Canoga™ Traffic Sensing System
Model 701Microloop™
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1. About These Installation Instructions

1.1 Purpose
This installation instruction provides step-by-step instructions for installing and setting-up the Canoga™ 701 Microloops™. This document is intended for use by installation and maintenance personnel responsible for installation of the system.

1.2 Conventions
The conventions in Table 1-1 help to make this installation instruction easier to use by presenting a uniform approach to the descriptions, phrases and nomenclature.

1.3 Related Publications

1.4 Installation Instruction Organization
This installation instruction manual is divided into 3 sections.

Section 1. About These Installation Instructions
This section describes the purpose of the installation instructions, defines the writing conventions, lists the related publications, and summarizes the organization of the installation instruction.

Section 2. Safety Messages and Safety Labels
This section contains important information about the safety messages in this installation instruction manual. This section also contains important information about safety precautions and procedures for installation of the 701 Microloops and sources for other safety information. This section also contains a compilation of all the safety messages and warning labels that appear in the instructions or on the Microloop.

Section 3. Introduction
This sections outlines the general properties and dimensions of the 701 Microloop.

Section 4. Installation Instructions
This section lists all important steps to install the 701 Microloops and to achieve optimal performance

Section 5: Specifications
This section contains the specifications and operational parameters

<table>
<thead>
<tr>
<th>Model Names</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Model Name</td>
<td>First or formal reference: initial caps Canoga™ 701 Microloop™</td>
</tr>
<tr>
<td>Subsequent use or informal reference: Initial caps for “model”, lowercase for remainder</td>
<td>701 Microloop, or Microloop</td>
</tr>
<tr>
<td>Canoga™ 701 Microloop assembly</td>
<td>Each Microloop assembly consists of one or more Microloops and the lead-in wire Single, double or triple 701 Microloop assembly</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>System Conditioners and Signal Names</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>System mode or phase</td>
<td>Initial caps Enable Microloop mode</td>
</tr>
<tr>
<td>System status</td>
<td>Initial caps the Status output or indication</td>
</tr>
<tr>
<td>Signal name</td>
<td>Initial caps the Reset signal</td>
</tr>
</tbody>
</table>
2. Safety Messages and Safety Labels

Your safety and the safety of others are very important. We provide important safety messages in this installation instruction and on the device. Please read the safety messages and safety labels carefully before beginning the work. We also provide important damage prevention messages in this installation instruction.

2.1 Safety Message Formats

A safety message alerts you to potential hazards that can cause personal injury to you and others, or property damage. Each safety message includes a safety alert symbol (▲) and one of three words: DANGER, WARNING, or CAUTION to describe the relative level of hazard.

The words and symbols and their meanings are shown below:

- **DANGER**
  - The safety message is in this box.
  
  DANGER means you and/or someone else WILL be KILLED or SERIOUSLY HURT if you do not follow these instructions.

- **WARNING**
  - The safety message is in this box.
  
  WARNING means you and/or someone else MAY be KILLED or SERIOUSLY HURT if you do not follow these instructions.

- **CAUTION**
  - The safety message is in this box.
  
  CAUTION means you and/or someone else MAY be HURT or property damage may result if you do not follow these instructions.

Each safety message explains what the hazard is, what can happen to you or others, and what you can and should do to avoid the risk of exposure to the hazard.

Please read the safety messages and safety labels carefully before beginning the work.

Damage Prevention Messages

We provide important safety messages in this manual to help you prevent damage to the devices. Each damage prevention message includes the word NOTICE.

This word and its meaning are shown below:

- **NOTICE**
  - The damage prevention message is in this box.
  
  NOTICE means that this device, or another device, may be damaged if you do not follow the instructions. These messages are to help you prevent damage to the device, other devices, and to the environment.

2.3 Safety Label Formats

A safety label alerts you to potential hazards that can cause personal injury to you and others, or property damage. Each safety label includes a symbol or pictogram, a word to describe the relative level of the hazard and explanatory text.

The words and symbols or pictograms and their meanings are shown below:

- **DANGER**
  - The pictorial is in this box.
  - The message is in this box.

  DANGER means you WILL be KILLED or SERIOUSLY HURT if you do not follow the instructions.
Safety Label Locations

Safety labels are placed on the devices where you will see them before you may be exposed to a hazard. Please read the safety labels. They contain important safety information. We consider safety labels to be an important part of the device and they should be replaced if they are damaged or they become hard to read. If any of the safety labels on this device are missing or cannot be read please contact your dealer or Global Traffic Technologies Technical Service for a replacement.

WARNING means you MAY be KILLED or SERIOUSLY HURT if you do not follow the instructions.

CAUTION means you MAY be HURT or property damage may result if you do not follow the instructions.

