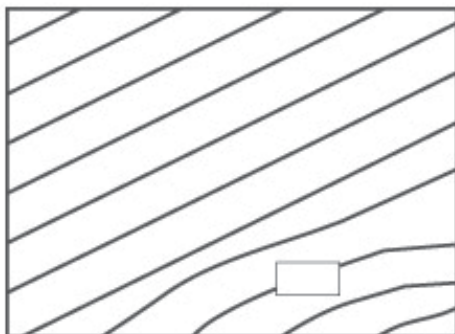


M-GAGE Overview

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

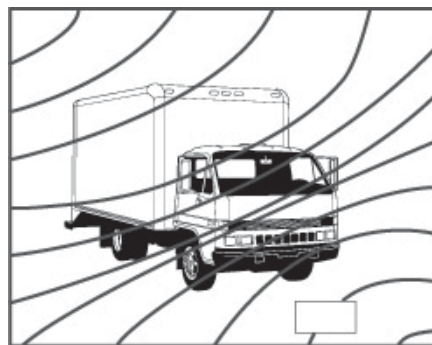
When a vehicle is detected, the M-GAGE Node output changes. After the vehicle leaves the desired position, the magnetic field returns to its natural state and the M-GAGE Node turns off its output signal to the master radio.

Figure 1. Small changes in the ambient magnetic field



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

Figure 2. Larger changes in the ambient magnetic field



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 the field produced by a large metal object. If the differential is greater than the sensitivity threshold, the device reports a change of state.

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 M-GAGE 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.

The placement of the M-GAGE Node is critical for proper operation. Because the M-GAGE sensor detects anomalies in the Earth's magnetic field in the immediate space around the sensor, it must be placed in a prescribed location to properly detect vehicle presence.

Before installing the M-GAGE Node in the pavement, bind the Node to its master radio. For this installation guide, the master radio is a DXM Controller. The master radio may also be a Performance Gateway.

After the Node is installed, the DXM Controller monitors the M-GAGE Node's output and radio connection. The output of the DXM Controller can connect to an input (PNP) on any industrial programmable logic controller, industry controllers or visual/audible indication.

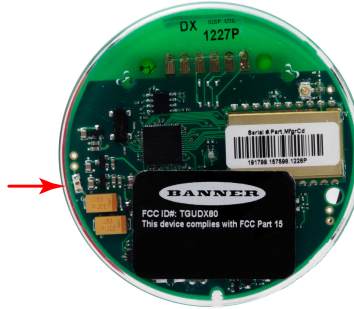
Configuration Instructions

Wake the M-GAGE from Deep Sleep Mode

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.

Follow these instructions to wake the device from deep sleep mode.

Figure 3. M-GAGE receiver window



1. Point the optical commissioning device at the receiver.
The red arrow is pointing to the receiver window.
2. Click and hold the optical commissioning device's 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 optical commissioning button until the red LED in the center of the M-GAGE stops blinking, about five seconds.

Bind the M-GAGE to the DXM Controller

Bind the M-GAGE Node to the DXM Controller before burying the M-GAGE.

To bind the M-GAGE Node to the DXM Controller, we have DXM Controller, M-GAGE, and the optical commissioning device (**BWA-MGFOB-001**) available.

1. Set the DXM Controller's ISM radio to operate at 250 mW.
Before the M-GAGE Node can bind to the DXM Controller, the DXM Controller's ISM radio must be set to operate at 250 mW.
 - a) On the DXM: Use the up and down arrows to scroll to the **System Config** menu. Press **ENTER**.
 - b) Scroll to the **ISM Radio** menu and press **ENTER**.
 - c) Scroll to **RF Power** and press **ENTER**.
 - d) Scroll to **900 0.25W** and press **ENTER**.
 - e) Press **ENTER** when the DXM indicates that it needs to restart.
The DXM restarts and returns to the main menu.
2. On the DXM: Scroll down the menu options to **ISM Radio** and press **ENTER**.
3. Select **Binding** and press **ENTER**.
4. Use the arrow buttons to scroll to Node 1 and press **ENTER**.
Each Node within the radio network must have a unique Node ID. This example is referring to Node 1, but the Node ID can be any valid ID.
The DXM enters binding mode with Node 1.
5. On the M-GAGE Node: Verify the M-GAGE is awake. If it is not awake, see [Wake the M-GAGE from Deep Sleep Mode](#) on page 1.
6. Hold the optical commissioning device to the M-GAGE's receiving window and click the button three times.

Figure 4. Triple-click the button to put the M-GAGE into binding mode



The LED in the center of the M-GAGE Node flashes an alternating red and green. When the both LEDs both are on, the binding process has started. The final binding process occurs when both LEDs flash in unison four times. After binding is complete, the M-GAGE Node automatically exits the binding process and reboots.

7. On the DXM: After the M-GAGE Node is bound to the DXM, press the DXM's **BACK** button to exit binding mode.

8. On the M-GAGE: Verify the center LED is flashing green approximately once a second.
 - Flashing green approximately once a second: The M-GAGE is bound to its DXM and is operating correctly.
 - Flashing red once every three seconds: Move the M-GAGE farther away from the DXM Controller and perform the binding process again.

