

## Datasheet



For additional information, updated documentation, and accessories, refer to Banner Engineering's website, [www.bannerengineering.com/surecross](http://www.bannerengineering.com/surecross).

The Sure Cross® wireless system is a radio frequency network with integrated I/O that can operate in most environments and eliminate the need for wiring runs. Wireless networks are formed around a Gateway, which acts as the wireless network master device, and one or more Nodes.

- Internal three-axis magnetoresistive-based technology senses three-dimensional changes to the Earth's magnetic field caused by the presence of ferrous objects
- Designed to minimize the effects of temperature changes and destabilizing magnetic fields
- Sensor learns ambient background and stores settings in non-volatile memory
- Powered by a lithium D-cell battery integrated into the housing
- Frequency Hopping Spread Spectrum (FHSS) technology and Time Division Multiple Access (TDMA) control architecture ensure reliable data delivery within the unlicensed Industrial, Scientific, and Medical (ISM) band
- Transceivers provide bidirectional communication between the Gateway and Node, including fully acknowledged data transmission
- Lost RF links are detected and relevant outputs set to user-defined conditions
- Fully potted and sealed housing contains the power source, sensor, and antenna for a completely wireless solution

| Models          | Power  | Frequency        | Inputs           |
|-----------------|--|------------------|------------------|
| DX80N9X1W0P0ZTD | D-cell lithium battery integrated into the housing | 900 MHz ISM Band | Internal M-GAGE™ |
| DX80N2X1W0P0ZTD |  | 2.4 GHz ISM Band |                  |



### WARNING: Not To Be Used for Personnel Protection

Never use this device as a sensing device for personnel protection. Doing so could lead to serious injury or death. This device does not include the self-checking redundant circuitry necessary to allow its use in personnel safety applications. A sensor failure or malfunction can cause either an energized or de-energized sensor output condition.

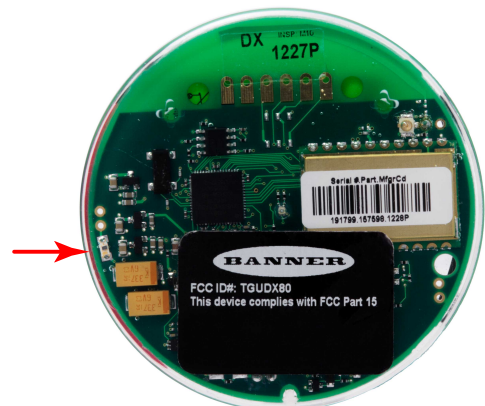
## M-GAGE Overview

The M-GAGE™ sensor uses a passive sensing technology to detect large ferrous objects. The sensor measures the change in the Earth's natural magnetic field (ambient magnetic field) caused by the introduction of a ferromagnetic object.

The M-GAGE provides a direct replacement for inductive loop systems and needs no external frequency box. Its unique design allows quick installation within a core hole. For best performance, mount the sensor below-grade, in the center of the traffic lane.

Because the M-GAGE uses an internal battery, the device ships from the factory in a "deep sleep" mode. While in "deep sleep" mode, the M-GAGE does not attempt to transmit to a parent radio and remains in deep sleep until an LED light at the receiving window wakes it up. To wake the device:

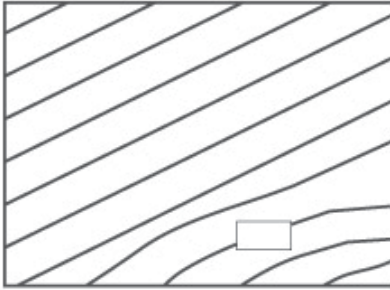
1. Point the optical commissioning device at the receiver.
2. Click and hold the button until the red/green LED in the center of the M-GAGE lights up, about five seconds.



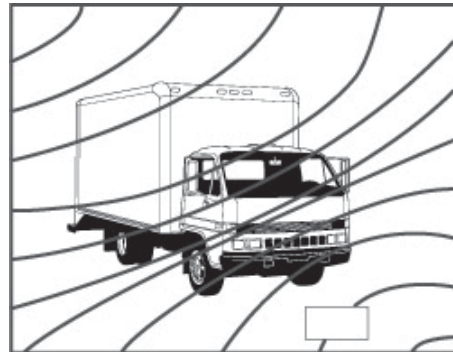
When the device wakes up, the LEDs flash according to the LED table. To return the M-GAGE back to its "deep sleep" mode, click and hold the button until the red LED in the center of the M-GAGE stops blinking, about five seconds.

