the voltage (See above)
0x34 (52)		13312-13336		Enable switched power #4, data field selects the voltage (See above)

Example: M-GAGE Baseline

To perform a baseline function on M-GAGE Node 1, write to register 31 (the Node's register 15).

Reg 31	0x10 (16)	0x00
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A baseline function on Node 1 will be initiated. (The command, both bytes together, in decimal would be 4096.)

Example: Forcing a Sample and Report

To force a sample and report of all Node 1's inputs, write the command and data to register 31.

Reg 31	0x13 (19)	0x3F
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The full command, both bytes together into a word, in decimal would be 4864 + 63 = 4927

6 Extended Control Registers (I/O 15 and 16)

Use extended control messages to configure I/O parameters.

Extended control messages allow custom configuration of I/O parameters, such as sample rate, threshold, and hysteresis, in a DX80 device. The I/O parameters are set using a host interface. The extended control message has three parts contained in registers of the Node to be updated.

- Register 15 contains the extended control code and parameter number. The extended control code defines the I/O point and/or function to be executed; the parameter number defines the I/O point parameter.
- Register 16 contains the parameter data.
- Register 7 contains the extended control message acknowledgement from the receiving device. The acknowledgement data is copied from the parameter control code and the parameter number written to register 15 and indicates the transaction has successfully completed.

6 Writing Parameter Data

When writing parameter data, write to register 16 first, then write to register 15.

Node Reg 16	Write Parameter Data [15:0]	
Node Reg 15	Extended Control Code [15:8]	Parameter Number [7:0]
Node Reg 7	Ack Extended Control Code [15:8]	Ack Parameter Number [7:0]

6 Reading Parameter Data

To read parameter data, write to register 15. The acknowledgement from the receiving device appears in register 7 and the read data is in register 16.

Node Reg 16	Read Parameter Data [15:0]	
Node Reg 15	Extended Control Code [15:8]	Parameter Number [7:0]
Node Reg 7	Ack Extended Control Code [15:8]	Ack Parameter Number [7:0]

6.1 Extended Control Codes

Use the extended control codes to write to or read from the specific I/O points of the given Node.

The write control codes are 129 through 144 while the read control codes are 161 through 168. Note that some control codes are reserved and not used at this time.

Extended Control Code (Dec)	Description	Extended Control Code (Dec)	Description	Extended Control Code (Dec)	Description
0x81 (129)	Write I/O 1	0xA1 (161)	Read I/O 1	0x87 (135)	Serial #1 Write
0x82 (130)	Write I/O 2	0xA2 (162)	Read I/O 2	0x88 (136)	Serial #2 Write
0x83 (131)	Write I/O 3	0xA3 (163)	Read I/O 3	0xA7 (167)	Serial #1 Read
0x84 (132)	Write I/O 4	0xA4 (164)	Read I/O 4	0xA8 (168)	Serial #2 Read
0x85 (133)	Write I/O 5	0xA5 (165)	Read I/O 5	0x8F (143)	Counter Low
0x86 (134)	Write I/O 6	0xA6 (166)	Read I/O 6	0x90 (144)	Counter High
0x89 (137)	Write I/O 9	0xA9 (169)	Read I/O 9	0xAF (175)	Reserved
0x8A (138)	Write I/O 10	0xAA (170)	Read I/O 10	0xB0 (176)	Reserved
0x8B (139)	Write I/O 11	0xAB (171)	Read I/O 11		
0x8C (140)	Write I/O 12	0xAC (172)	Read I/O 12		

Extended Control Code (Dec)	Description	Extended Control Code (Dec)	Description	Extended Control Code (Dec)	Description
0x8D (141)	Write I/O 13	0xAD (173)	Read I/O 13		
0x8E (142)	Write I/O 14	0xAE (174)	Read I/O 14		

6.2 Parameter Definitions and Numbers

The following parameters can be changed using the User Configuration Tool 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 use 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 Node's 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 (dec)	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).

6.2 M-GAGE Parameters

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. Setting options include the following values: (Parameter number 0x13).

Filter Threshold 30, 2 hour	Two hours after the M-GAGE reading of the ambient magnetic field (baseline) has dropped below 30, the algorithm begins to slowly lower the magnetic baseline reading to zero.
Filter Threshold 30, 8 hour	Eight hours after the M-GAGE reading of the ambient magnetic field (baseline) has dropped below 30, the algorithm begins to slowly lower the magnetic baseline reading to zero.

M-GAGE Baseline Filter (unrestricted). An M-GAGE only parameter, the baseline filter parameter sets the coefficient value of the baseline filter algorithm. (Parameter number 0x15).

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. (Parameter number 0x12).

M-GAGE Report Rate (Inputs). The report rate defines how often the Node communicates the I/O status to the Gateway. For *FlexPower*® applications, setting the report rate to a slower rate extends the battery life. (Parameter number 0x04).

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. (Sample high parameter number 0x06, Sample low parameter number: 0x07).

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. (Parameter number 0x03).

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. Setting a threshold establishes an ON point. Hysteresis defines how far below the threshold the analog input is required to be before the input is considered OFF. A typical hysteresis value is 10% to 20% of the unit's range.

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). (Threshold parameter number 0x08; Hysteresis parameter number 0x09).

6.2.1 I/O Types (Parameter 0x02)

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

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

Type #		Description	Type #		Description	Type #		Description
Hex	Dec		Hex	Dec		Hex	Dec	
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
			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

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

Type #		Description	Type #		Description	Type #		Description
Hex	Dec		Hex	Dec		Hex	Dec	
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

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
			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			

6.2.2 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.

Input Units

Units	Description	Definition
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. LCD: 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. LCD: 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. LCD: 0.00mA-20.00mA
3	Discrete (ON/OFF)	Default discrete input unit. LCD: ON/OFF

Units	Description	Definition
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. LCD: 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. LCD: 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. LCD: 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. LCD: 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. LCD: 0000.0F
10	Asynchronous Counter, 32-bit	The 32-bit counter value records counts up to 4.29 billion. LCD: 0000 0000
11	Asynchronous Counter, 16-bit	The 16-bit counter value records counts up to 65535. LCD: 0000

Output Units

Units	Description	Definition
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. LCD: 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. LCD: 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. LCD: 0.00mA–20.00mA
3	Discrete (ON/OFF)	Default discrete unit. LCD: 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. LCD: 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. LCD: 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. LCD: 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. LCD: 0.00mA–20.00mA

Units	Description	Definition
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. LCD: 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. LCD: 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. LCD: 0.00V–10.00V
11	Counter, 16-bit	The 16-bit counter value records counts up to 65535. LCD: 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. LCD: 4.00mA–20.00mA

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.

Input Type	I/O Range		Holding Register Representation		Data Conversion	Description
	Min.	Max.	Min.	Max.		
Discrete	0	1	0	1	-	-
0 to 20 mA	0.0 mA	20.0 mA	0	65535	$(20 \text{ mA} \div 65535) \times \text{Reg Value} = \text{mA}$	Linear mapping of unsigned register value to current
4 to 20 mA	4.0 mA	20.0 mA	0	65535	$((16 \text{ mA} \div 65535) \times \text{Reg Value}) + 4 = \text{mA}$	Linear mapping of unsigned register value to current
0 to 10 V dc	0.0 V dc	10.0 V dc	0	65535	$(10 \text{ V} \div 65535) \times \text{Reg Value} = \text{V}$	Linear mapping of unsigned register value to voltage
Temp C/F (high resolution)	-1638.3	+1638.4	0	65535	$(\text{Converted Reg Value}) \div 20 = \text{Temp}$	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	$(\text{Reg Value}) \div 100 = \text{Relative Humidity (RH)}$	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 $-1 \div 20 = -0.05^\circ$.
- 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 $-1 \div 2 = -0.5^\circ$. 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.