Before installing your M-GAGE, perform a Site Survey to verify radio communications.

Conduct a Site Survey Between the M-GAGE and DXM Controller

After the M-GAGE Node is bound to the DXM Controller, verify radio operations before installing the M-GAGE by conducting a Site Survey.

Place the M-GAGE Node at the application's desired location. Align the antenna (wire antenna inside the Node's epoxy housing) to face the DXM Controller's desired location.

1. On the DXM: Use the arrow buttons to select the **ISM Radio** menu and press **ENTER**.
2. Select the **Site Survey** menu and press **ENTER**.
3. Use the Up or Down arrows to select the device ID number and press **ENTER** to run the site survey with that radio. The site survey results display as green (strong radio signal), yellow (moderate signal), red (low signal), and missed (no signal) packets. Missed packets were not received.
4. When you are finished running the Site Survey, press **Back** twice to return to the main menu and exit site survey mode.

The desired outcome is to maximize the green signals and minimize the missed signals. Having more than 10 missed signals will decrease the M-GAGE's battery performance and should be corrected prior to final deployment. If all signals are missed, rerun the binding process and site survey.

Installation Instructions

Placing the M-GAGE

Figure 5. Optimum M-GAGE placement perpendicular parking stalls

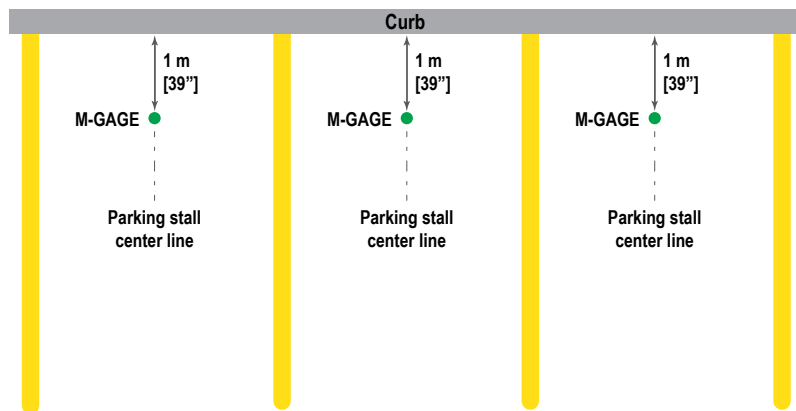


Figure 6. Optimum M-GAGE placement for angled parking stalls

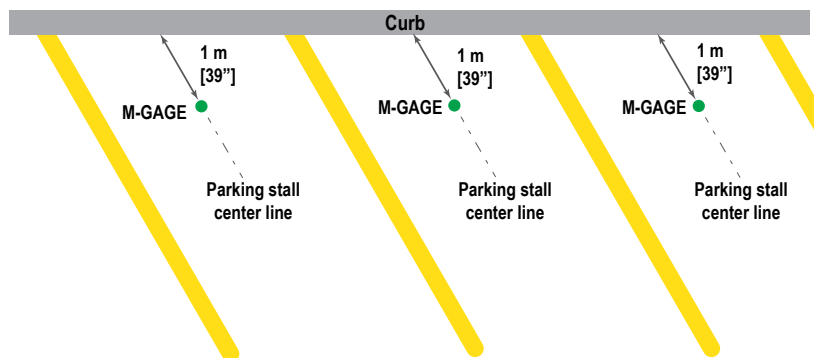


Figure 7. Optimum M-GAGE placement for parallel parking stalls

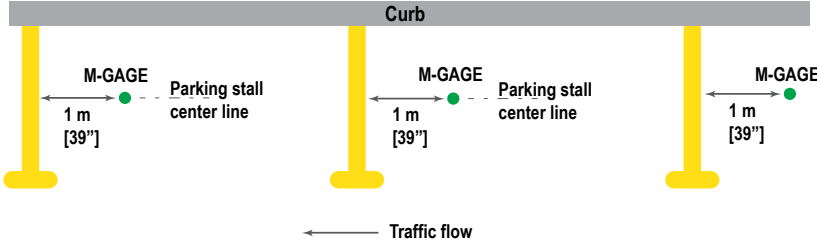
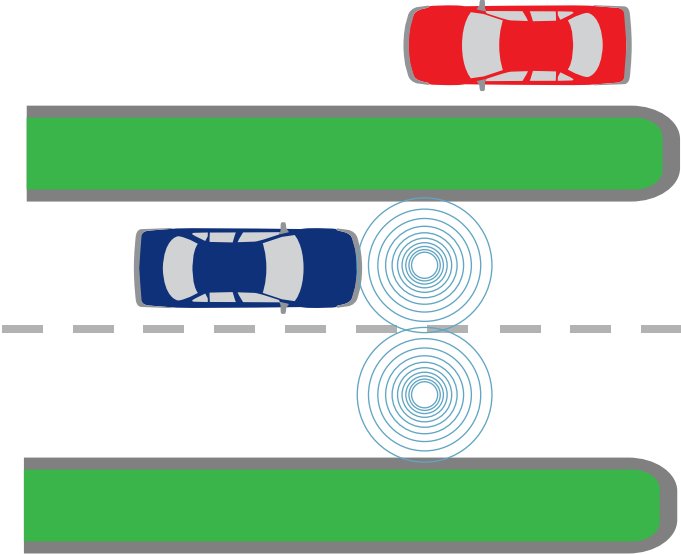
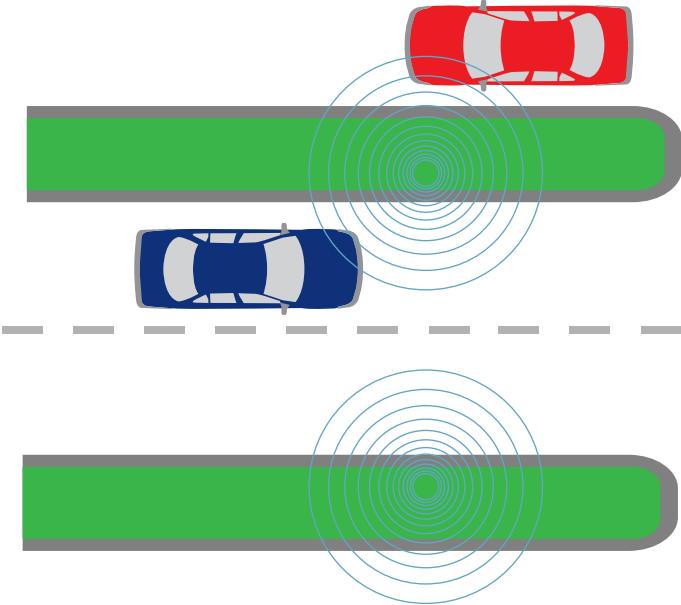


Figure 8. Optimum M-GAGE placement for traffic detection



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. 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 9. Poor M-GAGE placement for traffic detection



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

