



Sensor Products Division

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Measurement Specialties, Inc.

Dear Traffic Professional,

Thank you for your interest in the Measurement Specialties Inc (MSI) family of **Roadtrax®** Traffic Sensors for *In the Road* and *Over the Road* applications. These sensors are being used for Weigh in Motion (WIM), vehicle classification and counting, speed detection, red light cameras, and parking area control.

Enclosed are the Product Specifications and Installation instructions for the **Roadtrax** BL Sensor. The BL Sensor (named for what it looks like - a Brass Linguini®!) is installed directly into a slot in the road. The sensor is only 1/16" thick and 1/4" wide (1.5mm x 6.5mm), but will provide 500 mV for a car. It is installed in a 3/4" x 3/4" (19mm x 19mm) slot in the road. Available in any length, it can be coiled for easy shipping and handling. These sensors reject road noise 10:1 and reduce ghost axles due to their flat design. This gives your electronics a clean easy to read signal that translates into more accurate count, speed, and WIM data. The BL Sensor is also now available in a Class I (Weigh in Motion) configuration. Both the Class I and the Class II sensors are available in a variety of different lengths from 6' to 13', with standard cable lengths of 100' or more (metric lengths of 2 m to 5.5m, with cable lengths standard from 35m to 100m). These sensors are directly compatible with all counters and WIM Systems which have a piezoelectric input.

MSI **Roadtrax** sensors are in the field on a global basis. Collectively, they have performed in an exemplary manner, giving unrivaled accuracy and dependability. They have the highest signal to noise ratio of any of the sensors on the market today.

We are dedicated to working with you to ensure you have the right product to fully fit your needs. We can assist you in preparing for the installation of the sensors, to ensure that this goes smoothly. We are committed to making the **Roadtrax** traffic sensors the best in the world. We appreciate the opportunity to work with you on your traffic data collection needs, and to assist you in making your job easier, safer and at the best cost.

Please give me a call if you have any questions. I would be happy to provide you with any further information or to quote you for your specific requirements. We now have an installation video available - just give us a call and we will send you a copy.

Sincerely,

Donald Halvorsen

Donald L. Halvorsen

Director, Business Development

Sensor Products Division

The MSI Roadtrax® Brass Linguini® axle sensor ... and why it's the best sensor for you!!

Great Signal

- ✓ Positive signal as tires pass over the sensor
- ✓ High output - detects small vehicles - motorcycles, even bicycles
- ✓ Good dynamic range - can work with large to small vehicles
- ✓ Reduced Bow Wave
- ✓ Reduced Road Flexing noise
- ✓ High Signal to Noise Ratio for ease of signal processing
- ✓ High capacitance - can drive long cables
- ✓ Works even for slow speeds

Easy to handle

- ✓ Conforms to any road profile
- ✓ Stiff enough not to droop
- ✓ Coils in a 2'x2' (600x600mm) box
- ✓ Rugged so that it does not break in handling

Easy installation

- ✓ Installs in a 3/4" x 3/4" (19 x 19mm) cut in the road to minimize damage to the road
- ✓ Installs with fast curing grout or acrylic
- ✓ No need for the heaters
- ✓ Smaller cut means less encapsulation material - a 6' BL sensor only uses under 1/2 gallon (2m sensor uses less than 1.5 liters)

Quality

- ✓ Sensors 100% tested for capacitance and insulation resistance, and then impacted every 1/4" (6mm) along the length of the sensor to determine the activity and uniformity of the sensor.
- ✓ Computerized process controls for the extrusion and polarization of the cable
- ✓ All data electronically archived
- ✓ All sensors Serial Numbered for traceability

Durability

- ✓ Triple sealed coax splice between the sensor and the passive cable
- ✓ The sensor will not be damaged by bending to a radius of > 1' (300mm)
- ✓ Will withstand normal handling without tender loving care
- ✓ Tested to 40 Million Equivalent Single Axle Loadings

Versatility

- ✓ Same sensor for over and in the road applications
- ✓ Surface sensors can be mounted permanently or temporarily
- ✓ Can be used in Portland Cement or Asphalt
- ✓ Several encapsulation techniques can be used - Grout, acrylic, or filled grout

Great Passive cable

- ✓ Super tough High Density Poly Ethylene (HDPE)
- ✓ Rated as Waterproof for direct burial
- ✓ Low capacitance - 27 pF/foot (89 pF/m)
- ✓ Lengths from 100' to 300' (35-100m) standard - longer lengths on a custom basis

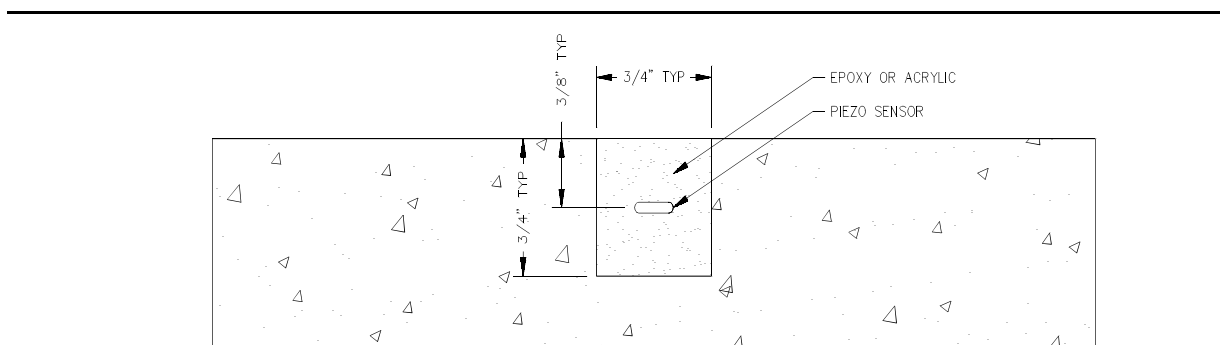
Customer Support

- ✓ Fast delivery - Units in stock
- ✓ Any length - 6', 8', 9', 10', 11', 12', and 13' - with a standard of 100' of passive cable but with the option of any length in multiples of 50'
- ✓ Now available in metric lengths - 2.5, 3.0, 3.5, 4.0, 4.5, 5.0 and 5.5 meters, with standard cable lengths of 35, 50, 75 and 100 meters
- ✓ Installation clips included with all sensors
- ✓ Installation instructions available on request
- ✓ Available Internationally
- ✓ On site installation training available

