Cardinal Quartz Weigh-in-Motion Sensors

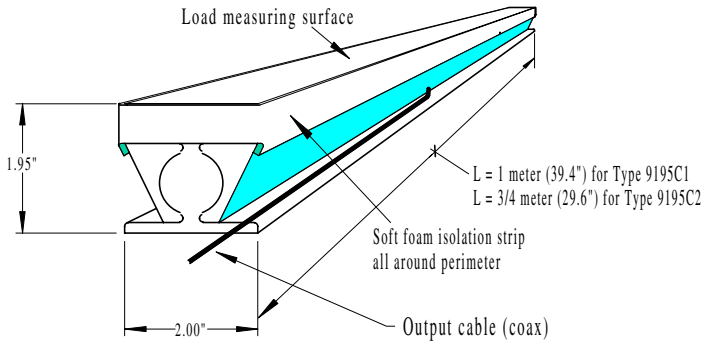
INSTALLATION INSTRUCTIONS

Cardinal Scale Manufacturing Co.
Webb City, Missouri 64870

1. General

Cardinal LINEAS WIM sensors are installed in saw-cut slots in concrete or asphalt pavements. The slots are cut across (perpendicular to) the direction of traffic flow. Two LINEAS sensors are required to make up a strip sensor to extend across one half-lane (one wheel path) and four sensors are required for a full-lane strip (see figures on page 2). 1-meter and ¾-meter sensor lengths (Types 9195C1 and 9195C2 respectively) are available and can be mixed within a strip to accommodate different lane widths.

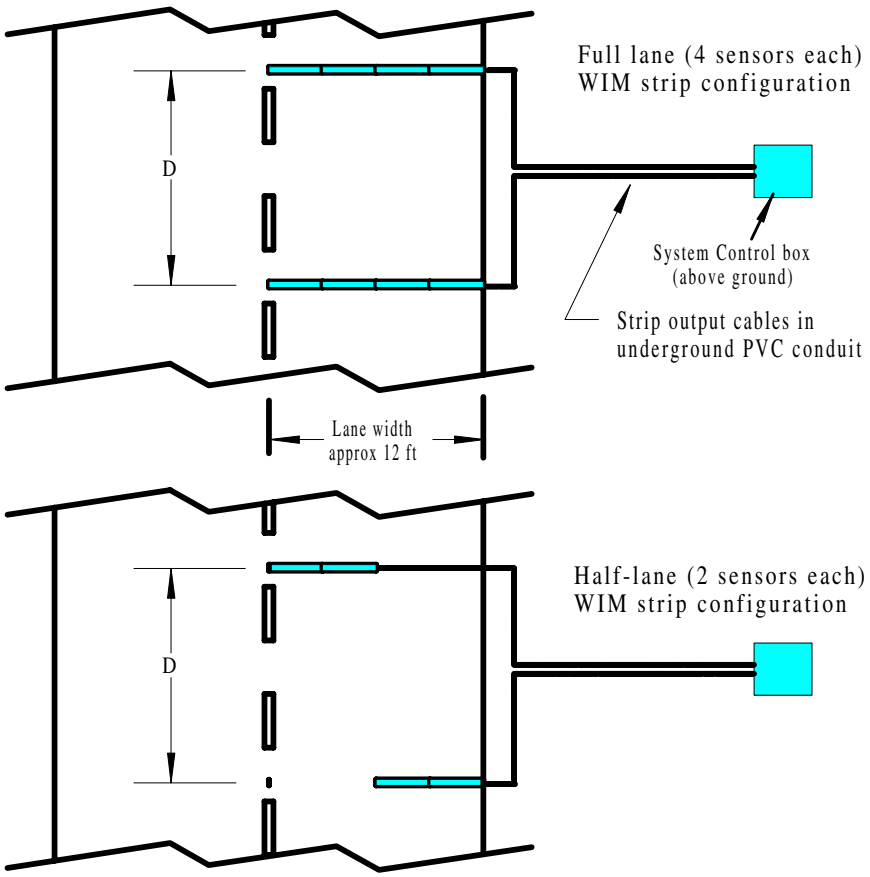
LINEAS WIM Sensor, Type 9195C(x)



The two strips are spaced a distance of around 14 feet along the direction of traffic flow - the exact spacing depends on the prevailing speed of site traffic and should be defined in the installation contract specifications for each site.

The sensors are secured in the slots with special sand / epoxy grout supplied by Cardinal. The grout is troweled off and, after curing (about 2 hours), is ground flat with an electric sander. At this point, the strip may be exposed to traffic without damage. However, a 24 hour post cure is required before strip calibration is performed.

WIM Strip Configurations Options



Notes:

1. Optimum strip spacing dimension "D" depends on estimation of prevailing traffic speed "v" in mph and average vehicle suspension frequency "f" in Hz.

