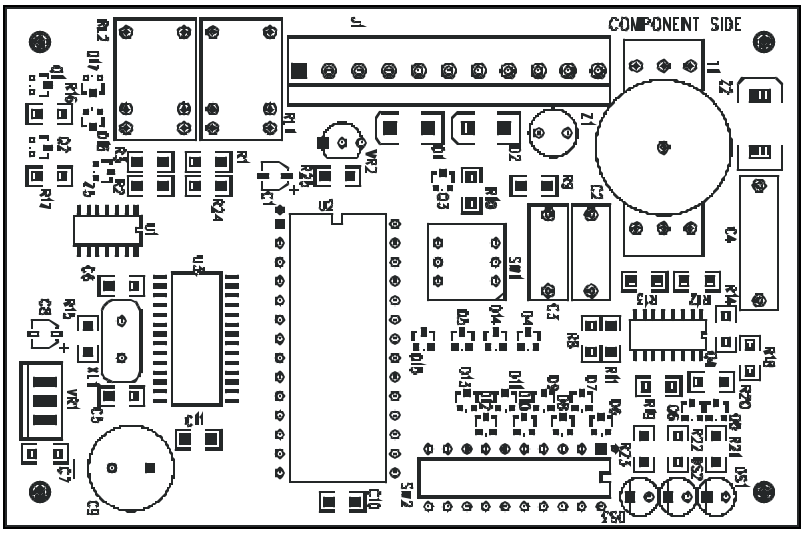
Operations Manual

LMA-400 Series
Inductive Loop Monitors™



This manual contains technical information for the LMA-400 Series Loop Monitor™. Included are General Description, Operation, Installation, Trouble Analysis, and Specification.

The LMA-400 Series Loop Monitors™ are designed and manufactured in the United States of America by Eberle Design, Inc., Phoenix, Arizona.

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1. DESCRIPTION

The LMA-400 Series Inductive Loop Vehicle Detectors are compact, single card inductive Loop Monitors™ which feature high performance capabilities in a small card format. A Molex (Male or Female type) gold plated connector allows connection to power, loop and call outputs. Board mounted switch controls are used to set operational parameters and two high-intensity LEDs indicated vehicle detection and loop fault monitor status. Two volt-free dry contact outputs are used to signal vehicle detections to an external controller or monitor. The LMA-400 series will tune to any loop and lead-in inductance between 20 and 2500 microhenries and will provide satisfactory operation with lead-ins as long as 5000 feet. Loop diagnostic capabilities incorporated within the Loop MonitorTM enable the detection of shorted or open circuit loops and sudden inductance changes exceeding 25 percent of the nominal value. Each type of fault is signified by the loop fault indicator emitting a different flash sequence. This information can greatly assist the user in the diagnosis of loop related problems.

2. OPERATION

Setting up the LMA-400 Series Loop Monitor™.

a. Make connections to power and the loop. Power supply level should be between 8 and 15 VDC for Models LMA-400-12M and LMA-400-12F. Power supply level should be between 18 and 28 VDC for Models LMA-400-24M and LMA-400-24F.

b. Make sure that the harness socket is fully mated with connector plug.

c. Check the LED indicators. If both LEDs are flashing, there is a problem with the loop or the connections to the loop. A single flash followed by a pause indicates an open circuit. A double flash followed by a pause indicates a short circuit. Check loop and lead-in connections carefully.
Note: If power was applied before the loop was connected, the FAULT indicator alone may be flashing. The unit may be reset by momentarily altering sensitivity and then returning to the original value.

d. Set board mounted Rotary & DIP switches as required:

Switch 1 – Sensitivity Boost: This function may be selected when small loops are being used and high bed vehicles are expected.

Switch 2 – Extended Presence: With switch 2 ON an output CALL will always be maintained while a vehicle is present over the loop. With switch 2 OFF, the output CALL will be terminated after 30 minutes whether or not the vehicle has left.

