



M-GAGE™ Q7M Flat-Pak

Vehicle Detection Sensor

Features

- Capable of detecting vehicles that have stopped within the sensor's sensing field
- Flat-Pak sensor fits into a single 3/8" saw cut
- 3-axis magnetoresistive-based technology; senses 3-dimensional changes to the Earth's magnetic field caused by the presence of ferrous objects
- Easy sensor installation (see page 5); above- or below-ground mounting options
- Compact, robust one-piece, self-contained sensor package replaces inductive-loop sensing technology; no external controller needed
- Designed to minimize the effects of temperature swings and destabilizing magnetic fields
- Sensor learns ambient background and stores settings; sensor will not lose configuration or range when power is cycled



Models

Model	Cable*	Cable Type	Supply Voltage	Output Type	Range
Q7MB	2 m (6.5') cable	26 gage/5-wire shielded cable with 0.160" diameter polyethylene jacket	10 to 30V dc	Bipolar NPN/PNP**	Range varies, depending on application and target being sensed. See Figures 6 and 7
Q7MB W/15	5 m (15') cable				
Q7MB W/30	9 m (30') cable				
Q7MB W/50	15 m (50') cable				
Q7MB W/100	30 m (100') cable				
Q7MBQ	5-pin Euro-style QD pigtail, 150 mm (6")	26 gage/5-wire cable with PVC jacket			

* Other cable lengths are available – up to 60 m (200'); consult factory for more information. A model with a QD connector requires a mating cable; see page 8.

** Consult factory for other output options.



WARNING . . . Appropriate Use – Overhead Doors

The mechanical opening, braking, and reversing systems of the door will not respond in sufficient time to prevent moving trucks, cars, or material handling vehicles, even those traveling at low speeds, from coming in contact with the door. In addition, the detection zone of the product may fluctuate due to changes in the local magnetic environment. All vehicles should approach doors at speeds that allow the operator to ensure the door is operating properly and in an open position. **Failure to follow these procedures may result in serious injury or death.**



WARNING . . . Not To Be Used for Personnel Protection

Never use these products as sensing devices for personnel protection. Doing so could lead to serious injury or death. These sensors do NOT include the self-checking redundant circuitry necessary to allow their use in personnel safety applications. A sensor failure or malfunction can cause either an energized or de-energized sensor output condition. Consult your current Banner Safety Products catalog for safety products which meet OSHA, ANSI and IEC standards for personnel protection.

†U.S. patent #6,546,344 B1

M-GAGE™ Q7M Flat-Pak – Vehicle Detection Sensor

Overview

The M-GAGE Q7M Flat-Pak sensor uses a passive sensing technology to detect large ferrous objects. The sensor measures the change in the the Earth's natural magnetic field (ambient magnetic field) caused by the introduction of a ferromagnetic object.

The M-GAGE Q7M Flat-Pak sensor provides a direct replacement for inductive loop systems, and needs no external frequency box. Its unique design allows quick installation within a single 3/8" saw cut. For applications where pavement has not been poured, consider the M-GAGE S18M, which can be mounted or replaced without disrupting the pavement.

For best performance, mount the sensor below-grade, in the center of the traffic lane. The M-GAGE also may be mounted above-ground (see page 5).

Theory of Operation

The sensor uses three mutually perpendicular magnetoresistive transducers. Each transducer detects magnetic field changes along one axis. By incorporating three sensing elements, maximum sensor sensitivity is achieved.

A ferrous object will alter the local (ambient) magnetic field surrounding the object, as shown in Figure 1. The magnitude of this magnetic field change is dependent both on the object (its size, shape, orientation, and composition) and on the ambient magnetic field (its strength and orientation).

During a simple programming procedure, the Q7M sensor measures the ambient magnetic field. When a large ferrous object (for example, a truck, automobile, or rail car) 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 sensor's discrete outputs switch.

Sensor Field of View and Range

The sensor range depends on three variables:

1. The local magnetic environment (including nearby ferrous material)
2. The magnetic properties of the object to be sensed
3. Sensor settings

The Q7M can detect changes in the ambient magnetic field in all directions. As with other sensors, the range will depend on the target. The strong disturbance of a large ferrous object decreases as distance from the sensor increases, and the magnitude and shape of the disturbance is dependent on the object's shape and content.