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.

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
1111 1111 1111 1100	65532	-4	-0.20
1111 1111 1111 1011	65531	-5	-0.25
1111 1100 0001 1000	64536	-1000	-50

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.

$$\text{Output} = (\text{Fullscale}/\text{Span})(\text{InputValue} - \text{Null}) + \text{Offset}$$

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.

Span. The total range of values mapped to the output.

Null. The starting point for the output scale.

Input Value. The value mapped to the output.

Offset. Defined in the table; the starting output value.

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 ($4\text{ mA} = -20^{\circ}\text{F}$, $20\text{ mA} = 50^{\circ}\text{F}$). 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:

$$\begin{aligned} \text{Output} &= (\text{Fullscale} \div \text{Span})(\text{InValue} - \text{Null}) + \text{Offset} \\ (\text{Fullscale} \div \text{Span}) &= 16 \div 70 = 0.22857 \\ (\text{Value} - \text{Null}) &= -5 - (-20) = 15 \\ \text{Offset} &= 4 \\ \text{Output} &= 0.22857 \times 15 + 4 = 7.42\text{ mA} \end{aligned}$$

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 ($4\text{ mA} = 200\text{ mm}$ and $20\text{ mA} = 2000\text{ mm}$). This defines the null as 200 and the span as 1800.

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

$$\begin{aligned} \text{Output} &= (\text{Fullscale} \div \text{Span})(\text{InValue} - \text{Null}) + \text{Offset} \\ (\text{Fullscale} \div \text{Span}) &= 10 \div 1800 = 0.00555 \\ (\text{Value} - \text{Null}) &= 1560 - 200 = 1360 \\ \text{Offset} &= 0 \\ \text{Output} &= 0.00555 \times 1360 + 0 = 7.54\text{ V} \end{aligned}$$

Alarm Conditions. The standard alarm conditions are as follows:

$$\begin{aligned} \text{Unsigned Alarm} &= 0\text{xFFFF} \\ \text{Signed Alarm} &= 0\text{x7FFF} \end{aligned}$$

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

7 Host Controller Configuration Examples

The following are some specific examples of using registers to clear an error condition, change device I/O parameters, and initiate a Site Survey.

7.1 Clearing Error Conditions Using Register Commands

All non-zero messages must be cleared by the user from either the Gateway or the host system.

The Gateway stores only the highest priority message in the register. A 0x00 message is not saved unless there is a 0x00 in the I/O point register. To disable all error reporting, send a value of 254 in the register for I/O point 8. To clear any I/O point 8 device message, use the Gateway's front panel menu system. A host connection can also choose to clear or disable I/O 8 registers. Nodes ignore error messages.

Control Code	Data Field	Restrictions	Description
04	Node 01-47	Gateway only	Reset error of Node # (defined by the data field). Control code available only on the Gateway I/O 15 register. (This results in a 00 placed in the register I/O 8 of the appropriate Node)
05	Node 01-47	Gateway only	Ignore error of Node # (defined by the data field). Control code available only on the Gateway I/O 15 register.
06	Node 01-47	Gateway only	Disable Error of Node # (defined by the data field). Control code available only on the Gateway I/O 15 register (This results in a 254 placed in the register I/O 8 of the appropriate Node). Reset using the Reset Error function (04)

7.2 Setting the Sample Rate

The sample rate establishes how often the Sure Cross device samples the sensors connected to it.

To set the sample rate to 900 seconds (15 minutes) on I/O point 1, Node #2, two register writes are required: register 47 and register 48 (Node 2's register 15 and 16).

1. Write the parameter data (900 seconds = 14400 62.5 millisecond intervals = 0x3840) into register 48.
2. Write the parameter control code (write I/O #1 = 129 = 0x81) and the parameter number (sample interval = 0x03) into register 47. Concatenated, the register value is 0x8103.

Register	Write	
48	0x38	0x40
47	0x81	0x03

3. Read register 39 to verify the message is completed.

Register	Read	
39	0x81	0x03

Verify the transaction is completed by reading register 39 and verifying the parameter control code and parameter number match the intended action.

7.3 Setting the Counter Preset using Register Commands

The event counter input is a 32-bit value that can be preset using the parameter control codes 143 (0x8F) and 144 (0x90). Parameter control code 143 writes the lower half [15:0] of the counter and code 144 writes the upper half [31:16] of the counter.

Select which counter to preset by defining the Counter Select Mask. The first bit position of the mask (bit 0, right justified) selects the first counter and the second bit position selected the second counter. Set the Node's register 16 to the high or low data value. Read Node register 7 for the transfer acknowledgement. Write to Node register 16 before writing to Node register 15.

There are 16 Modbus holding registers for each Sure Cross device. To calculate the registers for other Nodes, use this equation: Register number = I/O# + (Node # × 16). For example, the Gateway is always device 0 (or Node 0), so the Gateway's holding registers are registers 1 through 16. The registers for Node 1 are 17 through 32 and the registers for Node 2 are 33 through 48.

Node Reg 16	Low or High Value	
Node Reg 15	143 or 144 (0x8F or 0x90)	Counter Select Mask
Node Reg 7	Acknowledge Code 143 or 144	Acknowledge Counter Select Mask

Preset Node 2's counter to 20,567,001

To preset Node 2's counter 2 to the value 20,567,001 (hex 0139 D3D9), follow these steps:

1. Write the upper word to the counter using control code 144 (0x90).

Node Reg 48	0139	
Node Reg 47	0x90	2
Node Reg 39	0x90	2

2. Write the lower word to the counter using control code 143 (0x8F).

Node Reg 48	D3D9	
Node Reg 47	0x8F	2
Node Reg 39	0x8F	2

The counter has been preset to 20,567,001 (0x0139 D3D9)

7.4 Conduct a Site Survey Using Modbus Commands

Use Modbus commands sent from the host system to start a Site Survey.

To start a Site Survey using a Modbus write holding register command, send a control code of 32 (0x20) and the Node number 1 through 15 (0x01 to 0x0F) to the Gateway Modbus holding register for I/O 15.

	Modbus Register	
	[15:8]	[7:0]
I/O 15	Control Code	Data Field

I/O 15 Control Messages			
Control Code	Data Field	Restrictions	Description
32	Node # 1-15	Gateway only	Enable Site Survey between Gateway and Node defined by the data field. All error messages from the Gateway are ignored when running Site Survey. Only one Node can participate in Site Survey at a time. To disable the Site Survey, use control code 0x20 with Node 0. A Node must be enabled to run the Site Survey, then disabled before selecting the next Node.

7.4 Example Command

	Modbus Register	
I/O 15	32	02

When Site Survey runs, the accumulated results are stored in the Gateway's I/O 7 and I/O 8 holding registers. The LEDs on the both the Gateway and the Node's front panel display the signal strength for the wireless RF link. The quality of the communications link is indicated by:

- Green LED = excellent signal strength
- Amber LED = good signal strength
- Red LED = poor signal strength

The signal strength is the transmitted signal strength relative to the ambient RF signal present in a specific location, or noise floor.