PRODUCT DESCRIPTION

The Roadtrax BL Traffic Sensor is designed for Permanent or Temporary installation into or onto the road surface for the collection of traffic data. The unique construction of the sensor allows it to be installed directly into the road in a flexible format so that it can conform to the profile of the road. The flat construction of the sensor gives an inherent rejection of road noise due to road bending, adjacent lanes, and bow waves for approaching vehicles. The small cut in the road minimizes the damage that is done to the road, speeds up the installation and reduces the amount of grout that is used for the installation. The Roadtrax BL sensor is available both as a Class I sensor for the highest level of uniformity needed for Weigh in Motion applications and as a Class II sensor which is more cost effective for Counting, Classifying, High speed Toll Booths, Speed Detection, and Red Light Cameras.

- Uniform, **high amplitude** piezoelectric output **compatible with existing** counters and classifiers on the market.
- **Excellent Signal to Noise Ratio** which has an inherent **10:1 rejection** of road noise due to road bending, adjacent lanes and bow waves of approaching vehicles.
- **Easy installation** in a 3/4" x 3/4" (19 x 19mm) slot, which minimizes the disturbance of the road, decreases the depth of the road cut, and minimizes the amount of grout needed.
- **Flexible sensor** - conforms to any road profile while maintaining a uniform distance to the road surface.
- The **final installation is flush** with the road surface - snowplows will not do damage to the sensor.
- **Durable** enough to withstand normal installation handling and **hundreds of millions ESAL's**.
- All sensors are **100% tested and certified** for performance as a complete sensor prior to shipment.
- Custom Passive Signal Cable with **High Density Poly Ethylene Jacket** which is rated for direct burial and resists nicks and cuts.



Permanent In the Road Installation

Performance Characteristics	
Output Uniformity	< $\pm 20\%$ for Class II (Classification) < $\pm 7\%$ for Class I (Weigh in Motion)
Operating Temperature Range	- 40 to 160 °F (-40 to 70 °C)
Temperature Sensitivity	0.2%/°F typ, dependent on the grout used
Typical Output Level	A wheel load of 400 pounds will produce a minimum output signal of 250 mV, at 70 °F and 55 mph for a proper installation
Passive Signal Cable	RG 58C/U with a High Density Polyethylene Outer jacket that is rated for direct burial; 3/16" (4.75mm) OD
Product Life	40 Million ESAL's; dependent on the installation
Capacitance	See Chart
Weight	See Chart
Insulation Resistance	> 500 M Ω
Packaging	All sensors are packages two to the box in a 24"x20"x3"(600x550x75mm) corrugated cardboard box
Installation Brackets	Included. One bracket is used every 6" (150mm)

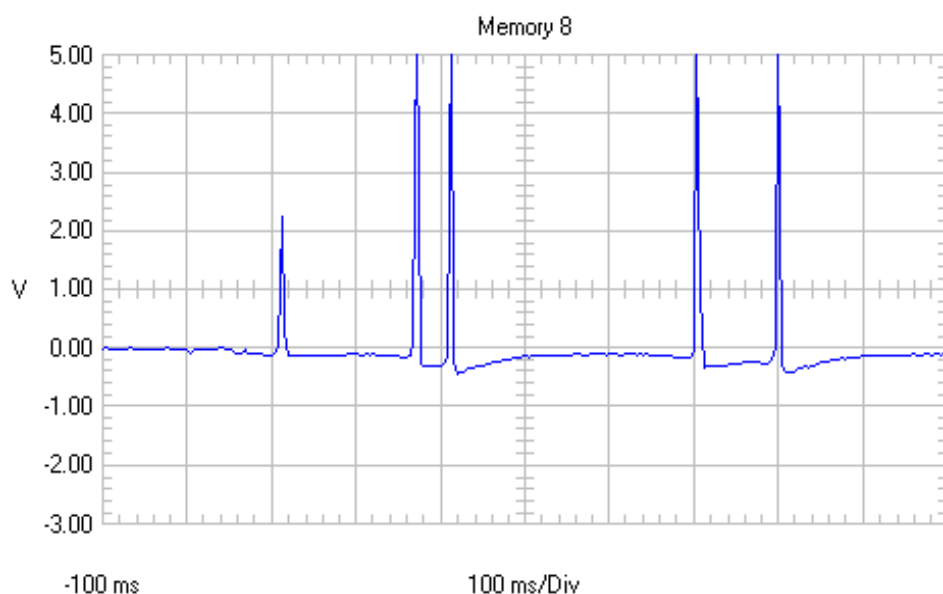
Specifications:

The MSI BL Traffic sensor has the following specifications:

1. Center Core: 16 gauge, flat, braided, silver plated copper wire.
2. Piezoelectric Material: Highly compressed piezoelectric copolymer, P(VDF-TrFE)
3. Outer Sheath: 0.016" thick brass, CDA-260, ASTM B587-88
4. Final Dimensions: 0.260" wide x 0.063" thick; ± 0.005 "
5. Insulation resistance between core and shield: > 500 M Ω .
6. Linear Capacitance of sensor: 1.1 nF/ft, $\pm 20\%$
7. Piezoelectric Coefficient: ≥ 20 pC/N.
8. Passive Signal Cable: RG 58 type with a underground/direct burial rated outer jacket. The OD of the cable is 0.187" (4.75mm). The nominal capacitance of the cable is 27 pF/ft (89pF/m).
9. Sensors are packaged 2 per box. The box size is 24"x20"x3" (600x550x75mm).
10. Installation brackets are included with the sensors. 1 bracket per 6" (150mm) of sensor length.