The sensor can be programmed to react to magnetic field disturbances of greater or lesser intensity, using two adjustments: background condition and sensitivity level.

Once background condition and sensitivity level are set, and both settings are stored in non-volatile memory, the sensor is ready to detect the target object.

NOTE: The Q7 will continue to sense a vehicle in its sensing field, even when the vehicle is stopped.

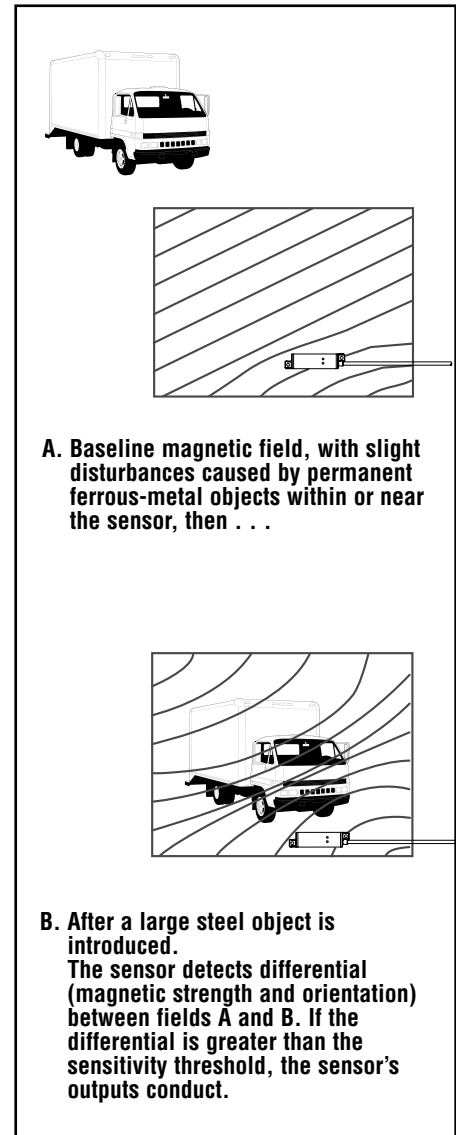


Figure 1. Magnetic detection overview

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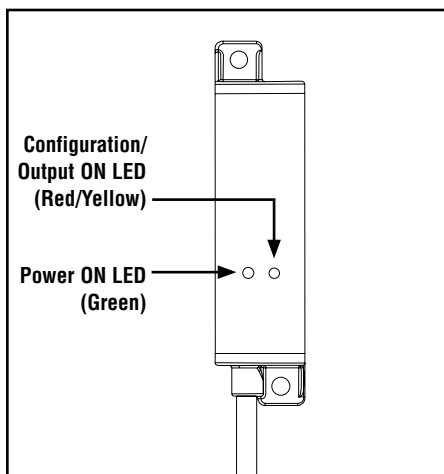


Figure 2. Sensor features

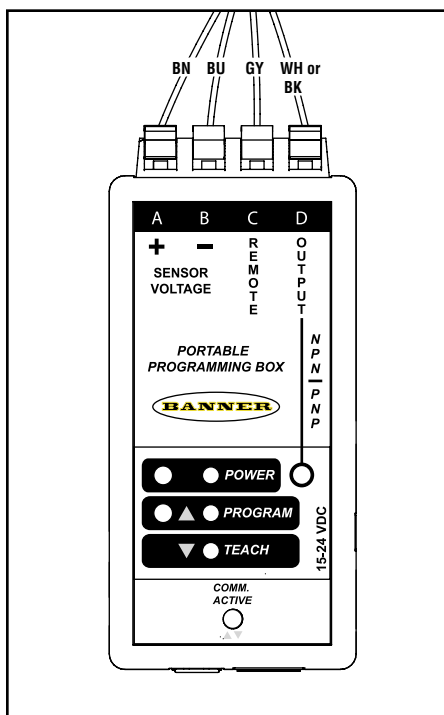


Figure 3. Connecting to the model DPB1 portable programming box

Sensor Configuration

The sensor is configured via its gray Remote wire. The gray wire is always active and the sensor may be re-taught at any time. **For optimum performance, fixture the sensor so that it will not move either during or following configuration.**

Programming pulses may be executed by connecting the sensor gray wire to sensor common (blue wire) with a normally open mechanical button connected between them, or as a low (< 2V dc) signal from a programmable logic controller (PLC), or using the model DPB1 Portable Programming Box, as shown in Figure 3. When a PLC is used for configuration, the pulses are acknowledged via the sensor output signal.