The Gateway also displays the Site Survey results on the LCD (for models with an LCD). For one transmit and receive interval, the Gateway saves the lowest signal strength. The LCD and Modbus registers contain the results of the last 100 samples. The totals are a running tally of the last 100 samples and are continuously updated. Four categories are displayed:

- G (green) = excellent signal strength
- Y (yellow) = good signal strength
- R (red) = poor signal strength
- M = Missed packet

To disable Site Survey, send control code 32 (0x20) and Node number 0 (0x0).

7.4 Site Survey Data Holding

With Site Survey active, registers I/O 7 and 8 are Site Survey data holding registers that store the accumulated Site Survey results. Error collections in holding register 8 are saved when Site Survey runs and restored after Site Survey is disabled.

Register			Example Results		
	[15:8]	[7:0]		[15:8]	[7:0]
I/O 7	Red Total	Missed Total	I/O 7	10	0
I/O 8	Green Total	Yellow Total	I/O 8	80	10



Note: This is the current register arrangement when using Modbus/TCP or Modbus RTU. In some older models, the Modbus/TCP registers are reversed (missed and yellow totals are in [8:15], red and green totals are in [0:7]).

7.5 Triggering Binding Mode on a Gateway from a Host System

To use a Modbus host controller system to trigger binding mode on the Gateway, the Gateway's LCD version must be 3.2A or higher To use a Modbus host controller to enter binding mode:

- Write one of the following values to the Gateway's register 6371.

Value (dec)	Action
256	Gateway enters binding mode, but doesn't assign a Node ID
257	Gateway enters binding mode, assigns ID 1 to the Node it will bind to
258	Gateway enters binding mode, assigns ID 2 to the Node it will bind to
...	... for up to 47 Nodes

The Gateway enters binding mode. If 256 was used, the Gateway does not assign a Node ID. If any other listed number is selected, the Gateway enters binding mode and will assign that Node ID to the Node it binds to.

- Verify the Gateway's LEDs flash red alternatively. For board module Gateways, the LED flashes green and red alternatively when in binding mode.

To disable binding mode, write a 0 to register 6371.

8 Host Controller Software Configuration

The following screenshots are configuration examples for specific software that may be used on a host system.

8 SLC 5 and ControlLogix Configuration

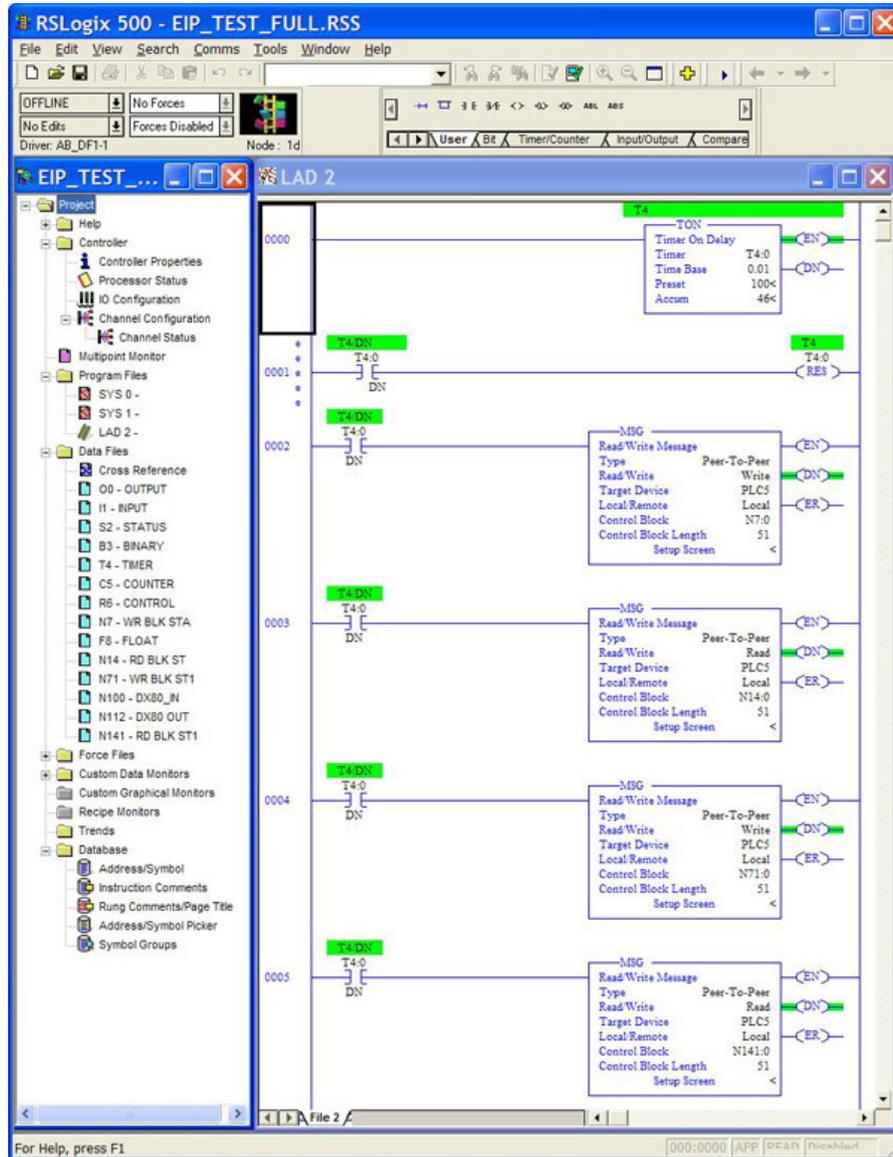


Figure 1. SLC 5 Set-up MSG. In the example screen shown, a counter is set up to activate the MSG Read or MSG Write blocks every one second. Also two write and two read MSG blocks are shown. Each MSG block can only handle up to 103 words.

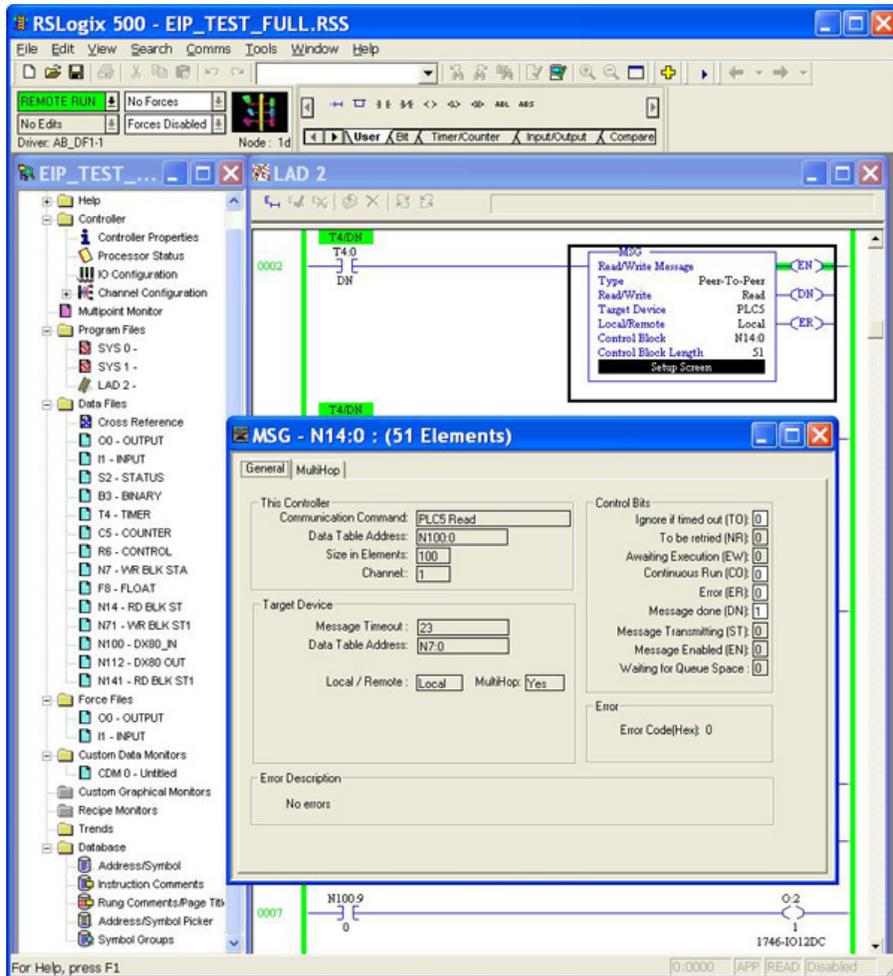


Figure 2. SLC 5 – MSG Read Instruction. The SLC 5 MSG read instruction with multi-hop enabled is shown. Click on the MultiHop tab and enter in the IP address of the DX80 Device (factory default 192.168.0.1)