## Theory of Operation

The sensor uses three mutually perpendicular magnetoresistive transducers, with each transducer detecting magnetic field changes along one axis. Incorporating three sensing elements produces maximum sensor sensitivity. A ferrous object alters the local (ambient) magnetic field surrounding the object, as shown. The magnitude of this magnetic field change depends both on the object (size, shape, orientation, and composition) and on the ambient magnetic field strength and orientation. During a simple programming procedure, the M-GAGE sensor measures the ambient magnetic field. When a large ferrous object alters that magnetic field, the sensor detects the magnetic field changes (anomalies). When the degree of magnetic field change reaches the sensor's threshold, the device reports a change of state.



Field A: Baseline magnetic field with slight disturbances caused by permanent ferrous-metal objects within or near the sensor.



Field B: After a large object is introduced, the magnetic field changes. The sensor detects the changes in the field's strength and orientation between the ambient field and Field B. If the differential is greater than the sensitivity threshold, the device reports a change of state.

## Sensor Field of View and Range

The sensor range depends upon three variables:

- The local magnetic environment (including nearby ferrous material)
- The magnetic properties of the object to be sensed
- Sensor settings

The sensor detects changes in the ambient magnetic field in all directions. As with other sensors, the range depends upon the target. The strong disturbance of a large ferrous object decreases as distance from the sensor increases; the magnitude and shape of the disturbance depends upon the object's shape and content. The sensor can be programmed to react to magnetic field disturbances of greater or lesser intensity, using three adjustments: baseline, threshold, and hysteresis.



**NOTE:** The sensor continues to sense a vehicle in its sensing field even when the vehicle is stopped.

## Gateway Optimization for M-GAGE Nodes

Any SureCross Gateway transmitting at 150 mW or 250 mW works with the M-GAGE Nodes. To optimize the communications between the Gateway and M-GAGE radios and maximize the M-GAGE battery life, use the User Configuration Tool (UCT) to configure the Gateway to use heartbeat mode and to define the network size.

1. In the System Parameters > Heartbeat Config screen, set the Node Heartbeat Interval to five minutes (300 seconds), and set the Number of Misses to 32.
2. Click Send to send the changes to the Gateway.
3. Use the System Parameters > Network Size screen in the UCT to set the network size to 47 Nodes.
4. Click Send to send the changes to the Gateway.

## Baseline Function

The baseline function of the M-GAGE Node stores the ambient magnetic field values of the X, Y, and Z axes as a baseline reading. Once this baseline is established, any deviation in the magnetic field will be reflected in the M-GAGE register. The more disruption in the magnetic field, the larger the M-GAGE register value.

For a host-connected system using standard Gateways, set the baseline magnetic field by writing to a Modbus register. Sending the value of 4096 (0x1000) to the Node's I/O point 15 (Control Message) triggers the M-GAGE to read the existing magnetic field as the new baseline.

For non-host connected systems, use one of the two special M-GAGE Gateways to set the baseline:

- The inputs of the DIP switch M-GAGE Gateway (model DX80G\*M6\*6P6ZP) are mapped to the M-GAGE Node's I/O point 14. Activating the Gateway's input for at least five seconds triggers the M-GAGE to use the existing magnetic field as the new baseline.
- The special M-GAGE Gateway (model DX80G\*M6\*6P6Z) uses special mapping to baseline up to six M-GAGE Nodes.

## Using the LED Light

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The LED flashlight is used to set device modes, such as entering binding mode.



Click and Hold. Click and hold the LED light at the receiving window to wake a wireless device from "deep sleep." If your device is not in "deep sleep," clicking and holding the LED light will put it into "deep sleep." While in "deep sleep" mode, the device does not attempt to transmit to a parent radio and remains in deep sleep until an LED light at the receiving window wakes it up.

Three clicks. Triple clicking at the receiving window puts the device into binding mode. The device binds to the Device ID the master radio is set to. Before putting the device into binding mode, verify the master radio's rotary dials are set to ensure the device will be binding to the correct device ID.

If the device is in binding mode, double click the LED light to exit binding mode.

Model Number: BWA-MGFOB-001

## Setting Up Your Wireless Network

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To set up and install your wireless network, follow these steps.

Disconnect the power from your Sure Cross devices.