   D (feet) = .733 (v / f)

   Assuming an average truck suspension frequency of 3 Hz and a prevailing speed of 60 mph then D = 14.6 feet.

2. Inductive loops not shown. They may be installed ahead of, between and/or after the WIM strips according to site layout requirements

1.1 Cardinal-supplied Materials

One lane of coverage (two half-strips) requires the following materials: four (4) LINEAS sensors with integral cables of standard 130 foot length (or longer if special ordered) to reach from the pavement slot to the site's control cabinet, 1/2-inch diameter flexible, non-metallic conduit for sensor cable runs to the pavement edge and on into a PVC conduit or J-box, and three (3) sealed pails of special, pre-measured, ready-to-mix grout compound to fill the slots and cable runs. The 1/2-inch flex-conduit is supplied in one piece with total length sufficient to satisfy the site plan. The conduit can be cut with a utility knife.

For two full width strips in one lane, eight (8) sensors and five (5) pails of grout are required.

1.2 Prior Site Preparations

Installation of the system equipment cabinet, roadside J-box, cable conduit from cabinet to J-box (typically 3-inch PVC pipe run below grade), and power and phone utility hook-ups in the cabinet should be completed before this WIM sensor installation procedure is begun. The J-box should have holes to accept two (2) ½-inch plastic flex-conduits coming off the road shoulder at about 1 foot below grade. Also, all components, trays, and system electronics boxes should be mounted within the cabinet and interconnected as required except for the traffic sensor output cables.

1.3 Minimum Installation Temperature

The recommended minimum ambient temperature for LINEAS installation is 40° F (5° C). At lower temperatures proper handling of the grout cannot be assured. Heating blowers must be employed if installation occurs in cold or wet weather. It is absolutely mandatory that the slot is completely dry before pouring the grout into it. Once the grout is in place in the pavement slot, it will cure properly even in the presence of water. Handling properties of the grout mixture are as follows:

Site Temperature	68° F (20° C)	40° F (5° C)
Maximum time available to install grout after mixing (pot life)	0.5 hr	1 hr
Minimum cure time required before grinding	2 hr	4 hr
Minimum cure time required before exposure to local traffic	3 hr	5 hr
Minimum cure time required before performing strip calibration procedures	24 hr	36 hr

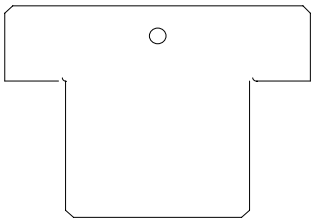
The following installation instructions assume a temperature of 20°C. For different ambient temperatures, elapsed times should be adjusted using the above table as a guide.

2. Slot Layout and Cutting

Layout WIM-strip slots per site plan requirements. Slots shall be perpendicular to lane centerlines within ½ inch. (a chalked-out 6' x 8' x 10' right triangle is useful here).

Saw cut the two slots for the sensor assemblies. The sensor slots shall be 2-7/8 inches wide by 2-1/8 inches deep into the pavement surface. The length of the slots shall equal the total length of the sensor assemblies plus 1 inch. The tolerance for slot width and depth is ±1/8 inch. Saw cut a 3/4 inch wide by 2-1/8 inch deep cable run slot from the end of each sensor slot to the edge of the pavement shoulder. The cable-run width shall be such that the flex tubing can to be pressed in with moderate force by hand or tapped in with a soft hammer. A twin saw blade set at 3/4-inch width to the outsides of the teeth is ideal for this. After saw-cutting all slot outside edges (plus an optional extra saw cut down the middle for sensor slots in concrete pavements), clean out the slots with hammer and chisel or a pneumatic hammer. Clean the bottoms and sides of the slots with a vacuum cleaner or a blower. Inspect sensor slot widths and depths with a slot gage provided by Cardinal.