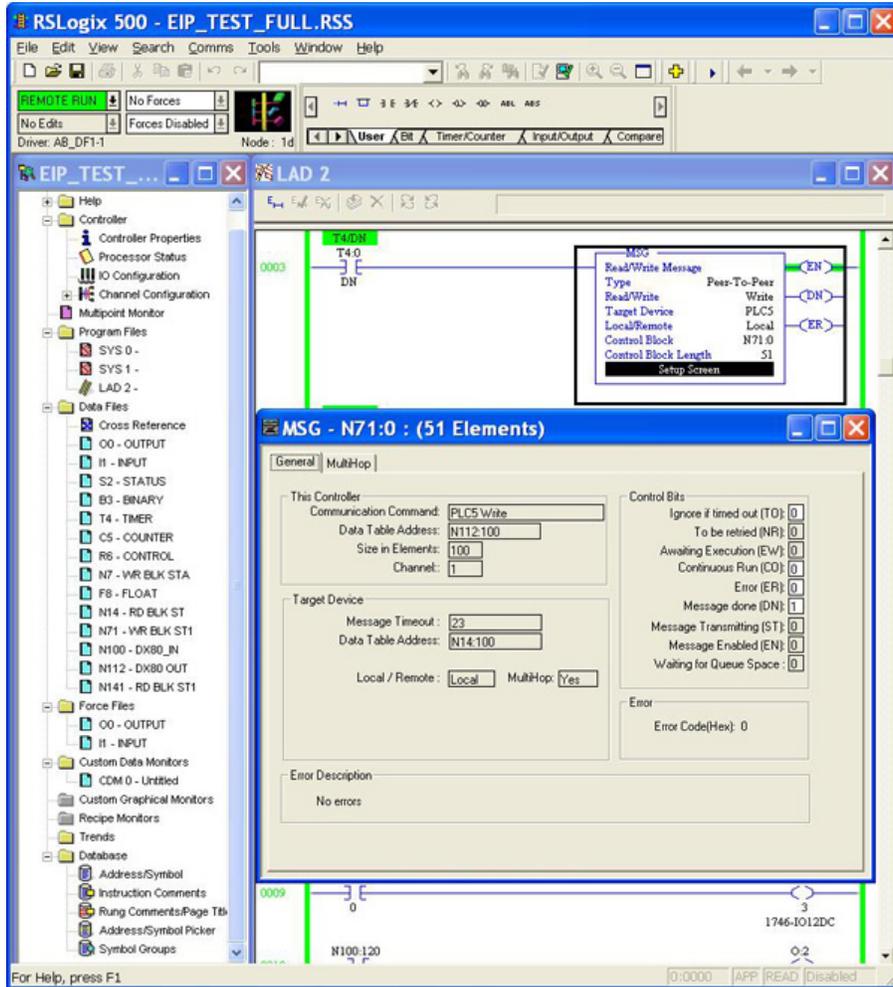
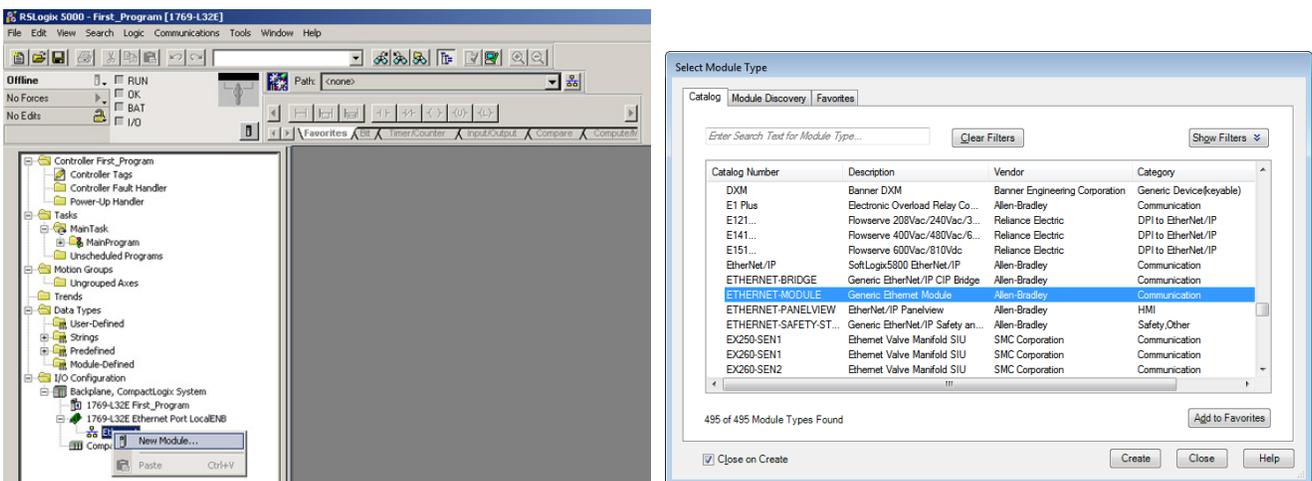


Figure 3. SLC 5 – MSG Write Setup. The SLC 5 MSG write setup instruction with multi-hop enabled is shown. Click on the 'MultiHop' tab and enter in the IP address of the DX80 Device (factory default 192.168.0.1)

8 RSLogix 5000 Configuration

To create an implicit Class 1 configuration to the DX80 using Ethernet/IP when using a ControlLogix family PLC, configure the DX80 as a “Generic Ethernet Module” under the ENET_MODULE.



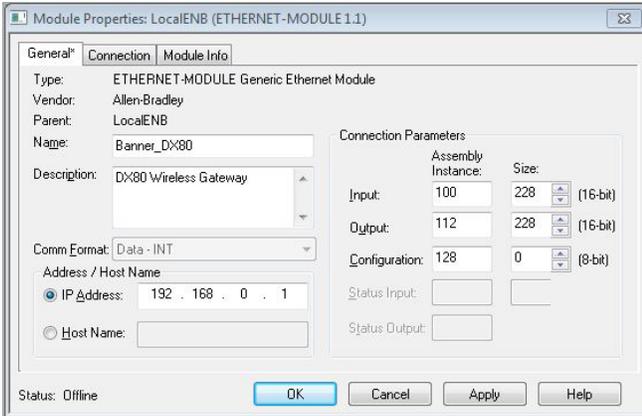


Figure 4. Configure Banner Module Properties

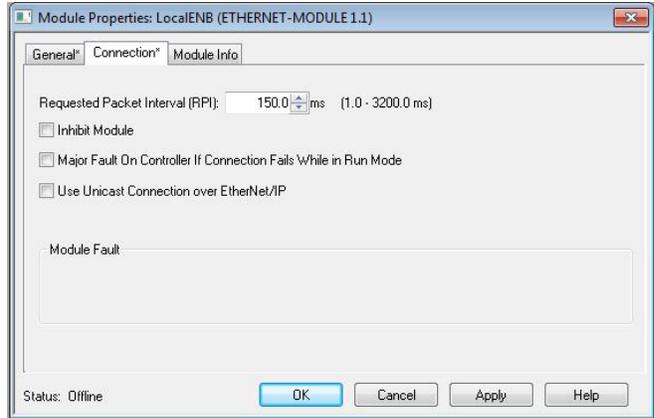


Figure 5. Requested Packet Interval. Verify the Requested Packet Interval is at least 150 milliseconds.