1. Configure the DIP switches of all devices.
2. If your device has I/O, connect the sensors to the Sure Cross devices. If your device does not have I/O, skip this step.
3. Refer to the wiring diagrams to apply power to all devices.
  - For two LED models, the Gateway's LED 1 is solid green and the Node's LED 2 flashes red to indicate there is no radio link to the Gateway.
  - For one LED models, the Gateway's LED is solid green and the Node's LED flashes red to indicate there is no radio link to the Gateway.
4. Form the wireless network by binding the Nodes to the Gateway. If the binding instructions are not included in the datasheet, refer to the product manual for binding instructions.
5. Observe the LED behavior to verify the devices are communicating with each other.
  - For two LED models, the Gateway's LED 1 is solid green and the Node's LED 1 flashes green to indicate it is communicating with the Gateway.
  - For one LED models, the Gateway's LED is solid green and the Node's LED flashes green to indicate it is communicating with the Gateway.
6. Conduct a site survey between the Gateway and Nodes. If the site survey instructions are not included in this datasheet, refer to the product manual for detailed site survey instructions.
7. Install your wireless sensor network components. If installation instructions are not included in this datasheet, refer to the product manual for detailed installation instructions.

For additional information, including installation and setup, weatherproofing, device menu maps, troubleshooting, and a list of accessories, refer to one of the following product manuals.

- Sure Cross® Quick Start Guide: [128185](#)
- Sure Cross® Wireless I/O Network Instruction Manual: [132607](#)
- Web Configurator Instruction Manual (used with "Pro" and DX83 models): [134421](#)
- Host Controller Systems Instruction Manual: [132114](#)

## Binding Radios to Form Networks (M-GAGE Optical Commissioning models)

Verify the Gateway is set to use Extended Addressing Mode (DIP switch 1 ON) before binding the Node to the Gateway. (Refer to the Setting DIP Switches section of the datasheet for instructions on accessing the DIP switches.) The Gateway and Node must both be powered to run binding mode.

Before using the M-GAGE devices, you must bind them to the Gateway and assign a Node address using the Gateway's rotary dials. There are no physical switches or dials on the M-GAGE Node. To bind and address an M-GAGE, follow these steps.

1. Put the Gateway into binding mode.
  - If your Gateway has buttons, triple-click button 2 to enter binding mode.
  - If your Gateway does not have buttons, remove the rotary dial access cover and set both the right and left rotary dials to 0, then set both the right and left rotary dials to F. Note that both rotary dials must be changed to F after applying power, not before applying power.

The red LEDs flash alternately when the Gateway is in binding mode. Any Node entering binding mode will bind to this Gateway.
2. Using the Gateway's rotary dials, select the Node address to assign to the M-GAGE. Use the left rotary dial for the left digit and the right rotary dial for the right digit.
 

For example, to assign your M-GAGE to Node 10, set the left dial to 1 and the right dial to 0. (Device ID 00 is reserved for the Gateway. Nodes assigned to 00 will not bind to a Gateway.)
3. On the M-GAGE Node, place the optical commissioning device in contact with the clear plastic housing and pointed directly at the configuration port indicated by the label.
4. Click the button on the optical commissioning device three times to place the Node into binding mode. (If the Node is in its "slow scan" mode, this will wake up the Node as well as begin binding mode.)
 

If binding doesn't occur within 60 seconds, the Node exits binding mode. After entering binding mode, the M-GAGE LEDs blink slowly, alternating between red and green. After the M-GAGE receives a valid binding code from the Gateway, the red and green LEDs are both illuminated continuously, resulting in a slightly orange light.
5. Click the button on the optical commissioning device three times to accept the binding code and return to RUN mode. If the binding code is not accepted within 60 seconds, the Node exits binding mode. The red and green LEDs simultaneously flash four times to indicate that the M-GAGE accepts the binding code. The M-GAGE enters RUN mode. Note: If the M-GAGE is in binding mode and the user does not accept the binding code with a triple click from the optical commissioning device, the M-GAGE automatically exits binding mode after one hour and returns to the previous binding code.
6. Write the Node address on the Node's label.
7. Repeat steps 3 through 6) for as many M-GAGE Nodes as you need to bind. When using this addressing system, up to 47 Nodes may be addressed by a single Gateway.
8. Exit binding mode on the Gateway.
  - If your Gateway has buttons, single-click either button 1 or button 2 to exit binding mode and reboot.
  - If your Gateway does not have buttons, change the Gateway's rotary dials to a valid Network ID. Valid Network IDs are 01 through 32, in decimal, established using both rotary dials. The left dial may be set to 0, 1, 2, or 3. The right dial may be set from 0 to 9 when the left dial is at 0, 1, or 2; or set to 0 through 2 when the left dial is at 3. (Positions A through F are invalid network ID numbers.)