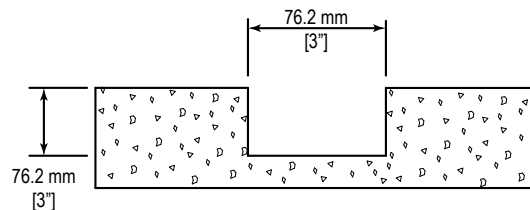
- Always wear proper eye protection when grinding or drilling.
- Gloves, hearing protection, and sturdy boots are highly recommended.
- Always read and follow all specific instructions and safety precautions provided by the manufacturer of all equipment.

Required equipment includes:

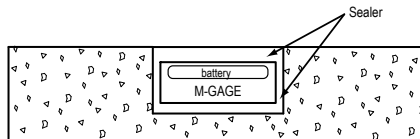
- 3" Coring equipment. Many options exist; choose what works best for the conditions of your installation site.
- Sealer. We recommend using a flexible, weather-proof liquid asphalt/concrete repair compound suitable for your needs. Banner Engineering used Fabick Protective Coatings joint sealers for test installations. Banner recommends Fabrick Pour-Pac™ MP-55. See www.fabick.com/sealants.html for more information.

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 0.25 inches of sealer into the hole.
6. Battery side up, place the M-GAGE into the hole and rotate until the internal antenna (black wire inside the housing) is facing the master radio location. Do NOT position so that the battery is between the antenna wire and the master radio. The top of the M-GAGE should be about 1.5 inches below the surface.
7. Verify the M-GAGE is communicating with its master radio.
8. 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.

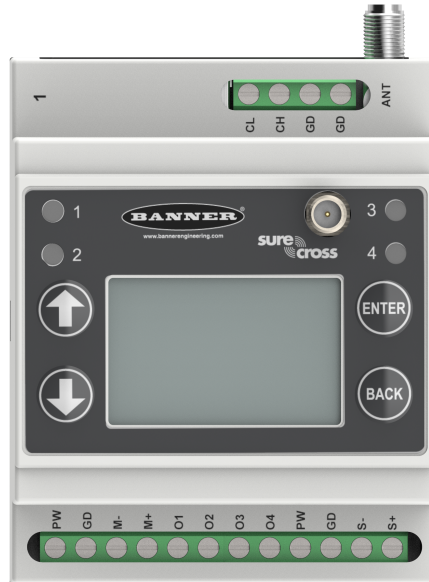


9. Repeat steps 5-8 for all M-GAGE Nodes.
10. Allow the sealant to set and harden. The M-GAGE Node is now properly installed.

Verify the M-GAGE Operation

Monitor the M-GAGE's performance using the DXM's Registers view.

Figure 10. Front view of a DXM700-Bx Controller



To verify the M-GAGE operation using the DXM's Registers view, follow these steps.

1. On the DXM: From the **Main** menu, select **Registers**.
2. View the **MG_1 Data** register.
This register displays the derived value of the M-GAGE sensor. The threshold for the application is 190. If the value in **MG_1 Data** is greater than 190, the output is active.