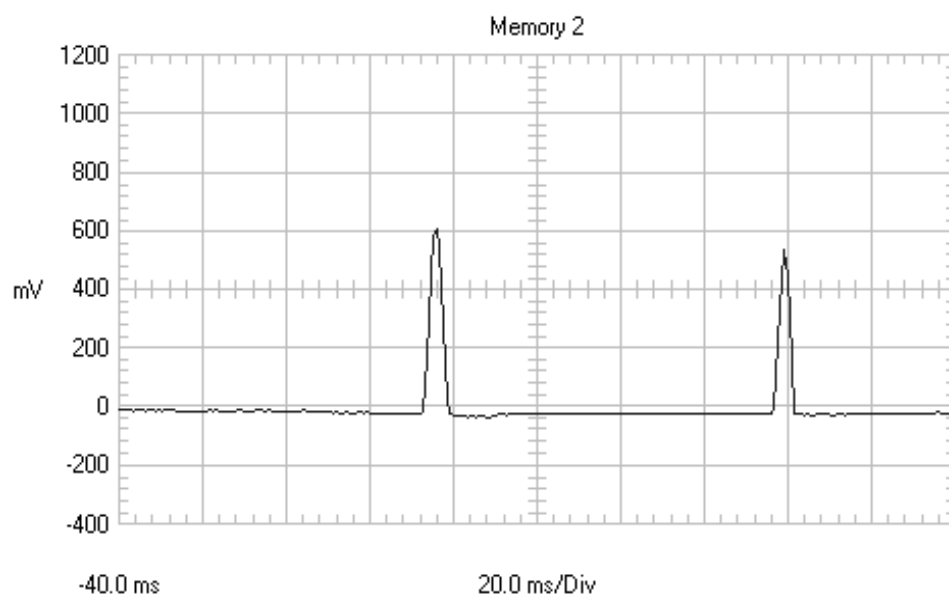
Sensor Length	Sensor Classification ¹	Capacitance with 100' cable ²	Weight ³ pounds (kg)	Visible Brass Length	Installed Length ⁴	Part Number ⁵
6' (1.82m)	Class II	9.4 nF	2.75 (1.25)	70" (1.78m)	76" (1.93m)	0-1005333-Y
8' (2.42m)	Class II	11.7 nF	2.80 (1.27)	94" (2.38m)	100" (2.54m)	1-1005333-Y
9' (2.73m)	Class II	12.85 nF	2.85 (1.30)	106" (2.69m)	112" (2.85m)	2-1005333-Y
10' (3.03m)	Class II	14.0 nF	2.90 (1.32)	118" (3.00m)	124" (3.15m)	3-1005333-Y
11' (3.33m)	Class II	15.15 nF	2.95 (1.34)	130" (3.30m)	136" (3.45m)	4-1005333-Y
12' (3.64m)	Class II	16.3 nF	3.00 (1.36)	139" (3.53m)	145" (3.68m)	5-1005333-Y
13' (3.94m)	Class II	17.45 nF	3.05 (1.39)	154" (3.91m)	160" (4.06m)	6-1005333-Y
6' (1.82m)	Class I (WIM)	9.4 nF	2.75 (1.25)	70" (1.78m)	76" (1.93m)	1-1005438-Y
8' (2.42m)	Class I (WIM)	11.7 nF	2.80 (1.27)	94" (2.38m)	100" (2.54m)	2-1005438-Y
9' (2.73m)	Class I (WIM)	12.85 nF	2.85 (1.30)	106" (2.69m)	112" (2.85m)	3-1005438-Y
10' (3.03m)	Class I (WIM)	14.0 nF	2.90 (1.32)	118" (3.00m)	124" (3.15m)	4-1005438-Y
11' (3.33m)	Class I (WIM)	15.15 nF	2.95 (1.34)	130" (3.30m)	136" (3.45m)	5-1005438-Y
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13' (3.94m)	Class I (WIM)	17.45 nF	3.05 (1.39)	154" (3.91m)	160" (4.06m)	7-1005438-Y
2.0m (6'7")	Class II	9.63 nF	2.75 (1.25)	1.98 m (78")	2.14 m (84")	1-1005528-Z
2.5m (8'3")	Class II	11.27 nF	2.85 (1.30)	2.48 m (98")	2.64 m (104")	2-1005528-Z
3.0m (9'11")	Class II	12.9 nF	2.95 (1.35)	2.98 m (117")	3.14 m (123")	3-1005528-Z
3.5m (11'6")	Class II	14.5 nF	3.05 (1.40)	3.48 m (137")	3.64 m (143")	4-1005528-Z
4.0m (13'2")	Class II	16.2 nF	3.15 (1.45)	3.98 m (157")	4.14 m (163")	5-1005528-Z
4.5m (14'10")	Class II	17.8 nF	3.25 (1.50)	4.48 m (177")	4.64 m (183")	6-1005528-Z
5.0m (16'6")	Class II	19.5 nF	3.35 (1.55)	4.98 m (196")	5.14 m (202")	7-1005528-Z
5.5m (18'2")	Class II	21.1 nF	3.45 (1.60)	5.48 m (216")	5.64 m (222")	8-1005528-Z
2.0m (6'7")	Class I (WIM)	9.63 nF	2.75 (1.25)	1.98 m (78")	2.14 m (84")	1-1005527-Z
2.5m (8'3")	Class I (WIM)	11.27 nF	2.85 (1.30)	2.48 m (98")	2.64 m (104")	2-1005527-Z
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5.5m (18'2")	Class I (WIM)	21.1 nF	3.45 (1.60)	5.48 m (216")	5.64 m (222")	8-1005527-Z

- 1 Class II sensors have a uniformity of $\leq \pm 20\%$ and are typically used for Classification purposes. Class I sensors have a uniformity of $\leq \pm 7\%$ and are typically used for Weigh in Motion applications.
- 2 All capacitance values are $\pm 20\%$. Additional cable has a capacitance of 27 pF/ft (89 pF/m) or 2.7 nF/100' (2.2 nF/25m).
- 3 All sensors are packaged 2 per box. The box weighs 1.5 lbs (0.7 kg).
- 4 This length refers to the installed length of the sensor. This is the minimum lane width for the installed sensor.
- 5 The suffix refers to the cable length. Cable lengths for -Y are as follows: -1 @ 100', -2 @ 150', -3 @ 200', -4 @ 250', -5 @ 300'. Cable lengths for the -Z are as follows: -1 @ 35m, -2 @ 50m, -3 @ 75M, and -4 @ 100m.