A few seconds after exiting binding mode, the M-GAGE Node's LED blinks green, indicating it is synchronized to the Gateway. The Gateway enters standard operating mode with the LCD autoscrolling through the menu options.

If two Nodes are accidentally assigned the same Node address, rerun the binding procedure on one of the Nodes to reassign the address. The binding sequence may be run on a Node as many times as necessary.

### M-GAGE LEDs

One two-color LED under the clear lid indicates the M-GAGE status.

Green blinking (1 per second). The M-GAGE is synchronized with the DX80 Gateway.

Green blinking (slow). The M-GAGE is synchronized with the DX80 Gateway in power-saving heartbeat mode. The slow blink is once every two seconds for 2.4 GHz models and once every four seconds for 900 MHz models.

Red blinking (every 3 seconds). The M-GAGE is attempting to synchronize with the DX80 Gateway.

No light. The M-GAGE is attempting to synchronize with the Gateway and it is in slow scan mode or hibernate/storage mode.

Alternating red and green blinking. The M-GAGE has entered binding mode.

Red and green on at the same time (looks orange). The M-GAGE has received the binding code.

Red and green flash simultaneously four times (looks orange). The M-GAGE has accepted the binding code and has entered RUN mode.

Slow scan mode occurs when the M-GAGE is out of synchronization with the Gateway for more than 15 minutes. After the M-GAGE enters slow scan mode, the M-GAGE may still synchronize with a Gateway, but the scanning period is longer. After the M-GAGE is synchronizes to the Gateway, the M-GAGE returns to standard operating mode.

## M-GAGE Installation

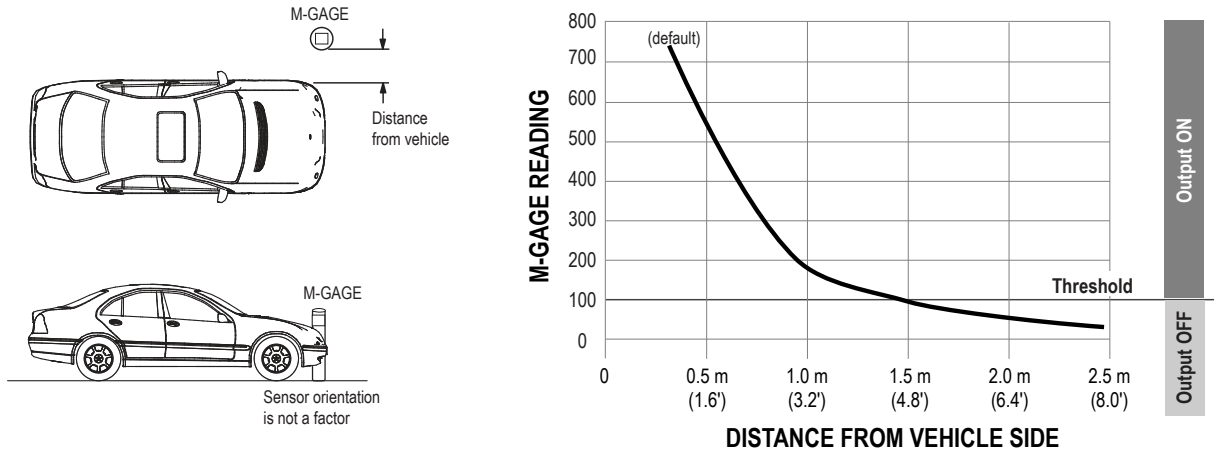


Figure 1. M-GAGE Reading when installed 1 meter above the ground.