Please read the safety messages and safety labels carefully before beginning the work.

2.4
3. Introduction

The Canoga™ 701 Microloop™ sensor is a unique, reliable device for sensing vehicles passing over the sensor. This passive device is contained in a small, cylindrical probe, which transforms changes in magnetic field intensity into changes in inductance similar to that of an inductive loop. Vehicles change the intensity of the earth’s magnetic field. When the Microloop is attached to a device that senses changes in inductance, such as a Canoga C900 or Traffic Monitoring Card vehicle detector, vehicle passage over the Microloop is detected.

- The 701 Microloops has been successfully used in cobblestone pavements, poor pavements, dirt/gravel roads, and bridge decks.

The area of detection provided by a traffic sensor is smaller than that provided by a 6-ft. x 6-ft. (1.8 m x 1.8 m) inductive loop and may be considered a small area sensor.

This characteristic allows separation of closely spaced vehicles, very good rejection of vehicles in adjacent lanes, and near immunity to “crosstalk” problems.

3.1 Description

The Canoga 701 Microloop is comprised of an injection molded urethane cylinder (7/8-in. or 2.2 cm) diameter) with cable emerging from one end as shown in Figure 3–1. The cable is jacketed with durable urethane and will fit into a ¼ in. (6.4 mm) sawcut.

The 701 Microloops are available in standard single, double or triple assemblies (see below for details). Custom configurations can be ordered, but incur a handling charge.

3.2 Basic Application Guide

The 701 Microloop sensors when connected to the Canoga C900 vehicle detectors or Traffic Monitoring Cards can be used in intersection, traffic monitoring, traffic counting and classification, and ramp metering applications.

The 701 Microloops and the Canoga C900 series vehicle detectors or the Traffic Monitoring Card form a match component system optimized for performance. The user must determine whether the performance is compromised when using a non-Canoga vehicle detector.
4. Installation follows these eight steps:
1. Installation planning
2. Magnetic field measurements at installation site
3. Hole boring and saw cutting
4. 701 Microloop sensor and cable placement
5. Resistance checks
6. Backfilling and sawcut sealing
7. Splice to lead-in (home-run) cable
8. Connection to inductive loop detector and final checks

4.1 Installation Planning
1. List the requirements for the application to be implemented using the 701 Microloops: vehicle types expected, traffic conditions, minimum and maximum speed, lane widths, and specific results desired

**CAUTION**

If an inductive loop detector other than Canoga Vehicle Detector is used with the 701 Microloop, then any performance issues and questions have to be addressed by the manufacturer of the inductive loop detector.

2. Plan the physical requirements of the installation based on the application needs. Some general guidelines are:
   - Single sensor assembly/lane: Use to detect passenger cars, trucks, buses.
   - Double sensor assembly/lane with 4-ft. (1.22 m) separation: use at locations where vehicle change lanes.
   - Triple sensor assembly with 3 ft. (0.91 cm) intervals: use when motorcycles in addition to motor vehicles have to be detected or for detecting bicycles (all steel-framed bikes).
   - Two double Microloop sensor assemblies per lane at 14ft. (4.3 m) separation down-the-lane and centered in the lane: Use to obtain vehicle speed and length data using the traffic monitoring card.
   - Probe Depth: 18-24 in. (45-60cm) from road surface to bottom of sensor.

Installing of 701 Microloops deeper may cause motorcycles and bicycles to go undetected.

3. Order standard Microloop Assemblies to match the installation requirements

<table>
<thead>
<tr>
<th>Table 4-1: List of Standard 701 Assemblies</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>701 Microloop Assembly</strong></td>
</tr>
<tr>
<td><strong>Lead-in Wire Length</strong></td>
</tr>
<tr>
<td><strong>Distance between Sensors</strong></td>
</tr>
<tr>
<td>Single Sensor Assembly</td>
</tr>
<tr>
<td>701-1 75 ft or 22 m Not Applicable</td>
</tr>
<tr>
<td>150 ft or 45 m Not Applicable</td>
</tr>
<tr>
<td>250 ft or 76 m Not Applicable</td>
</tr>
<tr>
<td>500 ft or 152 m Not Applicable</td>
</tr>
<tr>
<td>1000 ft or 304 m Not Applicable</td>
</tr>
<tr>
<td>Double Sensor Assembly</td>
</tr>
<tr>
<td>701-2 75 ft or 22 m 7 ft (2.13 m)</td>
</tr>
<tr>
<td>150 ft or 45 m 7 ft (2.13 m)</td>
</tr>
<tr>
<td>250 ft or 76 m 7 ft (2.13 m)</td>
</tr>
<tr>
<td>500 ft or 152 m 7 ft (2.13 m)</td>
</tr>
<tr>
<td>1000 ft or 304 m 7 ft (2.13 m)</td>
</tr>
<tr>
<td>Triple Sensor Assembly</td>
</tr>
<tr>
<td>701-3 75 ft or 22 m 6 ft (1.8 m)</td>
</tr>
<tr>
<td>150 ft or 45 m 6 ft (1.8 m)</td>
</tr>
<tr>
<td>250 ft or 76 m 6 ft (1.8 m)</td>
</tr>
<tr>
<td>500 ft or 152 m 6 ft (1.8 m)</td>
</tr>
<tr>
<td>1000 ft or 304 m 6 ft (1.8 m)</td>
</tr>
</tbody>
</table>

