Designation: E2561 – 07a (Reapproved 2018)

Standard Practice for the Installation of Inductive Loop Detectors[1]

This standard is issued under the fixed designation E2561; the number immediately following the designation indicates the year of original adoption or, in the case of revision, the year of last revision. A number in parentheses indicates the year of last reapproval. A superscript epsilon (ε) indicates an editorial change since the last revision or reapproval.

1. Scope

1.1 This practice describes the recommended procedure for installing inductive loop detectors in sawed slots in roadway pavement for use as a traffic monitoring device or to actuate traffic control devices such as a traffic signal. Although the practice is not intended for installing preformed loops, the practice does contain information of value for this type of loop, such as recommendations for the number of turns of loop wire, number and direction of twists in the lead-in wire and cable, splice location (if needed), and grounding options.

1.2 The values stated in inch-pound units are to be regarded as standard. The values given in parentheses are mathematical conversions to SI units that are provided for information only and are not considered standard.

1.3 *This standard does not purport to address all of the safety concerns, if any, associated with its use. It is the responsibility of the user of this standard to establish appropriate safety, health, and environmental practices and determine the applicability of regulatory limitations prior to use.*

1.4 *This international standard was developed in accordance with internationally recognized principles on standardization established in the Decision on Principles for the Development of International Standards, Guides and Recommendations issued by the World Trade Organization Technical Barriers to Trade (TBT) Committee.*

2. Terminology

2.1 *Definitions of Terms Specific to This Standard:*

2.1.1 *electronics unit, n*—a card or free-standing module that transmits energy into the wire loops, typically at frequencies between 20 kHz and 100 kHz; special applications such as vehicle classification may use electronics units that transmit at frequencies above 100 kHz; electronics units allow control of sensitivity, frequency, pulse or presence operation, and timing features (that is, delay and extension) in some models and indicate system failures.

2.1.2 *inductance, n*—property of an electric circuit or of two neighboring circuits that generates an electromotive force in one circuit when the current changes in that circuit or in the neighboring circuit; expressed in units of Henrys (H).

2.1.3 *inductive loop detector, n*—those parts of an inductive loop detector system that consist of the wire loops, lead-in wires, and lead-in cable and which respond to the passage or presence of a vehicle with a decrease in inductance of the wire loop.

2.1.4 *inductive loop detector system, n*—a sensor to detect vehicles and their traffic flow properties, whose major components are: *(1)* one or more turns of insulated loop wire wound in a slot sawed in the pavement, *(2)* lead-in wires extending from the loop wire to a curbside or shoulder pull box, *(3)* lead-in cable spliced to the lead-in wires that extends from the pull box to the controller cabinet, and *(4)* electronics unit housed in the controller cabinet.

2.1.5 *insulation resistance, n*—the resistance measured with a megohmmeter between a conductor and the outer insulating jacket of a wire or cable.

2.1.6 *lead-in cable, n*—shielded wire that is spliced to the lead-in wires in the pull box and which extends from the pull box to the controller cabinet, where it is connected to the electronics unit; also known as home-run cable, transmission line, or feeder cable.

2.1.7 *lead-in wires, n*—a continuation of the loop wire that runs from the physical edge of the loop to the pull box; usually twisted together to form a wire pair.

2.1.8 *loop system sensitivity, n*—smallest change of inductance at the electronics unit terminals that will result in a signal that indicates the passage or presence of a vehicle.

2.1.9 *loop wire, n*—one-conductor insulated wire used for both the wire loop and the lead-in wire; may be jacketed or encased in tube.

2.1.10 *pull box, n*—a container that encloses the splices between the lead-in wires and the lead-in cable; when installed underground, the removable cover is aligned flush with the ground surface; also known as a handhole, splice box, or junction box.

2.1.11 *quadrupole loop, n*—typically a rectangular wire loop configuration with a longitudinal slot extending along the

[1] This practice is under the jurisdiction of ASTM Committee E17 on Vehicle - Pavement Systems and is the direct responsibility of Subcommittee E17.52 on Traffic Monitoring.

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center of the loop so that the wire can be installed in a figure-eight pattern; the quadrupole loop produces four electromagnetic poles instead of the normal two, thus improving the sensitivity to small vehicles and minimizing splashover; quadrupole loops are also used in a diagonal configuration to detect bicycles (**1**).[2]

2.1.12 *saw cut, n*—opening made in the roadway pavement using a pavement saw into which the wire loop or lead-in wires are inserted; also referred to as a slot.

2.1.13 *splashover, n*—unwanted actuation caused by a vehicle in a lane adjacent to the lane in which a sensor is located.

2.1.14 *traffic monitoring device, n*—equipment that may count and classify vehicles and measure vehicle flow characteristics such as vehicle speed, lane occupancy, turning movements, and other parameters typically used to portray traffic movement.

2.1.15 *wire loop, n*—one or more turns of loop wire wound in a slot sawed in the pavement.

