

1. Basic Loop Detector Theory

The inductive loop detection system is comprised of two elements; the electronic detector module and the inductive loop coil and lead-in cable. The detector oscillator circuit drives energy (10 - 200KHz) through the loop wire creating an electromagnetic field. The loop detector forms a tuned electrical circuit of which the loop wire is the inductive element. If a metallic mass passes through the field, eddy currents will be induced in the conducting object. Since the loop inductance is proportional to the magnetic flux, it results in a decrease in loop inductance. The detector senses the change in inductance and actuates its electronic output.

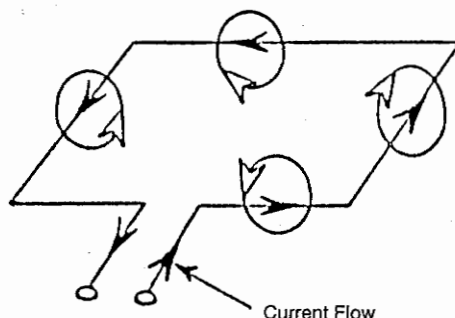


Figure 1

2. Basic Loop Theory

The loop wire and lead-in cable are the inductive elements of the detection system and possess a combination of resistance and capacitance (both interwire and wire-to-earth capacitance). The loop wire is wound to form a coil (usually two to four turns) where the magnetic field becomes more concentrated creating the zone of detection. All conductors or wires carrying an electrical current produce magnetic flux caused by the the current flowing through the wire. The effect of this flux is the electrical property called inductance which is measured in henrys (h). (See Figure 1)

3. Loop Wire

Inductive loops, lead-in wire and cables typically use #12 or #14 AWG wire with low AC and DC resistance. The wire thickness is important, however, more critical is the quality, thickness and type of wire insulation. The insulation may be rubber, thermoplastic or synthetic polymer. Cross-link polyethylene is the most popular insulation and is strongly recommended (XHHW). The insulation must withstand wear and abrasion from shifting streets, moisture and attack by solvents and oils, as well as withstand heat and high temperature sealants. Stranded loop wire is suggested over solid wire because of its mechanical characteristics. Stranded wire is more likely to survive bending and stretching than solid wire. (See Figure 2)

Designation	Description
TFF	Stranded copper conductor insulated with thermoplastic lead wire.
THHN	Building wire, plastic insulated, 90°C, 600 volt, nylon jacketed.
THW	Building wire, plastic insulated; heat, flame and moisture resistant, 75°C.
THWN	Same as THW with overall nylon jacket.
XHHW	Cross-linked polyethylene insulated wire rated at 90°C in dry locations and at 75°C in wet locations.

Note: Building wire is defined as a commercial wire used for light and power in permanent installations using 600 volts or less. Typically used in an enclosure which will not be exposed to outdoor environments.

Figure 2

4. Size of Loops

- Automobile detection is customarily done with rectangular loops of about 4' to 6' in the direction of travel. The use of smaller loops may result in the early loss of detection for high body vehicles. Loops are usually made wide enough to span the path where detection is required. Nevertheless, there should be adequate separation from adjacent lane loops (3') to prevent adjacent lane detections. (See Figure 3)

4 FOOT LOOP WIDTH											
Loop Size (ft)	Inductance (μh)				Loop Size (ft)	Inductance (μh)			Loop Size (ft)	Inductance (μh)	
	1 Turn	2 Turn	3 Turn	4 Turn		1 Turn	2 Turn	3 Turn		1 Turn	2 Turn
4 x 4	7	20	44	78	4 x 35	35	105	235	4 x 70	67	201
4 x 6	8	25	56	100	4 x 40	39	119	266	4 x 75	71	215
4 x 10	12	36	81	144	4 x 45	44	132		4 x 80	76	228
4 x 15	17	50	112	199	4 x 50	49	146		4 x 85	81	242
4 x 20	21	64	143	253	4 x 55	53	160		4 x 90	85	256
4 x 25	26	78	174		4 x 60	58	174		4 x 95	90	270
4 x 30	30	91	204		4 x 65	62	187		4 x 100	94	283

6 FOOT LOOP WIDTH											
Loop Size (ft)	Inductance (μh)				Loop Size (ft)	Inductance (μh)			Loop Size (ft)	Inductance (μh)	
	1 Turn	2 Turn	3 Turn	4 Turn		1 Turn	2 Turn	3 Turn		1 Turn	2 Turn
6 x 4	8	25	56	100	6 x 35	38	116	259	6 x 70	72	217
6 x 6	10	31	70	124	6 x 40	43	130		6 x 75	77	231
6 x 10	14	43	96	171	6 x 45	48	145		6 x 80	82	246
6 x 15	19	58	129	229	6 x 50	53	159		6 x 85	87	260
6 x 20	24	72	161	286	6 x 55	58	173		6 x 90	91	275
6 x 25	29	87	194		6 x 60	63	188		6 x 95	96	289
6 x 30	34	101	226		6 x 65	67	202		6 x 100	101	303