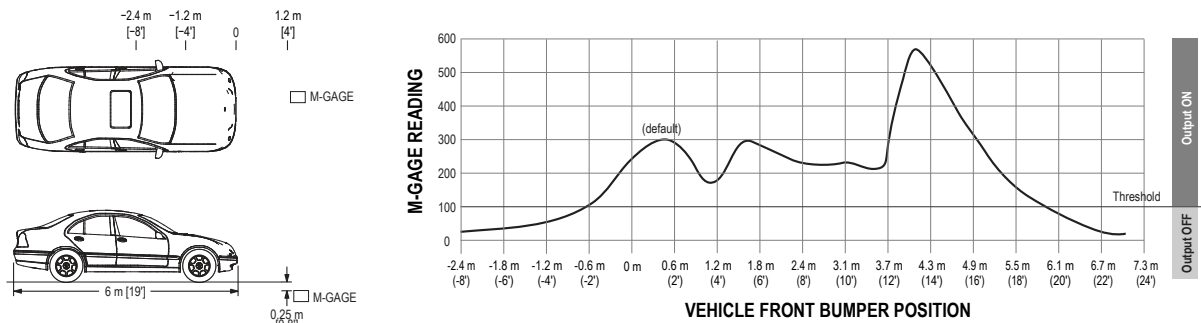


Figure 2. M-GAGE Reading when installed underground.

## Placing the M-GAGE for Best Results

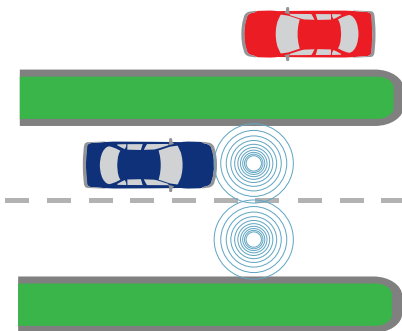


Figure 3. Optimum placement of M-GAGE

When the sensor is positioned in the middle of the traffic lane, it can be configured to a threshold level to detect vehicles only in the lane of interest. This is known as lane separation, or not detecting a vehicle in an adjacent lane.

A threshold level also aids the sensor in vehicle separation – detecting a break between the back bumper of a leading vehicle and the front bumper of the next vehicle. With proper placement and configuration, the M-GAGE can achieve vehicle separation with distances of 24 inches or less.

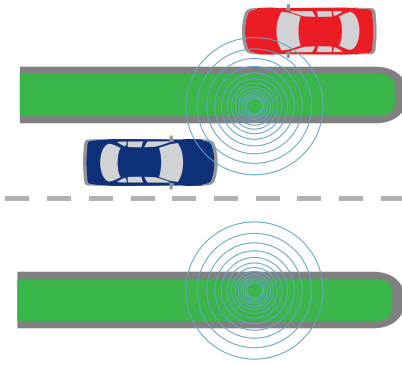


Figure 4. Poor placement of M-GAGE

Although mounting the sensor at the side of a lane may be successful, this mounting location increases the potential for problems. To reliably detect a vehicle from the side, the sensor threshold must be increased to see objects farther away in the lane of interest. Unfortunately, this enables the sensor to also detect lawn mowers in the median or vehicles in adjacent lanes, causing false counts.

Place the M-GAGE sensor at the edge of a traffic lane only if there is no possibility of the sensor detecting other objects. To avoid detecting other objects, ensure no vehicles will be within 10 feet of the sensor on the non-traffic side.

## Buried Installation

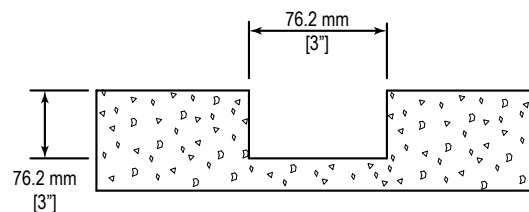
- Always wear proper eye protection when grinding or drilling.
- Gloves, hearing protection, and sturdy boots are highly recommended.
- Always read and follow all specific instructions and safety precautions provided by the manufacturer of all equipment.

Required equipment includes:

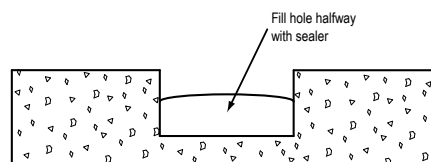
- 3" Coring equipment. Many options exist; choose what works best for the conditions of your installation site.
- Sealer. We recommend using a flexible, weather-proof liquid asphalt/concrete repair compound suitable for your needs. Banner Engineering used Fabick Protective Coatings joint sealers for test installations.

The installation objective is to fully encapsulate the M-GAGE sensor in sealant.

1. Bind and configure all devices before continuing.
2. Drill a 3 inch diameter hole to a depth of about 3 inches. Use a chisel to break off the plug of material and remove any loose material remaining in the bottom of the hole.