Switch 3 – Call Delay: With switch 3 ON, the outputs will be delayed for a period of 2 seconds after a vehicle has entered the detection zone. If the vehicle does not remain for the full 2 seconds the delay will terminate and no output call will be produced.

Switch 4 and 5 - Call Extension: The output CALL is held for the selected time after the vehicle has left the zone of detection. One of four extension hold times may be selected:

- Switch 4 OFF & Switch 5 OFF = 0 seconds
- Switch 4 ON & Switch 5 OFF = 2 seconds
- Switch 4 OFF & Switch 5 ON = 5 seconds
- Switch 4 ON & Switch 5 ON = 25 seconds

Switch 6 and 7 – Output "B" Operation:

- Switch 6 OFF & Switch 7 OFF = 250 millisecond pulse on vehicle entry.
- Switch 6 ON & Switch 7 OFF = Output B follows operation of Output A.
- Switch 6 OFF & Switch 7 ON = 250 millisecond pulse on vehicle exit.
- Switch 6 ON & Switch 7 ON = Output B is ON during a loop fault condition.

Switch 8 – Failsafe / Failsecure: Output A is failsafe with switch 8 OFF (a constant CALL is produced during a power failure or during a loop fault condition). Output A is failsecure with switch 8 ON (output A does not produce a call during a power failure or during a loop fault).

Switch 9 and 10 – Loop Frequency: The Loop Frequency only needs to be changed if interference occurs between adjacent loops connected to different Loop Monitors™. Interference or crosstalk may manifest itself as chattering of the CALL output or a detect CALL occurring at the same time as an adjacent detector when there is no vehicle present over the loop. If crosstalk is suspected, try to separate the frequencies of the units causing the problem. For example, set one unit to LOW and the other to HIGH.

Operation (Continued)

Four frequency positions are available to assist in alleviating interference affecting more than two units. Switch positions 9 and 10 control frequency:

- Switch 9 OFF & Switch 10 OFF = High Frequency
- Switch 9 ON & Switch 10 OFF = Medium Frequency
- Switch 9 OFF & Switch 10 ON = Medium Low Frequency
- Switch 9 ON & Switch 10 ON = Low Frequency

Note: Monitor the operation of the detector and make adjustments to the sensitivity and frequency as necessary. If the detector detects a fault in the loop, the LED indicators will display the fault type by emitting a sequence of flashes followed by a pause.

Rotary Switch – Sensitivity: Setting sensitivity by moving the rotary switch to the desired position can set 10 switch selectable levels. Position 9 is the highest sensitivity, 0 is the lowest. It is suggested that a value of 4 be set initially, and then increase or decrease the sensitivity as vehicles pass over the loop.

Faults from which the Loop Monitor™ has recovered are indicated by the Fault indicator alone flashing. If the fault remains present both FAULT and DETECT indicators will be flashing. The following are the fault types that can be detected and the flash sequences assigned to each:

a. One Flash: Indicates an open circuit loop or a loop inductance exceeding the upper limit of the tuning range.
b. Two Flashes: Indicates a shorted circuit loop or loop inductance less than the lower limit of the tuning range.
c. Three Flashes: Indicates that a sudden change in inductance occurred which exceeded 25% $\Delta L/L$.

3. LOOP INSTALLATION

The following are suggested guidelines for loop installation. To begin, make sure that the pavement surface in the area that loops are to be installed is dry and free of debris.

The outline of the loop(s) should be marked on the pavement in such a way that the lines can be followed easily by the saw operator and not be erased by the water feed from the saw itself.

All 90-degree corners should be chamfered so that the course of the loop wire does not change direction sharply but rather at shallower angles of 45 degrees or less. Core drilling of the corners achieves the same effect but can still lead to failure due to sharp edges remaining in the corner area.

When the outline of the loop and lead-in has been marked, the pavement can be cut. Diamond blade cutting saws are recommended. The saw cut should be approximately 1.5 to 3.0 inches deep and 0.25 inches wide. The saw slot should then be cleaned out and allowed to dry. Compressed air is useful both for ejecting debris and speeding up the drying process. All debris in the vicinity of the saw slot should also be removed so that it is not accidentally pushed back in.