Figure 3

Optimum range is between 70μh and 200μh

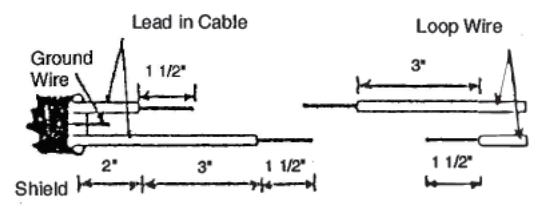
- b. For large vehicle detection, i.e. trucks and semi-trailers, use loops of not less than 6' in width and length. With smaller loops, the high ground clearance and axles can cause detection problems. Each axle group can be seen as a separate detection on a small loop.

Note: Typically the field height of detection will be 1/2 to 2/3 the distance of the loop's shortest side, i.e. a 6' x 6' loop should produce a field height of detection around 3' to 3 1/2' above the loop wires.

5. Splicing The Wire

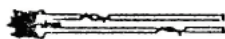
If splicing a long lead-in to loop wires is necessary, great care should be taken to ensure an environmentally sound connection. There are two preferred methods of physically connecting the loop lead-in wires: 1) twisting and soldering or 2) crimping and soldering. Soldering provides the least resistance and is less susceptible to corrosive degradation. Once the wires are spliced, a variety of methods are used to environmentally seal the splice. To protect against weather, moisture, abrasion, etc. any of the following methods are acceptable: heat shrinkable tubing, special sealing kits, pill bottles with slot sealant, tape and coating. Any method is acceptable as long as it provides a sound environmental seal (waterproof). (See Figure 4)

Step 1. Strip Loop Wires and Lead-in Cable



Step 2. Connect and Solder

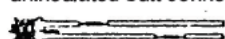
Twist bare conductors together



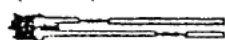
and solder with 60/40 (tin/lead) resin solder



Crimp bare conductors together with an uninsulated butt connector



and solder with 60/40 (tin/lead) resin solder



Step 3. Insulate Each Solder Joint Separately

Electrical Tape



OR Shrink Tube



Step 4. Environmentally Seal Total Splice



Figure 4

6. Installing The Loop

Loops are normally installed into slots cut in the road surface. They are typically 1/4" to 5/16" wide by 1 1/2" to 2" deep. Thoroughly clean and dry the slot before placing the wire in. (See Figure 5)

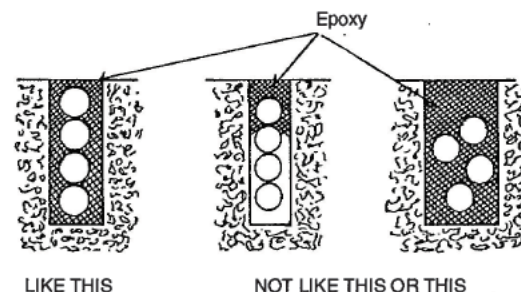
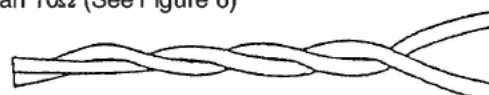


Figure 5

Remember, loops put in above concrete reinforcing rebar must be at least 2" above the bars. A loop slot must not contain any conductor other than the loop itself. Loop placement should be greater than 4 feet from any moving metal objects (gates or doors).

Lead-in wire should be twisted at least five twists per foot, keeping the conductors as close together as possible to cancel the unwanted detection field between the loop and the detector. This forms a continuous run of wire from the detector to the loop slots, around the loop in the correct turn ratio and back to the detector. The loop and lead-in should have an insulation resistance to earth greater than 10MΩ, measured at 500 volts and a series resistance of less than 10Ω (See Figure 6)



Correct way to twist wire



Incorrect way to twist wire

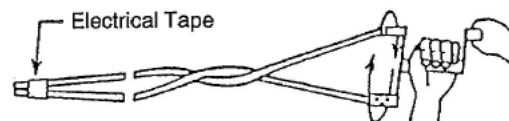
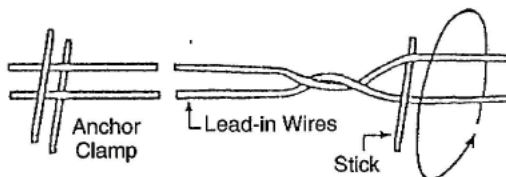


Figure 6