When the DPB1 is used, the pulses are accomplished by “clicking” the DPB1 TEACH push button (0.04 seconds ≤ “click” ≤ 0.8 seconds). Sensor output status is reflected by the DPB1 Output indicator LED.

Set Background Condition (No Vehicle Present) Connect M-GAGE sensor as described above.		
	Configuration (0.04 seconds ≤ “T” ≤ 0.8 seconds)	Result
Set Background	<ul style="list-style-type: none"> Remove all temporary metal objects from the sensing area. Single-pulse the remote wire. 	<ul style="list-style-type: none"> Sensor learns background. Output LED flashes approx. 12 times, while background is taught. Sensor returns to RUN mode.
Set Sensitivity Level (level 1 least sensitive, level 6 most sensitive)		
	Configuration (0.04 seconds ≤ “T” ≤ 0.8 seconds)	Result
Access Sensitivity Mode	<ul style="list-style-type: none"> Double-pulse the remote wire. 	<ul style="list-style-type: none"> Output LED flashes 1 to 6 times every 2 seconds to indicate sensitivity level (e.g., twice indicates level 2). When DPB1 is used: Sensor always begins at level 1.
Adjust Sensitivity	<ul style="list-style-type: none"> To increase the sensitivity in increments, single-pulse the remote wire again; continue until desired sensitivity level is reached. 	<ul style="list-style-type: none"> Output LED flashes 1 to 6 times every 2 seconds to indicate sensitivity level (e.g., twice indicates level 2).
	<ul style="list-style-type: none"> Double-pulse the remote wire to save setting. 	<ul style="list-style-type: none"> Sensor returns to RUN mode.
Test Operation	<ul style="list-style-type: none"> Drive a vehicle past/over the sensor to trip the output. (Use a small/lightweight vehicle to ensure larger vehicles will be detected later.) Adjust the sensitivity as needed. 	<ul style="list-style-type: none"> Verify Output LED comes ON as expected.
Prepare for Operation	<ul style="list-style-type: none"> Disconnect DPB1 or other temporary switch used for configuration and connect sensor to permanent power supply/output device (user-supplied; see page 8). 	

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Excess Gain vs Sensitivity Level (Assumes Level 5)	
Level	Excess Gain Multiplier
1 (least sensitive)	0.33
2	0.4
3	0.5
4	0.66
5*	1.0
6 (most sensitive)	1.3

* Factory default setting

Excess Gain

Typical Target Excess Gain Curves

Once the sensor has been securely mounted and is configured, it is ready to operate. The following two example applications show typical responses for the M-GAGE sensor.

Figure 4 (example 1) describes mounting the M-GAGE 1 meter above the ground to sense an automobile. The graph in Figure 4 shows the excess gain for a typical car. Excess gain is a measure of the amount of “extra” signal detected by the sensor over and above the level needed to detect the target. The table at left compares the change in excess gain if the sensitivity level changes.

If the sensitivity is at level 6, then the excess gain at a given distance would be 1.3 times larger than for a level 5 sensitivity. Conversely, if the sensitivity threshold is level 1, then the excess gain would be one third as big as for level 5.

Figure 5 (example 2) illustrates a typical vehicle passing over a sensor mounted underground. Note that excess gain is greatest when the bulk of the vehicle (the rear axle) is positioned directly over the sensor.