Sensor Slot Gage



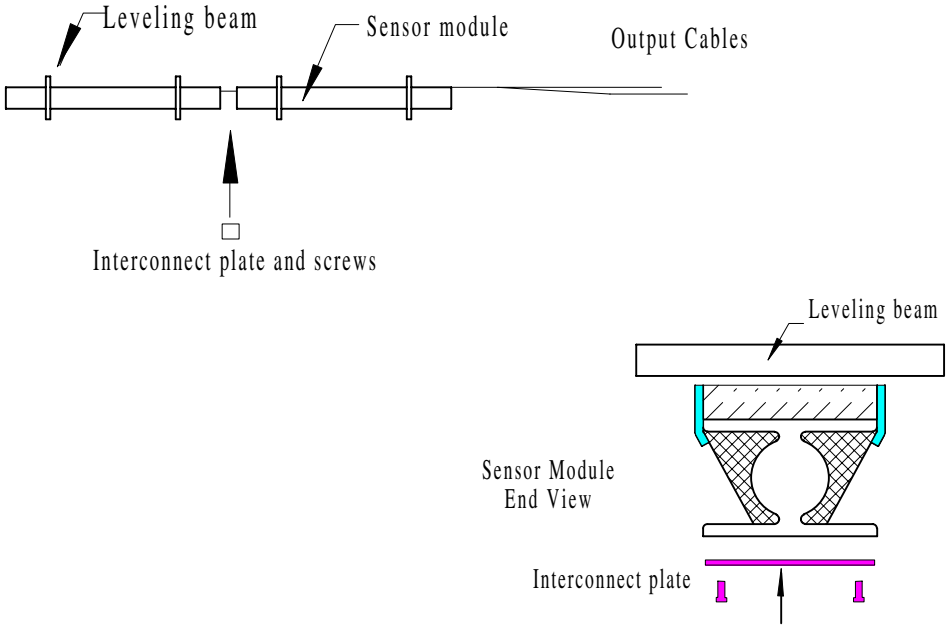
3. Constructing Sensor Strip Assemblies from LINEAS Sensor modules

Place the LINEAS sensor modules onto the pavement and arranged as shown on page 5. Note that the output cables should exit the sensors from the same side and with cables running toward the road edge where the pullbox is located. Record the serial numbers of the sensors, noting in the record what their relative positions are along the strip.

Attach two plastic leveling beams to the top surface of each sensor. The beams and attachment screws are found inside each sensor's shipping container. Remove the contact paper protecting the foam strips at the sensor ends only. Leave the remaining paper in place on the sensor sides. Physically connect the two sensors to each other by means of a small brass interconnecting plate which is attached as shown on page 5. (Plates and screws are supplied with the sensor). Snap on the provided bent-wire clips to loosely secure the cables to the lower flange of the sensor assembly (see lower figure, page 5).

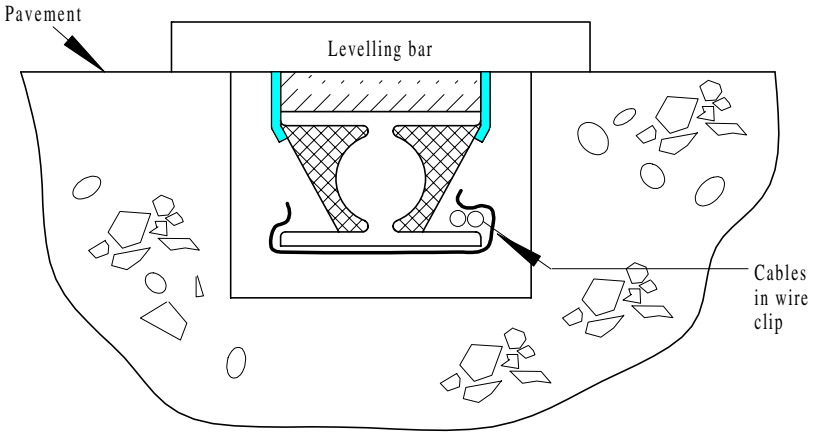
This provides an assembly that can lowered as one piece into the slot.

Sensor Assembly Arrangement



Lower the assembled sensor strip into the pavement slot for a preliminary fit check. The sensor assembly-to-slot-edge clearance should be ¼ to ½ inch all around. The assembly should hang freely from the leveling beams without touching the slot floor. Then remove the assembly and place it next to the slot and in readiness for pulling cables to the pullbox and on to the controller cabinet.

Sensor Suspended on Beams in Slot



4. Flex-conduit Installation and Cable Pulls

Install 1/2-inch flex-conduit into (and bottomed-out in) cable-run sawcuts. Conduit should extend from the ends of the sensor slots to the pullbox, with the length between the road shoulder and pullbox buried 8 to 12 inches below grade. Trim end of conduit to extend a few inches into pullbox. Seal access hole in pullbox around the conduit with duck seal putty.

Pull all sensor cables into and through the flex-conduit, pullbox, buried PVC (or other) conduit and into the cabinet. Trim and terminate cable lengths as required to connect to the system controller inputs – typically with BNC connectors. When terminations are complete, measure the insulation resistance between center conductor to shield of the terminated cable ends (looking back toward the sensors) with a high-insulation resistance ohmmeter. All measured values shall be $\geq 10^9$ ohms.

5. Installing the Sensor Assemblies into the Pavement

The sensor assemblies will now be permanently grouted in place in the slots. The grout resin is provided in plastic pails with a separate metal canister of hardener provided for each pail of resin. Mixing will be done with a paddle stirrer driven by a heavy-duty, ½-inch (minimum) electric or pneumatic hand drill. Grout quantity required is one pail for a half-strip, two pails for a full strip, plus one for cable run slots.