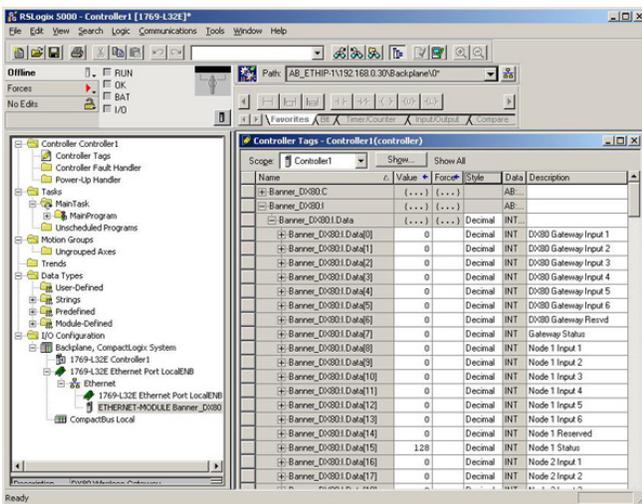


Figure 6. Banner DX80 inputs from wireless devices

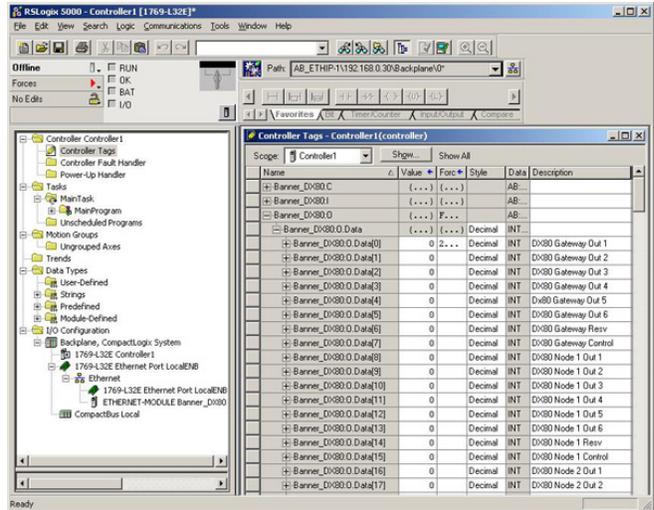


Figure 7. Banner DX80 outputs from wireless devices

9 Troubleshooting

The following troubleshooting tips include some basic instructions for common problems.

9.1 Host Systems

Problem	Solution
No communication with the Gateway when using RS-485	The default communications settings for the RS-485 port are: 1 start bit, 8 data bits, no parity, 1 stop bit, and 19.2k baud. The DX80 Gateway uses Modbus RTU protocol for all communications. Supported Modbus function codes are 3, 6, and 16.
	Verify the DX80 model supports RS-485 serial communications.
	Verify the Slave ID address is set for the bus environment. Factory default Slave ID = 1.
	The factory default for the Modbus timeout is set to zero (disabled). Verify the time is set correctly.
	RS-485 termination or biasing is not supplied on the Gateway and should be provided externally to the Gateway. (Termination is not required by the Gateway, proper biasing of the serial lines is required.)

9.2 Modbus Message Codes for Register 8

Register I/O 8 is reserved for device messages or Site Survey data when in Site Survey mode.

Conditions are detected as they occur and are reported to the Gateway. After the message is sent to the Gateway, the Node does not resend the message until the condition changes or there is a higher priority message. The higher the message code, the higher the priority. For more information about how Site Survey data is stored in registers 7 and 8, refer to [Conducting a Site Survey \(Gateway and Nodes\)](#).

The following are the Modbus message codes, shown in hex, that may appear on the Sure Cross devices' I/O 8 Modbus register.

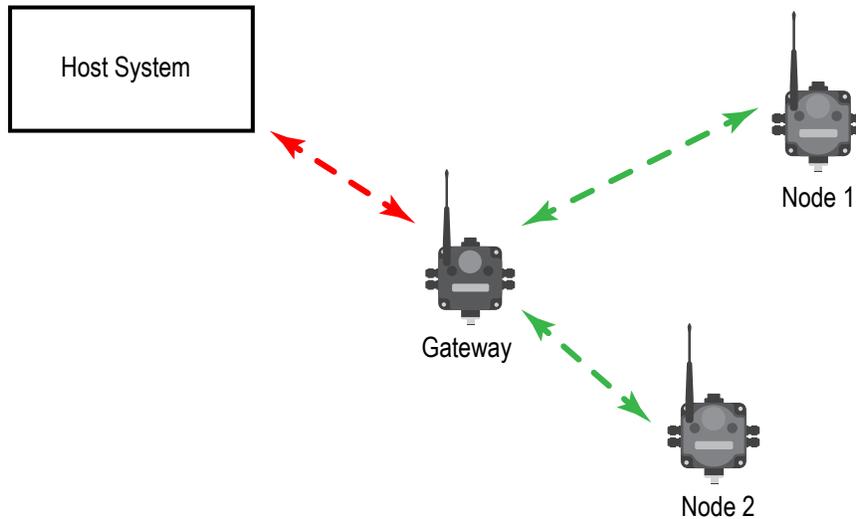
Message Code [15:8]	Data Field [7:0]	Description
00	80	Normal operation. Device message register contents 0x0080 indicate the Node is synchronized to the Gateway. (Decimal value 128.) A value of zero (0) indicates there is no device present.
01	00-FF	Unknown message. The message was received correctly (correct checksum), but it is not a recognized command. This type of message is usually caused by devices with poor radio links or collocated networks that are not uniquely separated by binding codes and Network IDs. Network performance is not affected. (Decimal values 256 through 511.)
35	01	Radio Device (polling/heartbeat) Timeout. (Decimal value 13569.) A Node dropped out of the wireless network based on the polling or heartbeat parameters. Refer to the User Configuration Tool documentation for polling or heartbeat parameters and the timeout operation. When the least significant bit is on (1), an error condition exists. <ul style="list-style-type: none"> Run a site survey to determine the quality of the radio link. If no communication exists between the Gateway and Node, verify the power at the Node and all antenna connections. Blocked radio communications may also be a result of recently changed environmental conditions. Replace the battery of a battery-powered Node. Although the LCD and device may appear functional, the battery may not have enough capacity to handle radio communication.
36	01	Modbus time-out. A Gateway timeout (inactivity on the serial channel) was detected. (Decimal value 13825.) When the least significant bit is on (1), an error condition exists.
FE	--	Modbus register 8 device messages are disabled. The Modbus register 8 clears or disables messages using the Gateway's Modbus register 15. (Decimal values 65024 through 65279.)