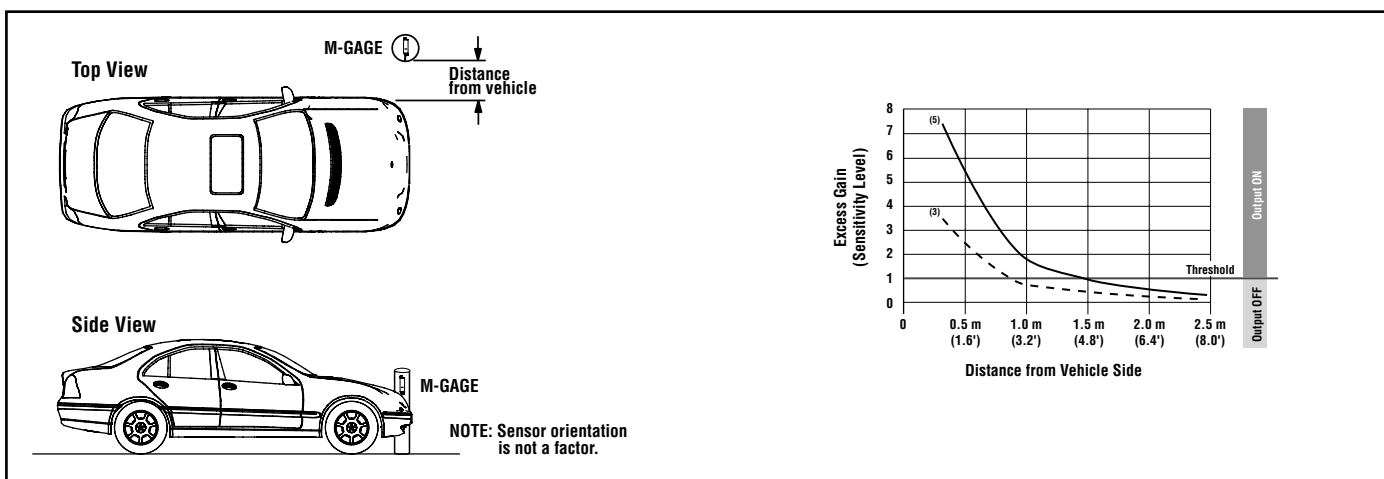


Figure 4. Application example 1: sensor mounted 1 meter (3.2') above ground

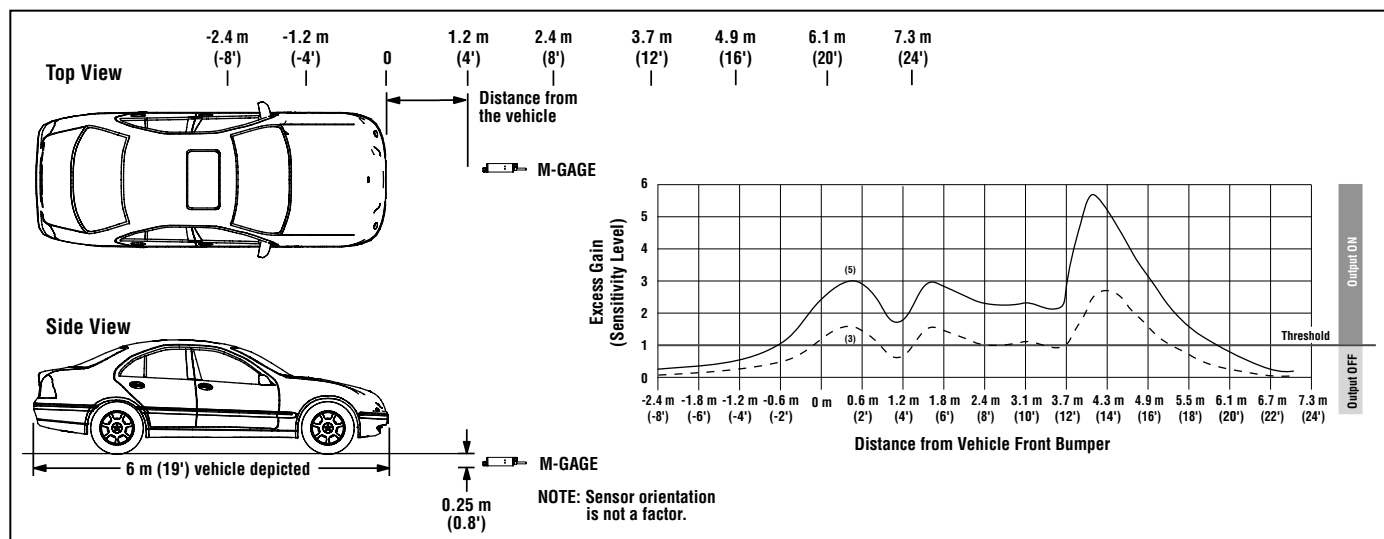


Figure 5. Application example 2: sensor mounted 0.25 meters (0.8') below ground

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Below-Grade Installation

Optimally, the Q7M Flat-Pak should be mounted in the center of the vehicle traffic lane (see Figure 8). The axles of the vehicles provide the most effective and most repeatable magnetic field changes. When replacing an inductive loop, the geometric center of the failed loop is typically a good location for mounting.