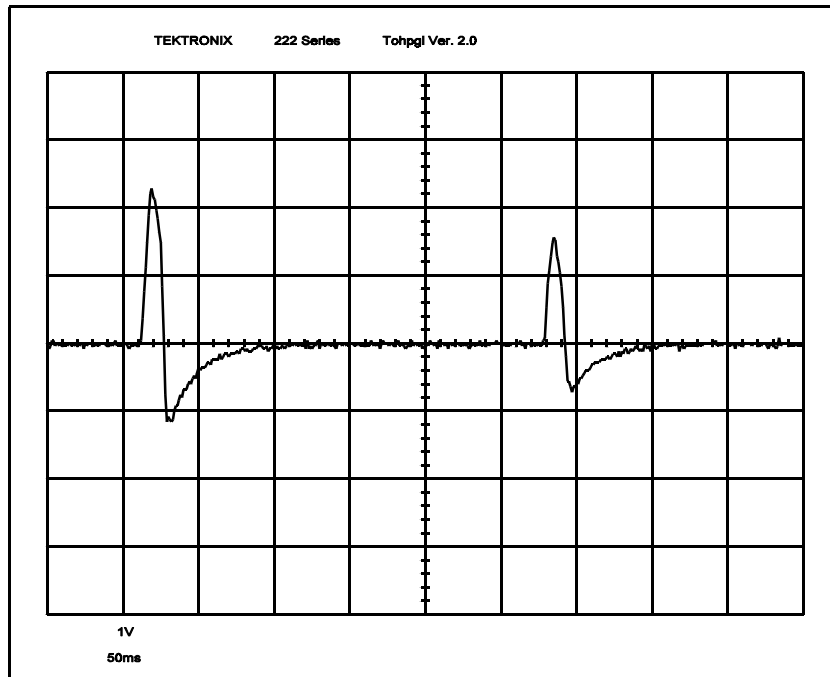
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Date	= 5/20/97
Time	= 8:55:43 PM
Y Scale	= 1.00 V/Div
Y At 50%	= 1.00 V
X Scale	= 100 ms/Div
X At 0%	= -100 ms
X Size	= 250 (256)
Maximum	= 5.60 V
Minimum	= -0.44 V

AMP BL, I35n, brick truck, 6n



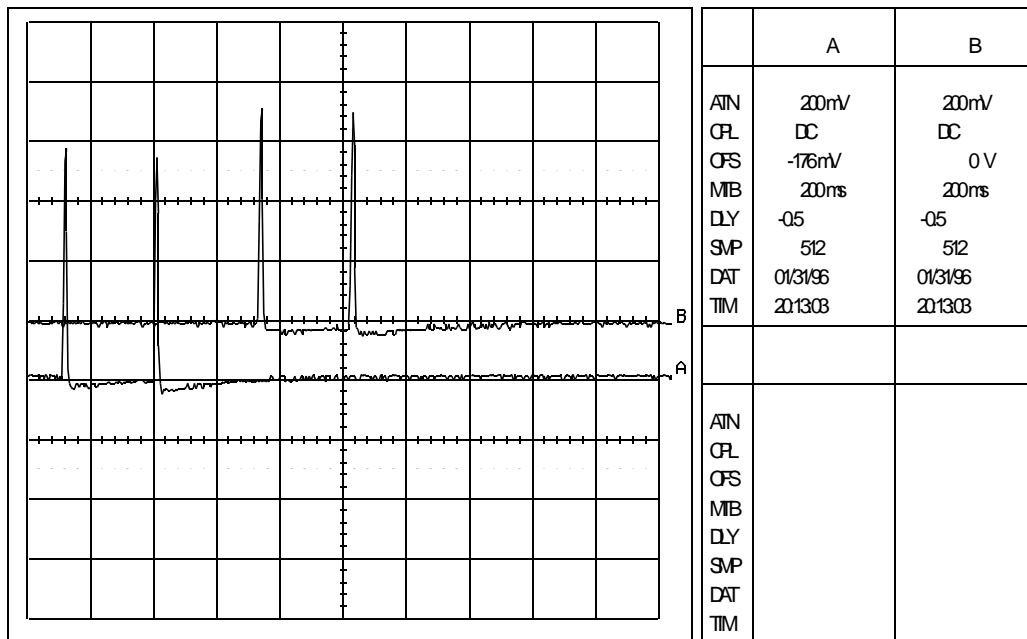
Datablock	
Name	= Memory 2
Date	= 6/14/97
Time	= 9:13:37 AM
Y Scale	= 200 mV/Div
Y At 50%	= 400 mV
X Scale	= 20.0 ms/Div
X At 0%	= -40.0 ms
X Size	= 250 (256)
Maximum	= 608 mV
Minimum	= -40 mV

AMP BL, A74 (England) 12' Sensor, Global 768, Car



Roadtrax BL Sensor taped to the road. 12' long with 100' passive cable. Chevy Caprice \approx 25 mph. 4/25/96. 1V/div vertical scale; 50 msec/div horizontal.