9.3 Host Link Failure

A host link failure occurs when the defined timeout period, typically set to four seconds, has elapsed with no communications between the host system (or Modbus master device) and the Gateway.

The Gateway places an error code in its I/O 8 register and sends a message to all relevant Nodes within the system to set outputs to the user-defined default states. Each Node has an enable flag for a host link failure condition. If a Node's 'host link failure' flag is not set, the outputs on the Node are not affected.

In the example shown, a host link failure between the host system and Gateway result in the outputs of Node 1 and Node 2 sent to the defined conditions if both Nodes have the host link failure checkbox selected.



10 Additional Information for the GatewayPro and DX83 Models

The following sections are specific to the GatewayPro and DX83 Ethernet Bridge models and do not apply to the DXM Wireless Controller series.

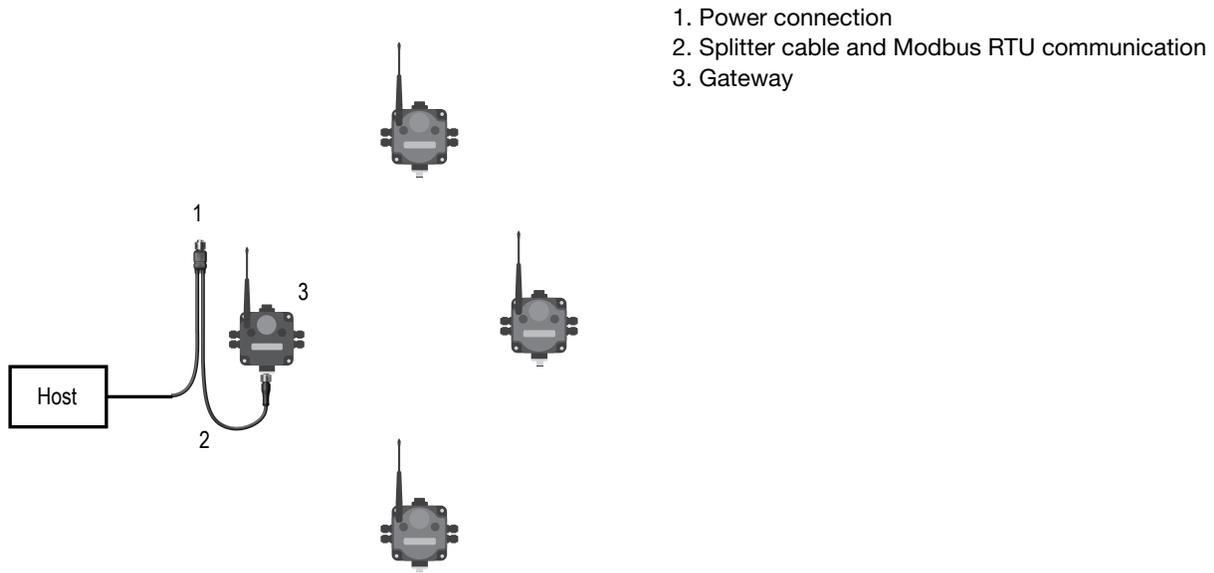
10.1 Web-based Configuration

The SureCross wireless systems are configured using an Ethernet network connection and a common Web page browser. An Ethernet connection can be established from a GatewayPro or from a DX83 Ethernet Bridge serially connected to the Gateway.

The Ethernet Bridge and GatewayPro each ship with an Ethernet crossover cable. One end of the cable is a RJ45 connector and the other end is an industrial Ethernet connector. This cable is designed to be connected directly to a computer.

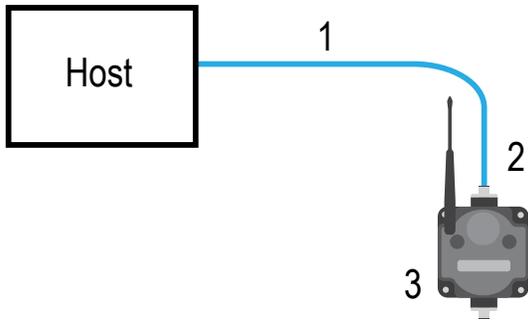
10.1 Example Layout #1

When connecting a Gateway to a host system, the wireless network must be configured using the User Configuration Tool (UCT). When you are not using a GatewayPro or Ethernet Bridge, you cannot configure the wireless network using the Web Configurator.



10.1 Example Layout #2

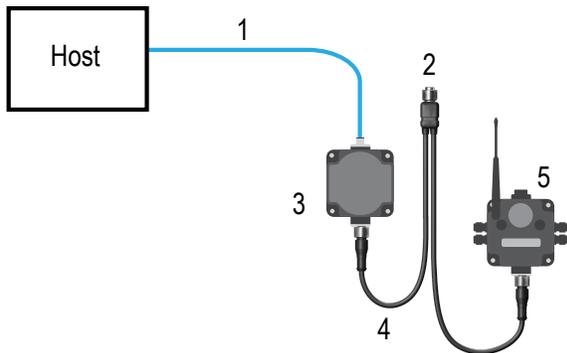
This system uses a GatewayPro connected directly to a host system using an Ethernet crossover cable. This system can be configured using the web pages.



1. Ethernet crossover cable using the Modbus/TCP or EtherNet/IP™ communication protocol
2. Industrial Ethernet connection
3. GatewayPro

10.1 Example Layout #3

This example system layout may also be configured using the web pages. Instead of using a GatewayPro to connect to the host system, a Gateway and Ethernet Bridge is used to achieve the same function. In this configuration, the Gateway is Modbus Slave 1.



1. Ethernet crossover cable using the Modbus/TCP or EtherNet/IP communication protocol
2. Power connection
3. DX83 Ethernet Bridge
4. Splitter cable CSRB-M1250M125.47M125.73 using Modbus RTU
5. Gateway

Typically, the Modbus RTU connection at a GatewayPro is not used because the GatewayPro contains a master and slave device. The Modbus RTU factory default settings for a standard Gateway are: 19200 baud; 8 data bits; No stop bits; 1 parity bit; Modbus Slave ID 1.

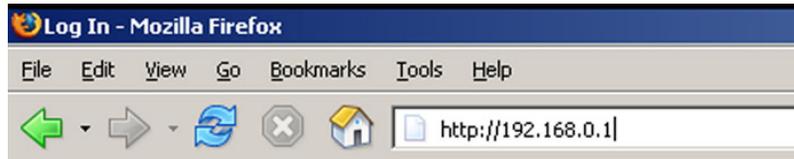
10.1.1 Accessing the Web-based Configuration Screens

The configuration Web pages are served from the DX83 Ethernet Bridge or GatewayPro and are accessed using any Internet browser.

Before accessing the Web-based configuration screens, configure the browser for a direct connection to the Internet. If you are experiencing problems connecting, verify the browser is not set to use a proxy server. Use a crossover Ethernet cable when connecting directly from a host computer to the DX83 Ethernet Bridge or GatewayPro; use a standard Ethernet cable when connecting through a switch or Ethernet hub.

The factory default IP address for the DX83 Ethernet Bridge or GatewayPro is: 192.168.0.1 To change the default IP address, set up the host PC with an IP address different from the Ethernet Bridge or GatewayPro IP addresses. (Refer to Banner document p/n 133116 for detailed instructions on setting up the host computer's network IP address.) For example, change the PC host IP address to: 192.168.0.2. To access the configuration screens, follow these steps.

1. Open a Web browser and log into the Ethernet Bridge or GatewayPro by typing the IP address in the browser location window: http://192.168.0.1.



