State of Wisconsin
Department of Transportation

Traffic Signal Design Manual

ORIGINATOR Director, Bureau of Highway Operations		8-1-8
CHAPTER 8	Detector and Controller Logic	
SECTION 1	Vehicle Detection	
SUBJECT 8	Inductance Calculations	

The ability to detect vehicles is primarily a function of the loop's inductance and sensitivity, not its shape. The advent of digital detector amplifiers and electronics has eliminated many problems associated with older loop-detector amplifiers. These problems included splash-over, cross-talk, and difficulty in detecting smaller vehicles with standard detector configurations.

The total inductance of loop detector systems is related to loop size, the number of turns in the loop and the length of lead-in cable. These elements will have an effect on inductance associated with them. As a general rule, the actual loop *should* have approximately twice the inductance as the lead-in cable to ensure good detection efficiency. Lead-in cable has approximately 23 microHenries of inductance per 100 feet. For the detector loop to have a 2:1 ratio of inductance compared to the lead-in cable, the loop must have a certain number of turns. The longer the lead-in the greater the number of turns. A commonly used formula for determining the loop inductance is shown below.

Inductance = $(N^2 \times 5 \times P) / (10 + N)$ Where: N = Number of turns in loop
P = Perimeter of loop

If two or more loops are wired in series, their inductances are additive (total inductance: $L = L_1 + L_2 + \ldots + L_n$). When several loops are installed, maximum inductance is obtain by wiring the loops in series. The total inductance for a single detector amplifier *should* not exceed 800 to 1000 mH.

If two or more loops are wired in parallel, the combined inductance is reduced (total inductance: $1/L = 1/L_1 + 1/L_2 + \ldots + 1/L_n$). When using parallel connections, the designer *should* calculate the total loop inductance to be sure it is approximately two (2) times that of the lead-in cable inductance. Often times a combination of parallel and series connections is used to keep the total inductance below 800 to 1000 mH and also to aid in installation.

An effort *should* be made to avoid installing loops of equal size, side by side with the same number of turns. Such installations are potential sources of trouble (cross-talk, false calls). If, for example, one loop (closest to the cabinet) has 3 turns, then the farther one *should* have 4 turns.

Table I can be used as a quick reference for single loop inductance for various loop sizes. Inductance for this table is determined by the formula stated above.

It is the responsibility of the signal designer to determine the proper loop size and number of turns. The designer is not restricted to the loop sizes shown in the following table.

Loop Size	INDUCTION					
	1 turn	2 turns	3 turns	4 turns	5 turns	6 turns
2' x 6'	7.3	26.7	55.4	91.4	133.3	180.0
2' x 8'	9.1	33.3	69.2	114.3	166.7	225.0
2' x 10'	10.9	40.0	83.1	137.1	200.0	270.0
2' x 12'	12.7	46.7	96.9	160.0	233.3	315.0
2' x 14'	14.5	53.3	110.8	182.9	266.7	360.0
2' x 16'	16.4	60.0	124.6	205.7	300.0	405.0
2' x 18'	18.2	66.7	138.5	228.6	333.3	450.0
2' x 20'	20.0	73.3	152.3	251.4	366.7	495.0
3' x 6'	8.2	30.0	62.3	102.9	150.0	202.5
3' x 8'	10.0	36.7	76.2	125.7	183.3	247.5
3' x 10'	11.8	43.3	90.0	148.6	216.7	292.5
3' x 12'	13.6	50.0	103.8	171.4	250.0	337.5
3' x 14'	15.5	56.7	117.7	194.3	283.3	382.5
3' x 16'	17.3	63.3	131.5	217.1	316.7	427.5
3' x 18'	19.1	70.0	145.4	240.0	350.0	472.5
3' x 20'	20.9	76.7	159.2	262.9	383.3	517.5
4' x 4'	7.3	26.7	55.4	91.4	133.3	180.0
4' x 6'	9.1	33.3	69.2	114.3	166.7	225.0
4' x 8'	10.9	40.0	83.1	137.1	200.0	270.0
4' x 10'	12.7	46.7	96.9	160.0	233.3	315.0
4' x 12'	14.5	53.3	110.8	182.9	266.7	360.0
4' x 14'	16.4	60.0	124.6	205.7	300.0	405.0
4' x 16'	18.2	66.7	138.5	228.6	333.3	450.0
4' x 18'	20.0	73.3	152.3	251.4	366.7	495.0
4' x 20'	21.8	80.0	166.2	274.3	400.0	540.0
4' x 30'	30.8	113.5	235.7	388.8		
5' x 6'	10.0	36.7	76.2	125.7	183.3	247.5
5' x 8'	11.8	43.3	90.0	148.6	216.7	292.5
5' x 10'	13.6	50.0	103.8	171.4	250.0	337.5
5' x 12'	15.5	56.7	117.7	194.3	283.3	382.5
5' x 14'	17.3	63.3	131.5	217.1	316.7	427.5
5' x 16'	19.1	70.0	145.4	240.0	350.0	472.5
5' x 17'	20.0	73.3	152.3	251.4	366.7	495.0
5' x 18'	20.9	76.7	159.2	262.9	383.3	517.5
5' x 20'	22.7	83.3	173.1	285.7	416.7	562.5
5' x 30'	31.8	116.7	242.3	400.0	583.3	787.5