For applications at the “side” of the traffic lane, consideration must be made for movement of metallic objects within a few feet of the sensor on the side opposite the traffic lane, even if the activity is not visible (e.g., behind a wall, or inside a building). Consult a Banner Applications Engineer with any questions.

The M-GAGE Q7M Flat-Pak sensor’s narrow housing allows the sensor to be mounted in pavement, within a single 3/8" saw cut. The depth of the cut into the pavement is not critical; saw cut depths of 2" to 4" are typical. Consult Banner Engineering Applications if planning to install the sensor more than 24" below final grade. The sensor cable will fit into a slot as narrow as 1/4". If a blade smaller than 3/8" thick is used, make a “double-cut” where needed to accommodate the sensor width. Rebar or other metal embedded in the pavement will not affect the sensor’s performance.

CAUTION: Take care to avoid any utilities, including heated floors, when cutting into pavement or floors.

Use an air hose to remove loose particles and moisture from the saw cut. Lay the sensor and cable into the saw cut, with the cable extending back to the control cabinet. Fill the saw cut with loop or pavement sealant. **Do NOT fill the saw cut with heated asphalt.** Work the sealant around the sensor and cable with a thin object, to eliminate any trapped air gaps.

To remove the Q7M Flat-Pak, simply pull the sensor cable straight up, from the control cabinet end. This will pull the cable, the cured sealant and the sensor from the saw cut.

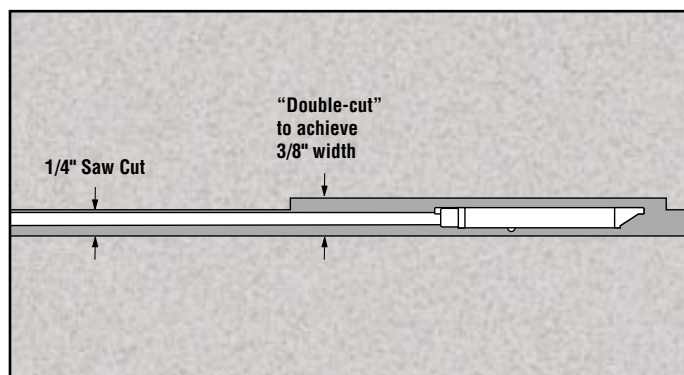


Figure 6. Sensor placed in saw cut in pavement

Above-Grade Installation

NOTE: For optimal performance in detecting vehicles, mount the M-GAGE below-grade, in the center of the traffic lane (see Figure 8). In applications where the sensor must be mounted to the side of the vehicle traffic lane (e.g., in a kiosk, menu board, or gate control box), make sure that no other moving metal objects can affect the M-GAGE sensor. Consult a Banner representative for further information.

The Q7M Flat-Pak is “non-directional”; the sensor can be mounted in any position.

For above-grade mounting, the end caps provide mounting holes at either end of the sensor. Select a location as close as possible to the vehicle(s) to be detected. Using the end cap mounting holes, mount to any desired surface (e.g., cement or metal).

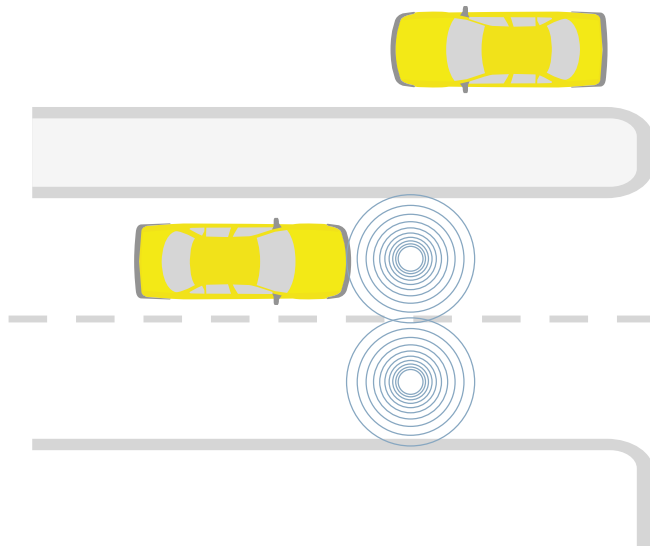
When mounting a QD-cable model, it is recommended to route the cable through conduit for protection from environmental conditions, but the integral cable needs no such protection.