- The Web home page for the Ethernet Bridge or GatewayPro displays.
2. Click on any tab at the top of page to log into the configuration software.



3. Enter `system` as the user name and `admin` as the password.

After making your changes and saving the file, close the browser to log out of the configuration system.

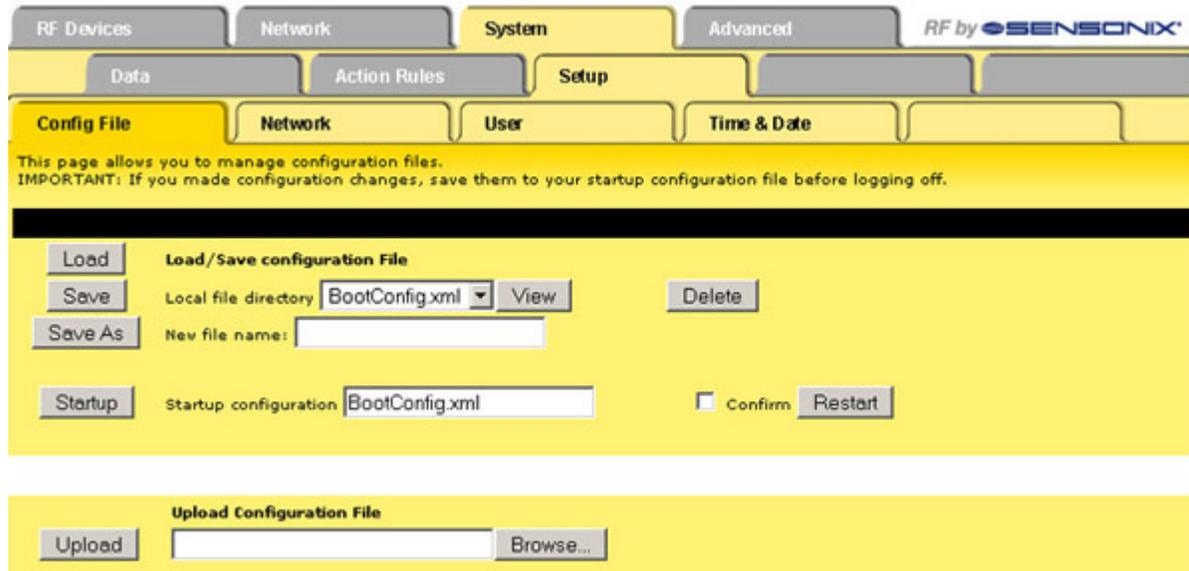
10.1.2 Saving the System Configuration

Save the system configuration by going to the *System > Setup > Config File* page.

- To write the changes to the factory default XML file (BootConfig.xml), click the **Save** button.
- To save the configuration changes under a different file name, enter the new XML file name, including the .XML extension, in the New File Name box and click the **Save As** button.

To define which XML configuration file loads when the device cycles power or restarts, enter the file name in the Startup Configuration box.

Cycle power to the Ethernet Bridge or GatewayPro to complete this update. After the device powers up, the changes should be registered.



10.1.3 Enabling EtherNet/IP Communication Protocol

By default the Ethernet Bridge and GatewayPro systems communicate using Modbus/TCP, but the system can also use EtherNet/IP™.

To change the system to EtherNet/IP, log in using the following user name and password.

User name: root

Password: sxi

At the bottom of the *System > Setup > Network* page is a checkbox to enable EtherNet/IP. Only select this box if the GatewayPro system is running on an EtherNet/IP network. This change cannot be enabled from a login other than the “root” login.

After selecting the EtherNet/IP Enabled checkbox, click the **Set Ports** button to save any changes made to the HTTP Port, Modbus Server Port, Telnet Port, and EtherNet/IP Enabled box. Cycle power to the Ethernet Bridge or GatewayPro to complete this update. After the device powers up, the changes should be registered.

For some SureCross devices, the Ethernet/IP checkbox may be enabled as the factory default.

To use EtherNet/IP, the GatewayPro or DX83 Ethernet Bridge interface requires the user to enable the EtherNet/IP interface, define the EtherNet/IP registers, and save the system configuration using the *System > Setup > Config File* page.

Defining EtherNet/IP Registers to Send to the Buffer

Define the registers sent to the EtherNet/IP interface buffers.

On the **System > Data > Local Registers** screen, select EtherNet/IP for every register to be visible by Ethernet/IP. After selecting the registers, click **Update** to save the changes on this configuration page.

For some Sure Cross devices, the EtherNet/IP checkbox may be enabled at the factory.

In the example screen shown, Node #1 Tank Alarm is mapped to EtherNet/IP buffer input 1, Node #1 Tank Level is mapped to buffer input 2, and Node #1 Status is mapped to buffer input 3. Only local registers defined by the EIP checkbox will be mapped to the EtherNet/IP buffer inputs.

After all selected inputs for device 1 are mapped to the EtherNet/IP buffer inputs, EIP selected inputs for the remaining devices are mapped in the order of the device (e.g. device 1, device 2, device 3).

RF Devices		Network		System		Advanced		RF by SENSONIX®		
Data		Action Rules		Setup						
Local Registers		Thresholds		Trend Data						
This page displays data as presently found in the local registers maintained by this device.										
Device #1		Showing registers from 17				Update		< Prev		Next >
Local Register #	Register Name	Hex	Update	Register Data	Unsigned	EIP	Register Type	Default Data	Server Timeout(s)	
00017	Node #1 Tank Alarm	<input type="checkbox"/>	<input type="checkbox"/>	0	<input type="checkbox"/>	<input checked="" type="checkbox"/>	Integer	0.000000	0.0	
00018		<input type="checkbox"/>	<input type="checkbox"/>	0	<input type="checkbox"/>	<input type="checkbox"/>	Integer	0.000000	0.0	
00019		<input type="checkbox"/>	<input type="checkbox"/>	0	<input type="checkbox"/>	<input type="checkbox"/>	Integer	0.000000	0.0	
00020		<input type="checkbox"/>	<input type="checkbox"/>	0	<input type="checkbox"/>	<input type="checkbox"/>	Integer	0.000000	0.0	
00021	Node #1 Tank Level	<input type="checkbox"/>	<input type="checkbox"/>	0	<input type="checkbox"/>	<input checked="" type="checkbox"/>	Integer	0.000000	0.0	
00022		<input type="checkbox"/>	<input type="checkbox"/>	0	<input type="checkbox"/>	<input type="checkbox"/>	Integer	0.000000	0.0	
00023		<input type="checkbox"/>	<input type="checkbox"/>	0	<input type="checkbox"/>	<input type="checkbox"/>	Integer	0.000000	0.0	
00024	Node #1 Status	<input type="checkbox"/>	<input type="checkbox"/>	0	<input type="checkbox"/>	<input checked="" type="checkbox"/>	Integer	0.000000	0.0	
00025		<input type="checkbox"/>	<input type="checkbox"/>	0	<input type="checkbox"/>	<input type="checkbox"/>	Integer	0.000000	0.0	
00026		<input type="checkbox"/>	<input type="checkbox"/>	0	<input type="checkbox"/>	<input type="checkbox"/>	Integer	0.000000	0.0	
00027		<input type="checkbox"/>	<input type="checkbox"/>	0	<input type="checkbox"/>	<input type="checkbox"/>	Integer	0.000000	0.0	
00028		<input type="checkbox"/>	<input type="checkbox"/>	0	<input type="checkbox"/>	<input type="checkbox"/>	Integer	0.000000	0.0	
00029		<input type="checkbox"/>	<input type="checkbox"/>	0	<input type="checkbox"/>	<input type="checkbox"/>	Integer	0.000000	0.0	
00030		<input type="checkbox"/>	<input type="checkbox"/>	0	<input type="checkbox"/>	<input type="checkbox"/>	Integer	0.000000	0.0	
00031		<input type="checkbox"/>	<input type="checkbox"/>	0	<input type="checkbox"/>	<input type="checkbox"/>	Integer	0.000000	0.0	
00032		<input type="checkbox"/>	<input type="checkbox"/>	0	<input type="checkbox"/>	<input type="checkbox"/>	Integer	0.000000	0.0	

The following table shows how selecting inputs and outputs using the EIP checkbox maps DX80 registers to the EIP buffer inputs and outputs.