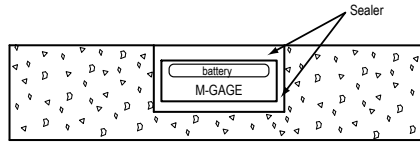
3. Verify all surfaces inside and near the hole are free of debris, warm (consult sealer manufacturer data for temperature threshold data), and thoroughly dry.
4. Repeat steps 1 through 3 for all locations.
5. One hole at a time, pour enough sealer into the hole to halfway fill the hole.



6. Battery side up, place the M-GAGE into the hole and press down until the sealer material flows up and around the M-GAGE and begins to pour onto the top. The top of the M-GAGE should be about 1.5 inches below the surface.



7. Immediately fill the spaces surrounding the device with sealer. Completely fill the hole with sealer to avoid leaving a recess that collects water and dirt.



## Modbus Register Table (M-GAGE)

| I/O # | Modbus Holding Register |                   | I/O Type              |
|-------|-------------------------|-------------------|-----------------------|
|       | Gateway                 | Any Node          |                       |
| 1     | 1                       | 1 + (Node# × 16)  | M-GAGE                |
|       |                         | ...               |                       |
| 7     | 7                       | 7 + (Node# × 16)  | Reserved              |
| 8     | 8                       | 8 + (Node# × 16)  | Device Message        |
|       |                         | ...               |                       |
| 13    | 13                      | 13 + (Node# × 16) | Configuration Message |
| 14    | 14                      | 14 + (Node# × 16) | Baseline Command      |
| 15    | 15                      | 15 + (Node# × 16) | Control Message       |
| 16    | 16                      | 16 + (Node# × 16) | Reserved              |

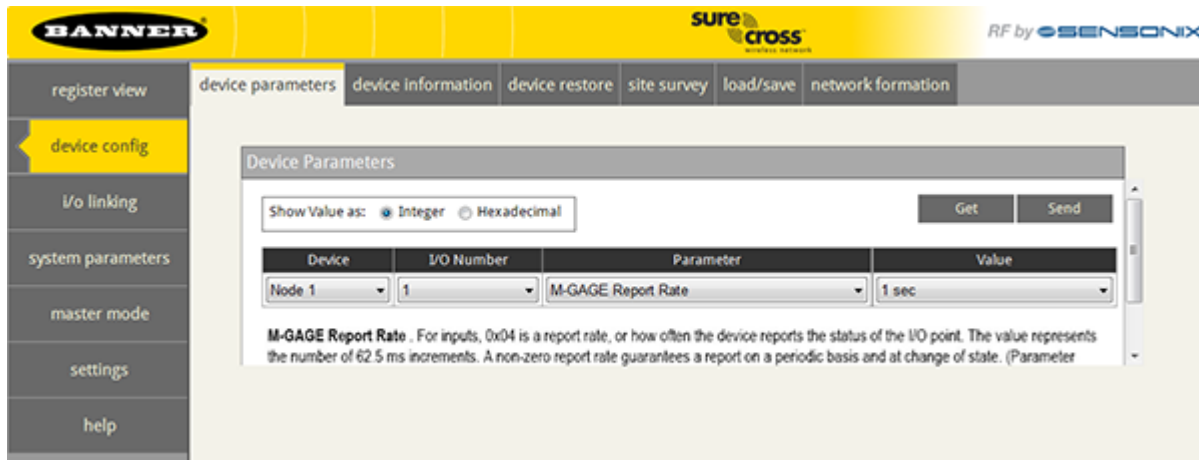
There are sixteen Modbus holding registers for each device. Calculate the holding register number for each device using the equation: Register number = I/O# + (Node# × 16).

Because the Gateway is always device 0, the Gateway's holding registers are registers 1 through 16. Registers for Node 1 are 17 through 32. Using the equation, the register number for I/O point 15 for Node 7 is 127.

The M-GAGE value in I/O 1 is the deviation between the total measured magnetic field in the X, Y, and Z axes and the stored baseline. To send configuration messages, use the Node's I/O point 13. To create a baseline command, use a control message or use the Node's I/O point 14. For more instructions, refer to the Baseline section.

## Configuring M-GAGE Parameters Using the UCT

The Device Parameters screen of the User Configuration Tool (UCT) is used to configure the M-GAGE parameters listed below.