Just before mixing the grout, make sure the slot and surrounding pavement (within about one foot from slot edges) are completely dry and free of loose material. Use a heater/blower if necessary. Mask off the sensor and cable-run slot edges with 3-inch duct tape. Lay down an adjacent layer of tape to create a 5 to 6 inch wide mask.

Remove the remaining protective contact-paper from around the edges of the sensors to expose the remaining surface of the flexible foam isolation strip. From here on, reasonable care should be taken to avoid contaminating this exposed surface with dust or particles. This surface will be contacted by and sealed by the grout.

Prepare the grout by peeling off the sealed cover from the pail the grout is delivered in. Each pail contains a pre-measured amount of epoxy resin and sand. This mixture may be quite stiff before the hardener is added and can be loosened in the pail by plunging the drill paddle (without rotation) up and down the middle and sides of the mixture. Then, with safety glasses and gloves to protect against splashes, gradually pour the hardener into the pail while slowly mixing the materials. Mix, with paddle rotation slow at first, for about two minutes. Watch the time. At 68° F, you must complete the mixing process, pour the grout mix, set the sensors, and trowel off - all within ½ to ¾ of an hour.

Pour the grout into the slot. Fill the entire length of the slot to within 1 inch below the pavement surface. Using a trowel and with an upward motion, smear the grout against the sides of the slot so that the sides surfaces are “painted” with grout material all the way up to the top edges.

Position the WIM sensor assembly above the filled slot and press it slowly into the grout so that the grout flows completely around the bottom flange of the modules and so that no air bubbles are formed. Continue to press the sensor assembly down until all the leveling beams

touch the pavement surface. The grout should ooze up and slightly out of the slot as this is being done. Localized small deficiencies should be corrected by troweling in additional grout. Use remaining grout to fill the cable-run slots.

Trowel off excess grout from the sensors and cable-runs. The grout bond line should be just slightly above the original pavement surface plane. The top surface of the duct tape forms a good trowel guide for this purpose. After about 20 minutes (temperature dependent), or when the grout sets up such that it is still tacky but the sensors are immovable, remove the leveling beams and duct tape.

After about 2 hours (also temperature dependent) the grout should be tack-free to the touch. Grind the WIM strip top surfaces until flat and level with the pavement surface. The top surface of the sensor can be ground along with the grout. It is important that the grinding leaves no high or low spots, and especially, no raised ridges at the leading or trailing edges of the sensor strip. Tip: an aluminum bar about 12 inches long with a reasonably straight edge, when "scrubbed" over the top of the sensor strip, leaves telltale dark marks showing high spots that can then be flattened with the sander.

Clean up the pavement in the vicinity of the installation with a broom and/or blower. The newly installed WIM strips can now be exposed to traffic. However, calibration should not be performed any earlier than the next day to allow for thorough hardening of the grout.

6. Typical Installation Schedule

Clock Time	Activity	Personnel Required
8 am	Close work site to traffic	Police, or other as authorized
8 am to 10 am	1. Cut and clean-out slots 2. Install flex-conduit 3. Assemble sensor modules	3 people: 2 for slot cutting and conduit installation and 1 for sensor assembly
10 am to 11 am	Pull cables, terminate in cabinet & check insulation resistance	3 people, 2 for cable pulls and one for cable termination and ohmmeter measurements.
11 am to 12 noon	Mix grout, install sensors	3 people
12 noon to 2 pm	Grout cure	None
2 pm to 3 pm	Surface grind off, cleanup	3 people, 2 for grinding, one for cleanup
4 pm	Road open to traffic	

7. Required equipment, tools, and consumable materials

- 115 V, 60-cycle power source and extension cords
- Air compressor
- Compressed-air blower (for slot clean-out and drying)
- Small pneumatic jack-hammer
- Gasoline powered wet/dry-cut pavement saw (dry-cut much preferred)
- Gas-fired hot air blower (optional, for slot drying or grout cure acceleration in cold weather)
- Straight or angle grinder/sander with 7" disk pad, 7/8" arbor, and with 16-grit aluminum oxide abrasive disks.
- 4-inch wide belt sander with 24-grit aluminum oxide abrasive belts
- Lay-out chalk and paint
- Trowels (plastic disposal recommended)
- Cable-pull snake or string
- Utility knife
- Tape measure
- Mixer (1/2" power drill with stirrer)
- Knee pads (optional but recommended)
- Protective gear for epoxy mixing: plastic glasses, disposable gloves.
- 3-inch wide duct tape
- Hammer and cold-chisel(s)
- Screw drivers (various)
- Cutting, stripping and crimping tools for coax cable-end trim and termination
- Insulation tester (for measuring $> 10^9$ ohms)