Wireless System Registers			Mapped To	EIP Registers			
Register	Gateway	EIP		Word	EIP Inputs	Word	EIP Outputs
1	Gateway input 1	x		0	Gateway input 1	0	Gateway output 2
2	Gateway input 2			1	Gateway input 6	1	Gateway output 4
3	Gateway input 3			2	Node 1 input 3	2	Node output 1
4	Gateway input 4			3	Node 1 input 4	3	Node output 3
5	Gateway input 5			4		4	
6	Gateway input 6	x		5		5	
7	Gateway input 7			6		6	
8	Gateway input 8			7		7	
9	Gateway output 1			8		8	
10	Gateway output 2	x		9		9	
11	Gateway output 3			10		10	
12	Gateway output 4	x		...		...
13	Gateway output 5						
14	Gateway output 6						
15	Gateway output 7						
16	Gateway output 8						
17	Node 1 input 1						

Wireless System Registers			Mapped To	EIP Registers			
Register	Gateway	EIP		Word	EIP Inputs	Word	EIP Outputs
18	Node 1 input 2						
19	Node 1 input 3	x					
20	Node 1 input 4	x					
21	Node 1 input 5						
22	Node 1 input 6						
23	Node 1 input 7						
24	Node 1 input 8						
25	Node 1 output 1	x					
26	Node 1 output 2						
27	Node 1 output 3	x					
28	Node 1 output 4						
29	Node 1 output 5			...		...
30	Node 1 output 6			225		225	
31	Node 1 output 7			226		226	
32	Node 1 output 8			227		227	

EtherNet/IP™ Registers

EtherNet/IP™ on ControlLogix PLC Register Map

A ControlLogix PLC may control the DX80 wireless system using EtherNet/IP through assembly objects and the Common Industrial Protocol (CIP). Add the SureCross Gateway to the ControlLogix PLC as a “Generic Ethernet Module.”

There is one input assembly object for all DX80 input points and one output assembly object for all DX80 output points. Each object is 228 elements long, with each element a 16-bit integer.

The SureCross Gateway is configured at the factory to send all inputs and outputs for the first 16 Nodes in the system. To change the factory settings, change the XML configuration file using the SureCross Web Configurator web pages.

Input Assembly Object, DX80 Input, Instance 100 (0x64). Words are not allocated for any specific unit but are used, in device order, for each of the device input registers selected using the EIP checkbox.

Output Assembly Object, DX80 Outputs, Instance 112 (0x70). Words are not allocated for any specific unit but are used, in device order, for each of the device output registers selected using the EIP checkbox.

For proper EtherNet/IP communication, the minimum requested packet interval should be 150 milliseconds or higher.

Instance 100		Instance 112	
Word #	Inputs	Word #	Outputs
0	Input 1	0	Output 1
1	Input 2	1	Output 2
2	Input 3	2	Output 3
3	Input 4	3	Output 4
...
...
226	Input 227	226	Output 227
227	Input 228	227	Output 228

EtherNet/IP™ to PLC5 and SLC5 Register Map

Allen-Bradley's PLC5 and SLC5 family of devices use PCCC communications over EtherNet/IP. The DX80 wireless system supports these PLCs using input and output register arrays.

There is one input assembly object for all DX80 input points and one output assembly object for all DX80 output points. Each object is 228 elements long, with each element a 16-bit integer. The DX80 wireless data table addresses are N7 for read and N14 for write. The MSG instruction only handles up to 103 words; use multiple MSG instructions if all data is required.

N7 - Read Registers		N14 - Write Registers	
0	Input 1	0	Output 1
1	Input 2	1	Output 2
2	Input 3	2	Output 3
3	Input 4	3	Output 4
...
...
226	Input 227	226	Output 227
227	Input 228	227	Output 228

10.2 Troubleshooting

The following troubleshooting tips include some basic instructions for common problems.

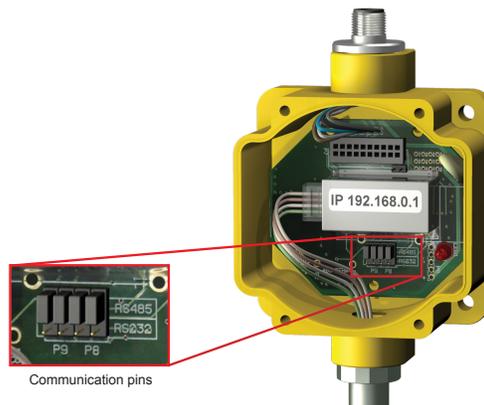
10.2.1 GatewayPro or DX83 Configuration

Problem	Solution
No communication with the Gateway when using the DX83 Ethernet Bridge	Load a properly configured XML file into the DX83 Ethernet Bridge.
	The DX83 Ethernet Bridge can be jumpered for RS-485 or RS-232 communications; verify the jumpers are set properly. All DX80 devices are RS-485 based. Please refer to the Jumper Configuration section.
No Web Page Access	The IP address is wrong. The device defaults to 192.168.0.1 and the host system should be set to 192.168.0.x. If the IP addresses were changed from the default settings, verify the first three sections of the address are the same for both the devices and the host.
	Check the proxy settings on the browser. (See Appendix A).
	When the devices are attached directly to a computer without using a hub or switch, use a crossover cable. When using a hub or switch, use a straight cable.
	After changing the IP address to the Gateway Pro or Ethernet Bridge, cycle the power to the device to activate the change.
Unknown IP Address	The device's default IP address is 192.168.0.1. The host should be set to 192.168.0.2. If another address is used, write it down or print out the set-up page and store in a safe place. If the IP address of the device was changed and is unknown, follow the Restoring Factory Default Settings instructions.

10.2.2 Serial Communication Configuration for DX83s

The DX83 Ethernet Bridge uses jumpers to select between RS-485 and RS-232 communications.

Install the four jumpers across the two top rows of pins for RS-485 and across the bottom two rows of pins for RS-232.



10.2.3 Restoring Factory Default Settings

Restoring the factory default settings resets the settings for the IP address, the root login and root password, the HTTP port setting, and a few other communication settings.

Restoring the factory default settings resets the settings for:

Parameter	Default Setting
IP Address	192.168.0.1
Root Login	root
Root Password	sxi
HTTP Port	80
Modbus Server Port	502
Telnet Port	23
EtherNet/IP Protocol	Disabled



To restore these settings, leave the device powered up and running and follow these steps:

1. Open the DX80 GatewayPro or DX83 Ethernet Bridge housing to access the board
2. Install the initialization (init) jumper on the pins shown
3. Wait 60 seconds
4. Remove the jumper
5. Cycle power to the device

Using the configuration Web page, verify the parameters have returned to the factory defaults listed in the table.

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