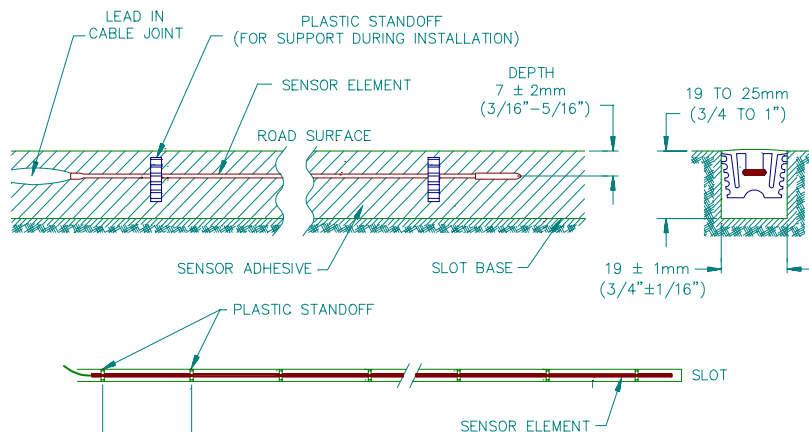
vicoraid bl, ford falc



Roadtrax BL Sensor installed in an asphalt road using grout. 200mV/div vertical scale, 200 msec/div horizontal scale. 12' sensor with 100' cable. Mid sized car at 35 mph.

**Read these instructions completely
PRIOR TO INSTALLATION**

Approved Installation Grouts: E-Bond G-100,
ECM P5G, Global Resin PU 200, IRD AS475



1. Carefully mark the slot to be cut, perpendicular to the flow of traffic. Ensure that the sensors are properly positioned in the lane. Shorter sensors are positioned to one side; longer sensors are typically centered on the lane.
2. Cut a slot $\frac{3}{4}$ " wide ($\pm 1/16$ ") and $\frac{3}{4}$ " deep (-0 ", $+1/4$ "). (19 mm wide, ± 1 mm, 19 to 25 mm deep). The slot should be ≈ 6 " (150 mm) longer than the sensor. The lead out should be centered on the slot.
3. It is strongly recommended that a $\frac{3}{4}$ " (19mm) wide diamond blade be used for cutting the slot, or that blades be ganged together to get a single $\frac{3}{4}$ " (19mm) wide cut. The slot should be wet cut to minimize damage to the road.
4. Drill a $\frac{1}{2}$ " (12mm) hole at a 45° angle into the bottom corner about every foot (300mm) along the length of the slot, alternating between the two sides of the slot.
5. Sweep and wash out the debris left in the slot and ensure it is clean and dry.
6. Use high pressure water, or water and compressed air to clean ALL foreign matter out of the slot and 6" (150 mm) on all sides of the slot. Remove all excess water and debris with a vacuum cleaner and/or sweeping.
7. Carefully dry the slot using torches, torpedo heaters, electric heaters, or natural evaporation, depending on weather conditions. Be very careful not to burn the asphalt if a torch is used.
8. Place a strip of duct tape along the pavement next to the slot. Cover out to about 3-4" (75-100mm) on either side of the slot for the full length of the slot.
9. Lay the sensor on the tape next to the slot. Ensure that the sensor is straight and flat. Place the clips on the sensor, about every 6" (150mm). DO NOT place the sensor in the slot at this point, as the clips are one way and it will be difficult to remove the sensor prior to putting in the grout.
10. Block off the ends of the slot using plumbers putty. Ensure that there are adequate 'dams' at both ends so that the encapsulation material does not flow out. On the passive cable end, the dam should be about 3-5" (75-125mm) past the end of the lead attachment area.
11. Test the sensor for Capacitance, Dissipation Factor and Resistance, according to the directions enclosed. Record the test results and the sensor serial number. This information should be stored in the counter cabinet or returned to a data storage file.
12. Mix the grout or acrylic according to the manufacturers instructions. Be sure to pre-mix the resin before combining the two parts since the filled materials have a tendency to settle. Fill the slot full of the encapsulation material. Using a trowel, distribute the encapsulation material along the sensor, and smooth it out.
13. Ensure that you are wearing protective plastic or rubber gloves. Place the sensor in the slot, with the brass element about $\frac{1}{4}$ " (6mm) below the road surface, and the top of the brackets about $\frac{1}{8}$ " (3mm) below the road surface. Ensure the ends of the sensors are pushed down sufficiently. Smooth out the grout on top of the sensor, ensuring there is not a trough on top.
14. Remove the tape on the sides of the sensor as soon as the adhesive starts to cure.
15. Carefully remove the plumbers putty (if used to form dams at each end) from both ends of the sensor.
16. Route the lead in cable through the slot cut for it, and cover with loop sealant or grout. NOTE: Hot Tar should not be used since the temperature is difficult to control and it can burn the cable.
17. Grind the top of the sensor using an angle grinder. The profile should be flat or with a slight 'mound', provided that there is no concave portion to the curve.
18. Clean up the site. When the encapsulation material is fully cured, it may be opened to traffic. Failure to wait for the encapsulation material to fully cure may ruin the installation and cause it to fail prematurely.

Important Notes and Hints:

- The quality of the road will affect the quality of the data. The roads should conform to ASTM specifications for Weigh in Motion applications.
- Diamond blades should be used on the road saw. The tolerance for the cut is 11/16" to 13/16". A 3/4" diamond blade is recommended for cutting the slot. Do not try to do two independent cuts as it is very difficult to achieve this level of accuracy.
- Wet cutting is preferred to dry cutting. The dry cutting forces particles into the side walls of the slot which are very difficult to thoroughly clean. This residue will diminish the adhesion of the adhesive to the road, potentially allowing for the premature failure of the sensor.
- The passive cable length should not exceed 300' without consulting the manufacturer. It is **STRONGLY** recommended that the sensors be ordered with sufficient cable to avoid splices. If splices are needed, only similar grade of RG-58 cable should be used, the splices must be soldered, and an approved splice kit used to waterproof the splice. MSI Sensors is not responsible for any problems arising from splicing the cable.
- Disposable gloves must be worn when working with the encapsulation material. Appropriate precautions should be taken, according to the encapsulation material manufacturer's instructions. Ensure you read and follow all safety instructions.
- Adequate traffic control is essential. Do not put any of your workers at risk.
- Ensure that the sensor is placed in the correct location on the road. Six foot sensors should be positioned in a wheel path, **NOT** in the center of the lane.
- Care should be taken when mixing the encapsulation material to minimize the amount of trapped air in the material. Do not lift the mixing paddle out of the encapsulation material while the mixing head is spinning. Stop the blade and then use a stirring paddle to scrape the edges of the can.
- If heaters are needed to speed the curing process for the grout, extreme care should be taken to ensure that the sensors are not destroyed. The maximum temperature that the sensors can withstand is 170°F!. An A-Frame should be constructed out of metal or plywood, and placed over the sensor. Warm air from a torpedo heater should be blown in horizontally into the A-Frame, but **NEVER** aimed directly at the sensor. The air temperature at the sensor location should not be higher than what can be tolerated by your hand for 20-30 seconds. If it is hotter than this, the sensor will lose its piezo activity and will not function.
- Once the sensor is installed and the grout is cured, it is recommended that any excessive grout be ground off, using an angle grinder. The best installation has the grout flush with the road surface to minimize any chance of the tires bridging over the sensor.
- Thin walled plastic tubing may be used to contain the home run cable. In the unlikely event that the sensor needs to be replaced, the passive cable can then be pulled through the tubing, thereby eliminating the need for recutting the home run slot.
- Read all of the directions carefully and completely prior to the installation. Ensure that you have all of the required equipment available. If there are any questions on the installation, call MSI Sensors and we will be happy to 'walk' you through the procedures.

Required/recommended tools and materials

- MSI BL Sensors with installation brackets. Sensors should be ordered with sufficient passive cable to go all the way to the control cabinet.
- Installation instruction. Read these instructions prior to the installation. There may need to be some adaptation of these instructions based on local conditions.
- Sensor support brackets. These are shipped in the box with the sensors.
- Installation encapsulation. See Recommended materials under frequently asked questions. Approximately ½ to 1 gallon (1.5 to 3 liters) of material is needed per sensor. The slot must be carefully cut in order to ensure that it is not too deep; otherwise excessive material is used. Read, understand and follow the directions supplied by the manufacturer of the installation encapsulation. Adhere to the temperature limits imposed on the material to ensure adequate drying time is available. Follow all recommended safety precautions.
- Loop sealant material, to cover the homerun cables. Amount used will depend on the length and width of the homerun cuts. Hot tar can only be used if the homerun cables are enclosed in conduit. The hot tar will destroy the passive signal cable if it is allowed to come into direct contact with the cable. Extreme care must be taken if using hot tar.
- Thin wall tubing for homerun cables. Minimum 3/8" (9mm) ID, flexible tubing. Materials for this tubing are typically flexible PVC or polyethylene. Sufficient quantity for all homeruns from the end of the sensors to the cabinet.
- PVC pipe, 2-3" (50-75mm) dia. For use as conduit for any underground runs from junction boxes to cabinets.
- PVC solvent and joints - as needed for any splices in the pipes.
- Wet cutting pavement saw. A self-propelled saw of at least 35 hp, fitted with a 14" (350mm) or larger blade. This saw must be capable of cutting a 3/4" wide x 1" deep (19mm wide x 19-25mm deep) cut in a single pass.
- Diamond Blades for the saw. Appropriate type for the pavement being cut. The Piezo sensor needs a cut 11/16" to 13/16" (19mm ± 1mm) wide, 1" (25mm) deep slot cut in the road in a single pass. Although this can be done by cutting two parallel slots and chiseling out the center material, it is highly recommended to do this in a single pass to save time and to ensure greater accuracy of the cut. If a single blade is not available, multiple blades can be put together to form a dado blade. A 3/8" (9mm) and a 1/4" (6mm) blade, with a 1/16" (2mm) spacer between them performs very well. Additional blade widths are necessary for cutting the slots for the tubing for the homerun cables.
- Large capacity air compressor with hose and nozzle - for blowing out the slot and drying the area after the cut.
- Trenching equipment as required for burying the conduit to the control cabinet.
- Power washer or high pressure water hose - for washing out the slot.
- Water - for saw and for washing out the slot
- Broom - Street broom type with stiff bristles for general cleanup.
- Slow speed electric drill with mixing paddle
- Additional mixing blade if a 2 part loop sealant is used. There should not be cross contamination of the grout used for the piezo and the loop sealant material.
- Wire Brush and/or bristle brush - for cleaning out the slot after cutting and during washing.
- 3" or 4" (75-100mm) putty knife for use with the grout
- Small pointed trowel for putting the grout into the slot.
- Wire Strippers. Knife type blade strippers, such as Ideal Tools Stripmasters should be used due to the toughness of the HDPE jacket on the sensor homerun cable.
- Cleaning Materials for hands and equipment. The citrus hand cleaner works well. Include lots of paper towels.
- Angle Grinder with appropriate grinding wheel for smoothing out the grout after the installation.
- Hammer and masonry chisels. May be required for chipping corners, etc.
- Disposable gloves (rubber dishwashing gloves work much better than the latex or plastic gloves)
- 2" (50mm) duct tape. Enough for twice the length of all the sensors. Used to keep excessive grout off the road next to the slot during installation.
- Plumbers putty or duct seal to form dams at the end of the grout
- Straight edge
- Tape measure - at least 20' (6m) long
- Pavement crayons
- Chalk line
- Pavement paint
- 1/8" (3mm) diameter cord or rope for use in laying out the lines
- Hammer drill and ½" (12mm) concrete bit
- LCR Meter, such as a BK 875A, to check and measure Capacitance and Resistance of the sensors before and after installation.
- Oscilloscope. Although not essential, it is the only instrument that will give a complete verification that the sensors are fully functioning when the installation is complete. If reliable power is not available on the site, a battery operated oscilloscope should be used, such as the Fluke Scopemeter.
- Generator if electrical power is not available on site. Verify the electrical load of the tools being used compared to the capacity of the generator.
- Appropriate traffic control, as required by local regulations and appropriate safety guidelines
- Safety equipment required for workers. Safety helmets, safety glasses, reflective vests, etc, as required.
- Not included in this list are materials required for inductive loops (if used), control cabinets, junction boxes, and other off the road work.