3. Summary of Practice

3.1 The major steps in installing an inductive loop detector system are:

3.1.1 Preparing plans and specifications,
3.1.2 Securing the work zone,
3.1.3 Installing underground conduit and pull box,
3.1.4 Cutting a slot for the loop wire and lead-in wires,
3.1.5 Installing the wires,
3.1.6 Twisting the lead-in wires,
3.1.7 Testing for proper operation of the wire loop and lead-in wires,
3.1.8 Sealing the saw cuts,
3.1.9 Splicing the lead-in wires to the lead-in cable in a pull box,
3.1.10 Connecting the lead-in cable to the terminal strip in the cabinet,
3.1.11 Testing for proper operation of the wire loop, lead-in wires, and lead-in cable assembly, and
3.1.12 Connecting the terminal strip to the electronics unit.

[2] The boldface numbers in parentheses refer to the list of references at the end of this practice.

3.2 Procedures needed to ensure work zone safety, traffic control, and installation of conduit, pull box, controller cabinet, and any equipment usually placed in the cabinet, such as the electronics unit, are not covered by this practice.

4. Significance and Use

4.1 This practice provides a method for the in-road installation of an inductive loop detector that consists of wire loops, lead-in wires, and lead-in cable. The practice is intended for installing wires in saw cuts made in the roadway surface and not for installing preformed loops that may be encased in a protective enclosure such as plastic conduit. Typical components of an inductive loop detector system are illustrated in Fig. 1. Modern inductive loop detector electronic units are capable of detecting vehicles even if the wire loop is laid on reinforcing steel before concrete is placed.

5. Procedure

5.1 Scale drawings of the installation site showing the geometry of the roadway and the exact location of the components of the inductive loop detector in relation to the pavement or lane markings are required. The drawings shall indicate the location and specifications for the wire loop (typically centered in the middle of the lane) and lead-in wires, lead-in cable, pull boxes, conduit, power sources, pavement materials and sealants, cabinets, and electronic units required for the installation. The accuracy of the drawings has a primary effect on the quality of the installation, as it provides fundamental guidance for the installation crew and becomes part of the procurement package used to acquire the needed components.

5.2 The dimensions of the loops and number of turns are selected according to the types of vehicles to be detected, vehicle undercarriage height, lane width, length of lead-in cable, and, for some applications, the data desired. Inductive loops should not be wider than 6 ft (183 cm) in a 12-ft (366-cm) lane. Loops should not be less than 5 ft (152 cm) wide because the detection distance between the road surface and the vehicle undercarriage becomes limited, as the detection distance is approximately equal to one-half to two-thirds of the loop width (such as, the minimum loop dimension). Since the inductance of the loop must be greater than the inductance of

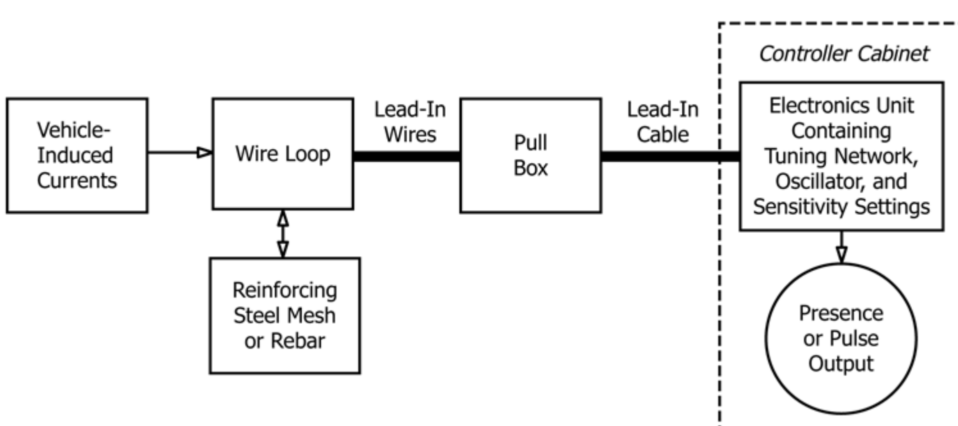

FIG. 1 Inductive Loop Detector System (Notional) (**2**)

the lead-in cable (that is, 21 μH per 100 ft (69 μH per 100 m) of #14 AWG lead-in cable) for the loop system to have sufficient sensitivity, Klein et al. (**2**) recommend that the inductance of single loops and series, parallel, or series-parallel combinations of loops be greater than 50 mH to ensure stable operation of the inductive loop detector system. Guidance for the number of turns needed to produce the required inductance value is found in Klein et al. (**2**) as follows: "If the loop perimeter is less than 30 ft (9 m), use three turns of wire; if the loop perimeter is greater than 30 ft (9 m), use two turns of wire." Appendix X1 contains tables showing the inductance values for various size loops and shapes (such as rectangular, quadrupole, and circular).

5.3 Manpower and the type and amount of installation material and equipment must be determined before the installation is begun. The required materials should be available in sufficient quantities to avoid any interruptions in the installation process. Table 1 contains a typical materials list for constructing an inductive loop detector. Table 2 contains typical equipment needed to install inductive loops. The equipment required for traffic control and installation of conduit, pull box, controller cabinet, and any equipment usually placed in the cabinet are not included.