As a general rule loops with circumference lengths less than 15 feet require 4 to 5 turns of wire, 15 to 30 feet require 3 to 4 turns of wire, loops with greater circumference lengths should have 2 turns.

Recommended loop wire is typically 14, 16, 18, or 20 AWG with cross-linked polyethylene insulation. Since moisture can cause significant changes in the dielectric constant of the insulation, which results in excessive loop (frequency) drift, choose an insulation that is most impervious to moisture. PVC, TFFN, THHN, and THHN-THWN should be avoided since they tend to absorb moisture and crack easily. XLPE (Cross Linked Polyethylene) is very resistant to moisture absorption and provides good abrasion resistance.

If long lead-ins are required, it is suggested that the loop cable be spliced onto shielded, pre-twisted, lead-in wire (IMSA specification 50-2 is suggested) at a convenient pull box location close to the loop. The shield may be connected to earth at the cabinet end but should then be insulated and isolated from earth ground at the loop end.

Start laying the loop wire from the termination of the lead-in out towards the loop, continue around the loop for the number of turns required and finally return to the lead-in termination. Leave the lead-in wire out of the slot so that it may be twisted together before being laid in the slot. Lead-ins should be twisted with a minimum of 4 to 6 twists per foot to prevent any separation of the lead-in wires.

Make sure that the loop wire is pushed fully to the bottom of the saw slot. Small pieces of foam rubber (backer rod) or similar material may be used at various points around the circumference to prevent the loop wire from rising up while the sealant is poured and curing.

Loop Installation (continued):

Many different types of loop sealant are now available. Single part types are the easiest to apply since no mixing is required, but they also tend to be more expensive in terms of linear feet of saw slot filled. When applying the sealant, make sure that it is able to sink to the bottom of the slot and completely encase the loop wire. The wire should not be able to move when the sealant has set. Ensure that there is enough sealant to completely fill the slot; if possible the sealant should protrude slightly above the surface of the pavement so that small rocks or other debris cannot collect in the slot.

The sealant manufacturer's instructions concerning setting time should be noted – especially when determining the length of time to wait before allowing vehicles to cross the loop area.

4. TROUBLE ANALYSIS

The following should be used to troubleshoot both the Loop Monitor™ and the installation.

a. No LEDs lit – detector does not operate or have power.

Power supply fault: The LMA-400-12F and LMA-400-12M detectors require a 10 to 15 VDC supply. Each detector consumes approximately 75mA. The Loop Monitor™ will operate at a voltage as low as 8 volts however supply voltages below this may result in the unit entering a reset state. In this case, the unit will appear to be non-functional.

b. Fault and Detect LEDs flashing.

Loop or lead-in wiring has a fault. Check the type of fault being indicated by number of flashes. The type of fault may assist in locating the problem. A single flash followed by a pause indicates an open circuit loop or loop inductance too large. A double flash followed by a pause, indicates a shorted loop or loop inductance too small.

c. Detector does not detect all vehicles

Sensitivity too low. Increase sensitivity by one setting and observe detection.

d. Detector is noisy/chatters/gives false detect CALLs.

Two or more units are interfering with each other (crosstalk). Check frequency settings on detectors which are connected to loops closest to the Loop Monitor™ exhibiting crosstalk; several may be showing signs of crosstalk themselves. Adjust the frequency switches on all units affected so that the largest possible margin exists between frequencies of loops positioned the closest.

e. Poor connections.

Loop connections are very important to the satisfactory operation of the Loop Monitor™. All connections whether they are in the cabinet or at the roadside must be secure preferably soldered and, in the case of connections made at the roadside, waterproofed to prevent shorting to ground.

f. Poor Loops

Loops that have become degraded due to the passage of traffic may cause Loop Monitors™ to exhibit crosstalk like symptoms. It may be possible to reduce the sensitivity while maintaining adequate detection of vehicles. However, the ideal solution is to replace the loop.