Sensor Testing:

The piezoelectric sensors should be tested prior to and after installation. Because of the high costs of installation compared to the cost of the sensor, it is imperative that the sensors be checked out prior to putting them into the road to determine if any damage has been done to the sensor during shipping and handling. The following tests should be done prior to installation:

Equipment needed: LCR meter, such as a BK Instruments 875A.

1. **Capacitance:** Measure the capacitance of the sensor with the attached lead in cable. This should be within the range as per the product data sheet for that length sensor and passive cable. The meter should typically be set on a 20nF range. The red probe should be connected to the center electrode of the cable and the Black probe to the outer braid. Make sure that your hands are not holding across the two connections.
2. **Dissipation Factor:** With the capacitance set on the scale indicated above, switch the meter over to Dissipation Factor. The reading should be less than 0.04.
3. **Resistance:** Measure the resistance across the sensor. The meter should be set on the 20MΩ setting. The meter should read in excess of 20MΩ, which is typically displayed with a '1'.

Testing after installation:

Once the sensor is installed and the grout has cured, retest the sensor according to the instructions above. In addition, it is recommended that an oscilloscope be connected to the sensor and typical waveforms be collected for a truck and a car. These should then be printed out and saved for permanent records. The output of the sensor will depend on the type of the installation, sensor length, cable length and grouts used for the installation. Typical settings for the scope would be 200 mV/div for a voltage setting and 50 msec/div for a time setting. The trigger should be set at about 50 mV for a positive going signal.

Sensor Maintenance:

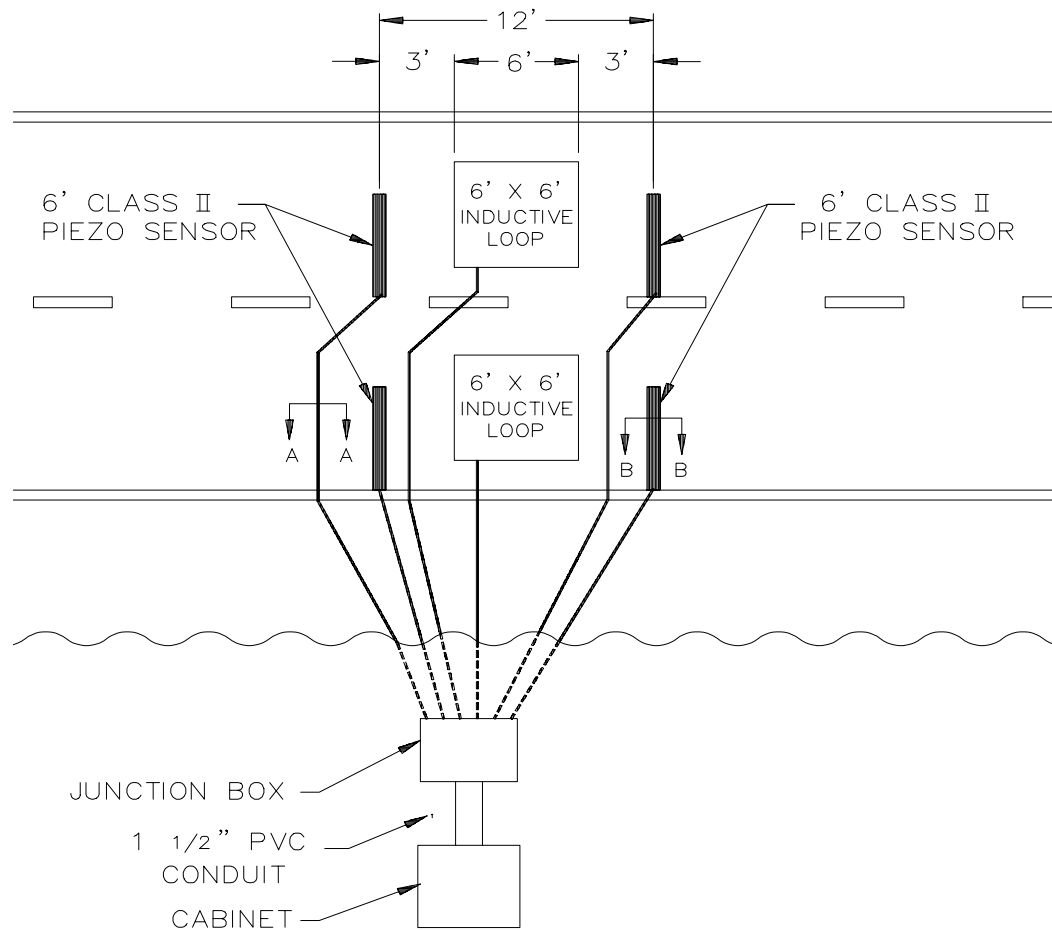
Like any piece of equipment, regular maintenance should be done to the piezoelectric sensors in order to maintain them for a long service life. The sensors should be inspected on a bi-annual basis, and any cracks in the road or in the sensor encapsulation should be filled. A low viscosity loop sealant such as Bondo 606 or a low viscosity grout such as Global PX768 should be poured into any cracks, and then squeegeed smooth. Any loose asphaltic material should be wire brushed away prior to pouring the sealant material in the cracks. Be careful not to raise the profile of the sensor. The sensor should be tested for capacitance and resistance, and the results logged in on the data sheet for the sensors.