5.4 To protect the integrity of the pavement and loop installation, cracks and joints in the roadway pavement should not be located closer than 18 in. (45 cm) upstream or downstream of the inductive loop detector being installed. Some agencies relax this constraint to 1 ft (0.3m) (**5**). Saw cuts for other wire loops or other in-roadway sensors must not be located closer than 2 ft (0.6 m) upstream or downstream of the inductive loop detector being installed (**6**). The distance between lead-in saw cuts shall be 6 in. (15 cm) minimum until they are within 1 ft (0.3 m) of the edge of the pavement or curb, at which point they may be placed closer together (**7**). Lead-in saw cuts shall not be closer than 12 in. (30 cm) from adjacent loop edges (**6**).

TABLE 1 Typical Materials List for 6-ft × 6-ft (1.8-m × 1.8-m) 3-Turn Inductive Loop

Description	Quantity/Loop
Loop and lead-in wires, such as., IMSA 51-3 or 51-5 (**3**)	200 ft (60 m)[A]
Lead-in cable, e.g., IMSA 50-2 (**3**)	200 ft (60 m) or more[A]
Tape ¾-in. (20-mm) rubber splicing[B]	1 roll per 6 loops
Loop sealant (per loop)	6 tubes or appropriate number of gallon containers
Sealant (per 4 ft (1 m) of lead-in cable)	1 tube
Caulking gun	1
Backer rod	As required
Cement, sand, or talc	1 bag
Duct seal for conduit	1 block
Pull box (sized as required)	1 per splicing location
Concrete	As required per pull box
Splice kits	1 per loop
Solder	As required
Surge voltage protector	As required
Conduit	As required

[A] Quantity varies according to site requirement, including loop location.

[B] Some states specify a first layer of PVC tape followed by a layer of rubber tape or heat shrinkage polyolefin tubing as insulation on the lead-in wire to lead-in cable splice (**4**).

TABLE 2 Typical Installation Equipment List for Inductive Loop Detectors

Item	Description and Use
Pavement saw	Creates saw cut for inserting wires. Typically a self-propelled 18- to 65-hp saw equipped with ¼- to ⅜-in. (6- to 10-mm) thick blade (abrasive or diamond), water valve, depth gauge, and horizontal guide
Water supply	Cools diamond blade and cleans out sawed slots
Jackhammer	Bores holes through concrete curb
Air compressor	Used with jackhammer and to clean and dry sawed slots
Chisel and hammer	Removes sharp edges at corners of saw cuts
Blunt tool	3⁄16-in. to ¼-in. (5-mm to 6-mm) thick wood paddle for seating wire in sawed slot
Wire twisting tool	Provides symmetrical twists in the lead-in wires
Template/Straightedge	Marks outlines of loops on pavement
Trenching machine	Creates trench for burying cable underground
Volt-ohm meter and megohmmeter	Tests wires for continuity and insulation resistance
Inductive loop system analyzer	Tests continuity and inductance of inductive loop detector system
Soldering device	Enables soldering of wire connections using a butane torch with a soldering tip or an electric soldering iron
12-ft (4-m) straightedge, chalk line, marking paint, crayons, or chalk	Marks location of all saw cuts
Wire cutters, lineman's pliers	Aids in cutting and splicing wires
Fish tape	Aids wire pulling
Measuring tape or wheel	Minimum of 100-ft (30-m) tape to facilitate measurements for placement of loop wires and lead-in wires
Power drill	Facilitates sealant mixing

5.5 After securing the work zone with appropriate barricades, cones, and so forth to divert traffic from the work area, mark the pavement to show the size and shape of the loop and lead-in wires to be installed and the required saw cuts. Lumber crayon, chalk, or spray paint is typically used for this purpose. If available, a template of the proper size and shape for the wire loop is recommended. However, a straightedge or a tightened string can be used as a marking guide. It is critical that the markings reflect the location shown on the construction plans.

5.6 Cut slots into the roadway pavement for the loop wire and lead-in wires using a pavement saw. Do not allow the saw cut in the pavement to deviate by more than 1 in. (25 mm) from the markings for the cut (**7**). The depth of the saw cut shall be sufficient to allow at least a 1-in. (25-mm) cover of sealant to be placed above the top loop wire or backer rod if such is used (**7, 8**). Some agencies use 3- and 4-in. (76- and 102-mm) slot depths for multiple wire-turn loops to prevent future grinding and overlay procedures from destroying the loop (**8**). Saw cut depth should be verified at several points during the cutting process to ensure a constant value. The width of the saw cut shall be sufficient to allow encapsulation of the wires by the sealant. Several methods are available to prevent damage to the wire at the corners of a square or rectangular loop by removing the 90° angle. In the first method, diagonal cuts are sawed at the four corners, allowing a minimum margin of 1 ft (30 cm) from the apparent corner as shown on the left of Fig. 2. When