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

## Configuring the M-GAGE Using Register 13

A host system can configure the M-GAGE Node by setting I/O 13 on the M-GAGE Node. Writing a defined value to the Modbus register sets the M-GAGE operation immediately. The following parameters can be configured by writing to the M-GAGE Node Modbus register 13. The host system must resend the configuration settings if power is cycled to the wireless system.



| Modbus Register 13 [15:8] |                 |    |    |                                |    |    |             |   |
|---------------------------|-----------------|----|----|--------------------------------|----|----|-------------|---|
|                           | Low Pass Filter |    |    | Sample High/Sample Low Counter |    |    | Report Rate |   |
| Device Settings           | 15              | 14 | 13 | 12                             | 11 | 10 | 9           | 8 |
| No Change                 | 0               | 0  | 0  |                                |    |    |             |   |
| No Low Pass Filter        | 0               | 0  | 1  |                                |    |    |             |   |
| Low Pass Filter T0        | 0               | 1  | 0  |                                |    |    |             |   |
| Low Pass Filter T1        | 0               | 1  | 1  |                                |    |    |             |   |
| Low Pass Filter T2        | 1               | 0  | 0  |                                |    |    |             |   |
| Low Pass Filter T3        | 1               | 0  | 1  |                                |    |    |             |   |
| Low Pass Filter T4        | 1               | 1  | 0  |                                |    |    |             |   |
| Low Pass Filter T6        | 1               | 1  | 1  |                                |    |    |             |   |
| No Change                 |                 |    |    | 0                              | 0  | 0  |             |   |
| 1                         |                 |    |    | 0                              | 0  | 1  |             |   |
| 2                         |                 |    |    | 0                              | 1  | 0  |             |   |
| 3                         |                 |    |    | 0                              | 1  | 1  |             |   |
| 4                         |                 |    |    | 1                              | 0  | 0  |             |   |
| 8                         |                 |    |    | 1                              | 0  | 1  |             |   |
| 16                        |                 |    |    | 1                              | 1  | 0  |             |   |
| 32                        |                 |    |    | 1                              | 1  | 1  |             |   |
| No Change                 |                 |    |    |                                |    |    | 0           | 0 |
| On Change of State        |                 |    |    |                                |    |    | 0           | 1 |
| 16 seconds                |                 |    |    |                                |    |    | 1           | 0 |
| Sample Rate               |                 |    |    |                                |    |    | 1           | 1 |

| Modbus Register 13 [7:0]       |             |   |   |                 |   |                          |   |   |
|--------------------------------|-------------|---|---|-----------------|---|--------------------------|---|---|
|                                | Sample Rate |   |   | Baseline Filter |   | Threshold and Hysteresis |   |   |
| Device Settings                | 7           | 6 | 5 | 4               | 3 | 2                        | 1 | 0 |
| No Change                      | 0           | 0 | 0 |                 |   |                          |   |   |
| 62.5 milliseconds              | 0           | 0 | 1 |                 |   |                          |   |   |
| 125 milliseconds               | 0           | 1 | 0 |                 |   |                          |   |   |
| 250 milliseconds               | 0           | 1 | 1 |                 |   |                          |   |   |
| 500 milliseconds               | 1           | 0 | 0 |                 |   |                          |   |   |
| 1 second                       | 1           | 0 | 1 |                 |   |                          |   |   |
| 31 milliseconds                | 1           | 1 | 0 |                 |   |                          |   |   |
| 20 milliseconds                | 1           | 1 | 1 |                 |   |                          |   |   |
| No Change                      |             |   |   | 0               | 0 |                          |   |   |
| Filter Off                     |             |   |   | 0               | 1 |                          |   |   |
| Filter Threshold 30, 2 hour    |             |   |   | 1               | 0 |                          |   |   |
| Filter Threshold 30, 8 hour    |             |   |   | 1               | 1 |                          |   |   |
| No Change                      |             |   |   |                 |   | 0                        | 0 | 0 |
| Threshold: 50, Hysteresis: 15  |             |   |   |                 |   | 0                        | 0 | 1 |
| Threshold: 100, Hysteresis: 30 |             |   |   |                 |   | 0                        | 1 | 0 |
| Threshold: 150, Hysteresis: 30 |             |   |   |                 |   | 0                        | 1 | 1 |