Table 1
Single-Loop Inductance Calculations

Loop Size	INDUCTION					
	1 turn	2 turns	3 turns	4 turns	5 turns	6 turns
6' x 6'	10.9	40.0	83.1	137.1	200.0	270.0
6' x 7'	11.8	43.3	90.0	148.6	216.7	292.5
6' x 8'	12.7	46.7	96.9	160.0	233.3	315.0
6' x 10'	14.5	53.3	110.8	182.9	266.7	360.0
6' x 12'	16.4	60.0	124.6	205.7	300.0	405.0
6' x 14'	18.2	66.7	138.5	228.6	333.3	450.0
6' x 15'	19.1	70.0	145.4	240.0	350.0	472.5
6' x 16'	20.0	73.3	152.3	251.4	366.7	495.0
6' x 17'	20.9	76.7	159.2	262.9	383.3	517.5
6' x 18'	21.8	80.0	166.2	274.3	400.0	540.0
6' x 20'	23.6	86.7	180.0	297.1	433.3	585.0
6' x 22'	25.5	93.3	193.8	320.0	466.7	630.0
6' x 24'	27.3	100.0	207.7	342.9	500.0	675.0
6' x 25'	28.2	103.3	214.6	354.3	516.7	697.5
6' x 26'	29.1	106.7	221.5	365.7	533.3	720.0
6' x 28'	30.9	113.3	235.4	388.6	566.7	765.0
6' x 30'	32.7	120.0	249.2	411.4	600.0	-
6' x 32'	34.5	126.7	263.1	434.3	633.3	-
6' x 34'	36.4	133.3	276.9	457.1	666.7	-
6' x 36'	38.2	140.0	290.8	480.0	700.0	-
6' x 38'	40.0	146.7	304.6	502.9	733.3	-
6' x 40'	41.8	153.3	318.5	525.7	766.7	-
6' x 42'	43.6	160.0	332.3	548.6	800.0	-
6' x 44'	45.5	166.7	346.2	571.4	-	-
6' x 46'	47.3	173.3	360.0	594.3	-	-
6' x 48'	49.1	180.0	373.8	617.1	-	-
6' x 50'	50.9	186.7	387.7	640.0	-	-
6' x 60'	60.0	220.0	456.9	754.3	-	-
6' x 70'	69.1	253.3	526.2	-	-	-
6' x 80'	78.2	286.7	595.4	-	-	-
7' x 16'	20.9	76.7	159.2	262.9	383.3	517.5
7' x 18'	22.7	83.3	173.1	285.7	416.7	562.5
7' x 20'	24.5	90.0	186.9	308.6	450.0	607.5
8' x 8'	14.5	53.3	110.8	182.9	266.7	360.0
8' x 10'	16.4	60.0	124.6	205.7	300.0	405.0
8' x 12'	18.2	66.7	138.5	228.6	333.3	450.0
8' x 14'	20.0	73.3	152.3	251.4	366.7	495.0
8' x 16'	21.8	80.0	166.2	274.3	400.0	540.0
8' x 18'	23.6	86.7	180.0	297.1	433.3	585.0
8' x 20'	25.5	93.3	193.8	320.	466.7	630.0

Table 1 (continued)
Single-Loop Inductance Calculations