TIP: Sensor may be mounted inside a non-ferrous architectural detail for cosmetic or security reasons. **It is important that, wherever it is mounted, the sensor is securely attached during configuration and all later use.** If the sensor moves after being tauged, detection errors may occur and sensor must be re-tauged. If a sensor appears to “lose its memory,” it may be a result of having shifted position after setup.



Figure 7. Above-ground installation, using the mounting holes in the sensor's end caps

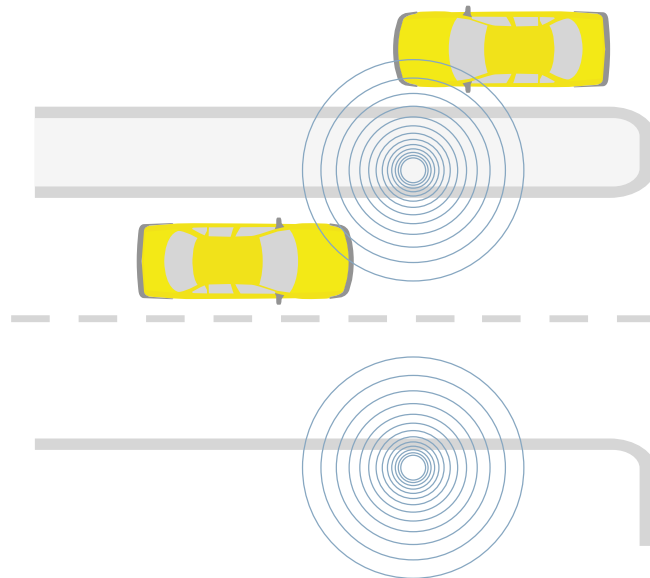
Installation Placement Considerations



Good Placement

The drawing at left shows the optimum placement of M-GAGE sensors for vehicle detection. When the sensor is positioned in the middle of the traffic lane, it can be configured to a lower sensitivity level and still detect vehicles in the lane of interest only. This is known as lane separation, or not detecting a vehicle in an adjacent lane.

A lower sensitivity 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" or less between vehicles.



Bad Placement


The drawing at left depicts a potential problem installation. While 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 sensitivity must be increased in order to see objects further away in the lane of interest. Unfortunately, this enables the sensor to also detect a lawn mower operating "behind" the sensor or vehicles in adjacent lanes, which will cause false counts.

Place the M-GAGE sensor at the edge of a traffic lane only if there is no possibility of other objects being detected by the sensor. A good rule of thumb: ensure that no vehicles will be within 10' of the sensor on the non-traffic side.

Figure 8. Examples of both good and bad sensor placement

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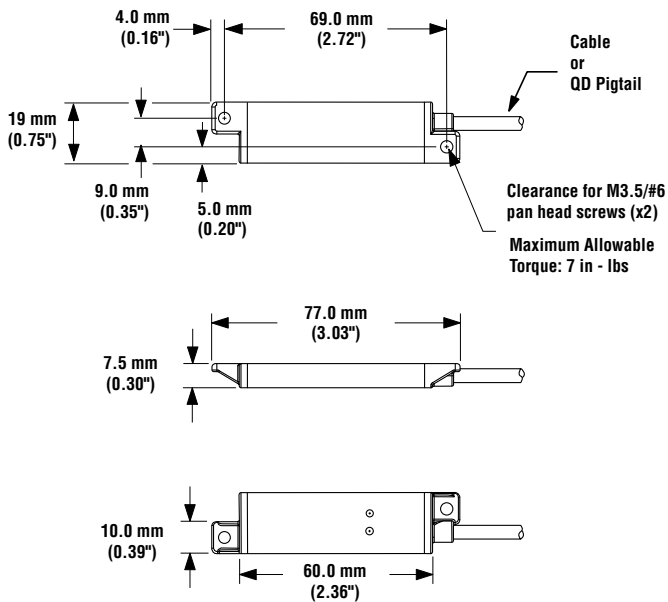
Specifications