5. SPECIFICATIONS

Power Supply: 10 to 15 volts DC, 75 mA max for models LMA-400-12M and LMA-400-12F. 18 to 28 volts DC, 70 mA max for models LMA-400-24M and LMA-400-24F.

Loop Input: The loop input incorporates lightning and transient protection devices and the loop oscillator circuitry is transformer-isolated. The lightning protection will withstand the discharge of a 10 uF capacitor charged to 2,000V across the loop inputs or between either loop input and earth ground. The transformer isolation allows operation with a loop, which is grounded at a single point.

Tuning: The detector series will automatically tune to any loop and lead-in combination within the tuning range upon application of power. The unit may be retuned by adjusting the rotary sensitivity control and resetting to the desired value.

Tuning Range: 20 to 2500 micro Henry with a Q factor greater than 5.

Lead-in Length: The detector will operate with lead-in (feeder) cable lengths up to 5,000 feet with appropriate loops and proper lead-in cable.

Specifications (continued)

Environmental Tracking: The detector series automatically and continuously compensates for component drift and environmental effects throughout the tuning range and across the entire temperature range.

Grounded Loop Operation: The detector series will operate when connected to poor quality loops including those that have a short to ground at a single point.

High Intensity Color-Coded LED Indicators: Two indicators are used:

The red DETECT LED indicates the detect state and the Yellow FAULT LED indicates the status of the fault monitor.

Fault Monitoring: The detector continuously checks the integrity of the loop. The system is able to detect shorted or open circuit loops, or sudden changes in inductance exceeding 25% of the nominal inductance. If a fault is detected, both the detect and fault LEDs continuously emit a sequence of flashes. Each type of fault is identified by a different flash sequence. See set up section for output response during fault condition.

Flash Sequence	Fault
1 Flash	Open Circuit Loop
2 Flashes	Short Circuit Loop
3 Flashes	25% change in inductance

If the fault condition is removed, the detect LED will return to normal operation. The fault LED will continue to flash with the sequence signifying the type of fault that was last detected. In the case of the excessive inductance change fault, the unit will log the fault and retune to the new inductance after a period of two seconds. The logged fault will be indicated by the fault LED emitting the flash sequence relating to the excessive inductance change fault.

Controls: Board mounted DIP switches allow the user to set up operational parameters and frequency. A rotary switch allows the user to select one of 10 levels of sensitivity.

Sensitivity: One of ten settings may be selected to optimize detection on varying loop and lead-in configurations. Sensitivity is stated in terms of $-\Delta L/L$. i.e. as the minimum percentage change in the total inductance (loop plus lead-in) to which the unit will respond at the given level setting.

Frequency: One of four settings may be selected to alleviate interference which may occur when loops connected to different detectors are located adjacent to one another.

Output Ratings: Relay Outputs. Contacts are rated 2A, 120 VAC, 30 VDC.

Mechanical:

Dimensions: ..... 4.14” Long x 2.71” wide x 0.75” tall

Weight: ..... 10 oz.

Environmental:

Operating Temperature Range: ..... -34^{o}C to $+74^{o}$C (-30^{o}F to 165^{o}F)

Humidity Range: ..... 0 to 95% relative

Connections: The connectors utilize a 10 pin Molex. The male connector is P/N 26-48-3105. The female connector is P/N 09-52-3101-P.

“M” Pin	Function	“F” Pin
1	Output A Relay Common	10
2	Output A Relay Normally Closed (N.C.)	9
3	Output A Relay Normally Open (N.O.)	8
4	Output B Relay Common	7
5	Output B Relay Normally Open (N.O.)	6
6	Reset (when connected to D.C. Power Common)	5
7	D.C. Power (+)	4
8	D.C. Power Common	3
9	Loop	2
10	Loop	1

Note: Relay contacts are shown with power applied, loop(s) connected, and no vehicles present.