Quantity of Grout to be Used:

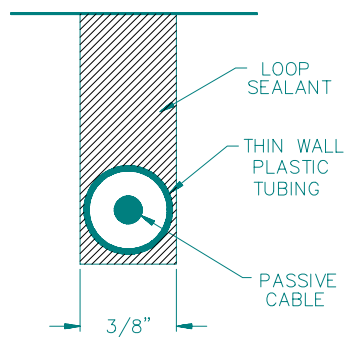
The BL sensor is to be installed in 3/4"x3/4" (19 x 19mm) slot. However, this is difficult to accurately cut, especially in depth. The formula for the purposes of calculating the amount of encapsulation material to be used is as follows:

$$(\text{Length of Sensor \{in inches\}} + 12") * (3/4" * 3/4") * 2 \quad \text{or} \quad (\text{Length of Sensor \{in millimeters\}} + 300\text{mm}) * (19\text{mm} * 19\text{mm}) * 2$$

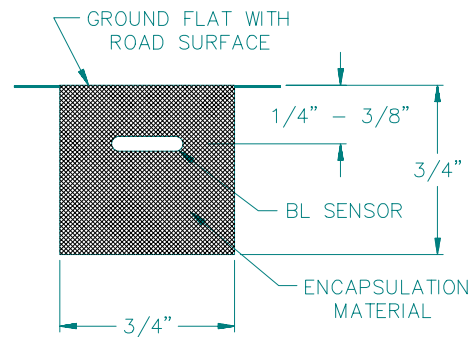
This gives a 100% safety factor, in case the slot is slightly deep or long and so that the bottom of the bucket is not being scraped. For planning purposes, 6' (2m) sensors use approximately 1/2 gallon (1.5 liters) of encapsulation material and 12' (3.5m) sensors use a gallon (3 liters) of material. There are 230 cubic inches in a US gallon. Check with the manufacturer of the encapsulation material for the closest package size. If the resin is sold by weight, divide the weight by the specific gravity (density) to get the volume.



Typical installation layout for a Piezo-Loop-Piezo installation for 6' Class II sensors.



A-A: The passive cable can be put in a thin wall plastic tube for additional protection.



B-B: Typical cross section of a BL Sensor installation.

Frequently Asked Questions:

Approved Grout for installation

Polyurethane

PU 200 (Winter and Summer versions are available)

Global Resins Limited
Unit 6, Corsham
Potley Lane
Corsham, Wilts SN13 9RJ
England
Tel: +44 1225 812201
Fax: +44 1225 812202

Available in the USA through:

International Traffic Corporation
2402 Spring Ridge Dr., Suite E
Spring Grove, IL 60081
Tel: 815 675 1430
Fax: 815 675 1530

Epoxy

E-Bond G-100
E-Bond Epoxies Inc
PO Box 23069
501 N.E. 33rd Street
Fort Lauderdale, FL 33307
Tel: 954 566 6555
Fax: 954 566 6663

Acrylic

ECM P5G
Electronic Control Measurement Inc
PO Box 888
Manor, TX 78653
Tel: 512 272 4346
Fax: 512 272 4966

AS475
International Road Dynamics
702 43rd Street East
Saskatoon, Saskatchewan
Canada S7K 3T9
Tel: 306 653 6600
Fax: 306 242 5599

Diamond Saw Blades

Texas Diamond Tools
805 Hilbig Rd
Conroe, TX 77301
Tel: 800 346 0646
Tel: 409 756 0646
Fax: 409 756 0687
14x.750x.250x1", PN# 07147507

Bituthane Tape for Temporary installations

Mar Mac Manufacturing Co, Inc
PO Box 278, US Highway One North
McBee, SC 29101
Tel: 803 335 8211
Fax: 803 335 8599
Tape ST0005604 (4" wide with a 2" pocket)

BNC Connectors

AMP Incorporated
PO Box 3608
Harrisburg, PA 17111
Tel: 1-800 52AMP52
Also available through Newark Electric and other Distributors
Part Number 227079-5 (BNC with Gold center contact)
Part Number 227079-1 (BNC with Tin-lead center contact)
Hand Crimper - PRO-CRIMPER Hand Tool 58433-1
Stripping Tool 603995-6
Installation Instructions 408-2798
RF Connector Catalog 82074

Installation hints for the MSI BL sensor when using Global Resin PU 200 Resin

- Cut the slot 3/4" wide and about 1" deep. This will give a bit more room for the grout to flow under the sensor, but will still allow you to install an 11' sensor with one tin of resin. If it is any deeper, you will need a second tin.
- Install the sensor into the road prior to pouring in the resin. Install the sensor so that it is 3/8" below the road surface. This will decrease the output slightly, which will actually make it more compatible with many of the electronics on the market.
- Cut a jig from wood that is "T" shaped, so that you can push the sensor 3/8" into the road. The flange should be about 5/8" wide and 3/8" long.
- Prior to placing the sensor into the road, make sure it is straight and not curved or twisted. It may need to be untwisted slightly. Use a block of wood (1" x 2" x 6") with a thin slot cut into the side as handles to untwist the sensor.
- Press the brass of the sensor into the slot, and then position it to the correct depth using the depth jib. Do not push down on the brackets.
- Premix the resin for about 2 minutes or until smooth. Use a drywall mixing paddle (for example, Grainger part number 4R539) in a 600 rpm drill. Make sure the resin is homogeneous prior to adding in the hardener.
- When everything is ready, add the hardener, and mix for about 30 seconds ONLY. Do not overmix, since the pot life is relatively short in warm weather.
- Squeeze in the sides of the can to form a pouring spout, then **IMMEDIATELY** pour the resin into the slot, trying to pour a thin bead on one side of the sensor in the slot. Pour the resin back and forth along the length of the sensor, letting it flow under the sensor as you move along the sensor.
- Fill in the slot very slightly overfull, at least on the first sensor until you get some experience.
- As soon as everything looks good, pull off the tape. The resin should still be slightly fluid when you pull off the tape. The resin will flow slightly and should be very close to being flush with the road.
- It is not necessary to trowel the resin into the slot. It will pour, provided that it is not over mixed.
- When the resin is cured, grind the top of the encapsulation flush with the road using an angle grinder.
- Any further comments or hints are greatly appreciated.