Supply Voltage	10 to 30V dc (10% max. ripple) at 43 mA, exclusive of load Above +50° C, supply voltage is 10 to 24V dc (10% max. ripple)
Sensing Range	See Figures 4 and 5.
Sensing Technology	Passive 3-axis magnetoresistive transducer
Supply Protection Circuitry	Protected against reverse polarity and transient voltages
Output Configuration	Two SPST solid-state outputs conduct when object is sensed; one NPN (current sinking) and one PNP (current sourcing).
Output Protection	Protected against short-circuit conditions
Output Ratings	100 mA maximum (each output) NPN saturation: < 200 mV @ 10 mA and < 600 mV @ 100 mA; OFF-state leakage current: < 200 microamps PNP saturation: < 1.2V @ 10 mA and < 1.6V @ 100 mA; OFF-state leakage current: < 5 microamps
Output Response Time	20 milliseconds
Delay at Power-Up	0.5 seconds
Temperature Effect	< 0.5 milligauss/°C
Adjustments	Configuration of Background Condition and Sensitivity Level may be set by pulsing the gray wire remotely via the portable programming box (see page 3).
Indicators	Two Indicators (see Figure 2 and instructions on page 3): Power Indicator (Green) Configuration/ Output Indicator (Red/Yellow)
Remote TEACH Input	Impedance 12K ohms (low = < 2V dc)
Construction	Housing: Anodized aluminum End Caps: Thermoplastic polyester
Operating Conditions	-40° to +70°C (-40° to +158° F); 100% max. rel. humidity
Connections	Shielded 5-conductor (with drain) polyethylene jacketed attached cable or 5-pin Euro-style quick-disconnect PVC pigtail (see page 8 for quick-disconnect cable options)
Environmental Rating	Leak proof design is rated IEC IP69K; NEMA 6P
Vibration and Mechanical Shock	All models meet Mil. Std. 202F requirements method 201A (vibration: 10 to 60 Hz max., double amplitude 0.06", maximum acceleration 10G). Also meets IEC 947-5-2; 30G 11 ms duration, half sine wave.
Certifications	

Product protected by U.S. Patent #6546344B1

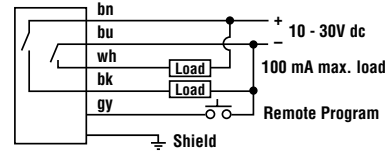
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Dimensions

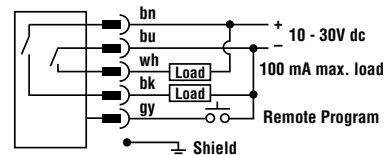


Hookups

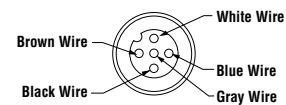
Cabled Model



Quick-Disconnect Model



Pin-Out



Quick-Disconnect Cables

Style	Model	Length	Connector	Style	Model	Length	Connector
5-Pin Euro, Straight with shield	MQDEC2-506 MQDEC2-515 MQDEC2-530	2 m (6.5') 5 m (15') 9 m (30')		5-Pin Euro, Right-angle with shield	MQDEC2-506RA MQDEC2-515RA MQDEC2-530RA	2 m (6.5') 5 m (15') 9 m (30')	

Accessories

DPB1	Handheld Portable Programming Box, used for configuring sensor. Battery-powered, with optional 115V ac power supply.	
111367	Optional 115V ac power supply for DPB1 Handheld Portable Programming Box	



WARRANTY: Banner Engineering Corp. warrants its products to be free from defects for one year. Banner Engineering Corp. will repair or replace, free of charge, any product of its manufacture found to be defective at the time it is returned to the factory during the warranty period. This warranty does not cover damage or liability for the improper application of Banner products. This warranty is in lieu of any other warranty either expressed or implied.