| Modbus Register 13 [7:0]       |             |   |   |                 |   |                          |   |   |
|--------------------------------|-------------|---|---|-----------------|---|--------------------------|---|---|
| Device Settings                | Sample Rate |   |   | Baseline Filter |   | Threshold and Hysteresis |   |   |
|                                | 7           | 6 | 5 | 4               | 3 | 2                        | 1 | 0 |
| Threshold: 200, Hysteresis: 30 |             |   |   |                 |   | 1                        | 0 | 0 |
| Threshold: 300, Hysteresis: 40 |             |   |   |                 |   | 1                        | 0 | 1 |
| Threshold: 500, Hysteresis: 50 |             |   |   |                 |   | 1                        | 1 | 0 |
| Threshold: 800, Hysteresis: 60 |             |   |   |                 |   | 1                        | 1 | 1 |

**Sending the Configuration Message to Register 13**

Modbus command 06 (write single holding register) is used in this example to set the parameter values for the M-GAGE Node. A sample configuration message for Node 1:

|        | Low Pass Filter |    |    | Sample High Counter |    |    | Report Rate |   | Sample Rate |   |   | Baseline Filter |   | Threshold and Hysteresis |   |   |
|--------|-----------------|----|----|---------------------|----|----|-------------|---|-------------|---|---|-----------------|---|--------------------------|---|---|
| Bits   | 15              | 14 | 13 | 12                  | 11 | 10 | 9           | 8 | 7           | 6 | 5 | 4               | 3 | 2                        | 1 | 0 |
| Values | 0               | 0  | 0  | 0                   | 1  | 0  | 1           | 1 | 0           | 1 | 0 | 0               | 1 | 1                        | 0 | 1 |
| Hex    | 0               |    |    | B                   |    |    | 4           |   |             | D |   |                 |   |                          |   |   |

Sending this configuration message to register 13 sets the low pass filter to “no change;” the sample high counter to 2; the report rate and sample rate to 125 milliseconds; the baseline filter to 0, 15; the threshold to 300; and the hysteresis to 40.

The complete Modbus command, in hexadecimal, is:

| Slave ID# | Modbus Command | Register Number |    | Configuration Value |    |     |     |
|-----------|----------------|-----------------|----|---------------------|----|-----|-----|
| 01        | 06             | 00              | 1C | 0B                  | 4D | CRC | CRC |

## Specifications

|  |  |
|--|--|
| Radio Range<br>300 m (1000 ft) <sup>1</sup>  | Power Requirements<br>Lithium battery integrated into the housing  |
| Radio Transmit Power<br>900 MHz: 20 dBm (100 mW) conducted<br>2.4 GHz, 65 mW: 18 dBm (65 mW) conducted, less than or equal to 20 dBm (100 mW) EIRP             | Housing<br>ABS<br>Weight: 0.14 kg (0.3 lbs)  |
| 900 MHz Compliance<br>FCC ID TGUDX80 - This device complies with FCC Part 15, Subpart C, 15.247<br>IC: 7044A-DX8009  | Interface<br>Indicators: One bi-color LED  |
| 2.4 GHz Compliance<br>FCC ID UE300DX80-2400 - This device complies with FCC Part 15, Subpart C, 15.247<br>ETSI EN 300 328 V1.8.1 (2012-06)<br>IC: 7044A-DX8024 | M-GAGE Inputs<br>Input: Internal Magnetometer<br>Sample Rate: 250 milliseconds<br>Report Rate: On Change of State<br>Ambient Temperature Effect: Less than 0.5 milligauss/°C<br>Sensing Range: See figures on previous pages |
| Spread Spectrum Technology<br>FHSS (Frequency Hopping Spread Spectrum)   | Environmental Rating<br>IEC IP67; NEMA 6   |
| Link Timeout<br>Gateway: Configurable via User Configuration Tool (UCT) software<br>Node: Defined by Gateway   | Operating Conditions<br>-40 °C to +85 °C (-40 °F to +185 °F)<br>95% maximum relative humidity (non-condensing)   |
|  | Radiated Immunity HF<br>10 V/m (EN 61000-4-3)  |
|  | Shock and Vibration<br>IEC 68-2-6 and IEC 68-2-27<br>Shock: 30g, 11 millisecond half sine wave, 18 shocks<br>Vibration: 0.5 mm p-p, 10 to 60 Hz  |
|  | Certifications   |



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<sup>1</sup> Radio range depends on the environment and line of sight and is lower when buried.