Custom ordered assemblies are available with a 10% handling charge.
The 701 Microloops have been used for many different vehicle detection applications. The following figures show two examples:

- Intersections: 701 Microloops have been used successfully for advance detection and presence detection in intersection when used with the Canoga C900 vehicle detectors.

- Detection of vehicles on bridges: The installation requirements for this application are described in detail in the document entitled: Application Guide: Using Canoga Microloops under Bridge Decks for Vehicle Detection.

Figure 4-1. Typical Microloop Installation for Advance Detection

Figure 4-2 Installation of 701 Microloop for Detection of Vehicles on Bridges
4.2 Magnetic Field Measurements at Installation Site

Microloops should never be installed without conducting a magnetic field analysis prior to commencing boring and cutting of pavement.

4.2.1 Operating Requirements

The ambient vertical magnetic field intensity must be greater than 200 milligauss and must be less than 800 milligauss to ensure adequate sensitivity to detect vehicles. A value of 500 milligauss/millioerstads to 600 milligauss/millioerstads is optimal.

4.2.2 Measuring Equipment

Measurements of the magnetic field intensity must be taken using a magnetometer to verify, from a magnetic field point of view, the acceptability of a proposed mounting location.

A magnetometer that is small and effective for taking the needed measurements is the Meda μMAG®-01 Magnetometer with 400 Hz option. This meter, when combined with a portable storage oscilloscope, can take all necessary measurements.

Information about the μMAG® 01 handheld fluxgate magnetometer is available from the following website:

4.2.3 Measurements

1. Take all measurements at the planned installation locations of each Microloop
2. Place the handheld magnetometer probe in a vertical position (cable up with probe arrow pointing down) and turn the selector switch to 2000 milligauss (Milligauss = milliOerstads in air). The unit will power-up and display numeric values in LCD display. If you do not see anything on the display, most likely the batteries are bad and need to be replaced.
3. Measure and record the magnitude and sign of the ambient magnetic field in the preferred area of the sensor location, but at a distance from the nearest steal structure of at least ½ of the height of the steel structure.
4. Take measurements at the desired installation location for each sensor in an assembly with multiple sensors

4.3 Hole Boring and Saw Cutting

Global Traffic Technologies recommends the placement of a PVC pipe inside the bored hole. The pipe will ensure that the soil is stabilized and that the 701 Microloop is mounted in a vertical position and is stable.

1. Measure the diameter of the pipe to be used for lining the hole to be drilled.
2. Adjust the size of the hole to be drilled based on the size of the pipe used. Plumbing pipe is different than electrical pipe. Plumbing PVC pipe might be 1-1/16 in. (2.7 cm) diameter and electrical PVC pipe 1-5/32 in. (2.93 cm) in diameter.
3. Bore a 1 1/4 in. (3.1 cm) diameter hole to a depth of several inches (centimeters) deeper than final placement to allow for debris in the bottom of the hole.
4. Insert PVC tube (if used) measure the hole depth to ensure sufficient depth for the sensor to be installed (18-24 in. or 45-60 cm).
5. Install the 701 Microloop in a vertically position (± 10° from vertical) and make sure that its position is mechanically stable.
3. Make one ¼ in. (6 mm) wide sawcut from the road edge to each sensor hole using the standard procedure for inductive loops. The cut can be shallower or deeper than the sawcut for inductive loop.
4.4 Placement of Sensor and Cable

1. Place a colored electrical tape around the lead-in cable to guide the depth of the sensor. The distance from the end of the sensor to the tape mark should be 18-24 in. (45-60 cm) minus the depth of the saw cut.

2. Insert the sensor and adjust the depth until the colored electrical tape is at the junction of the hole (PVC pipe) and the sawcut. The sensor is now at the optimal depth.

3. Insert all sensors or sensor assemblies and place the lead-in cables into the sawcut.

Note: When a sensor assembly is installed, the most distant sensor (sensor with only one lead-in cable) is installed first.

Recommended sensor installation is shown in Figure 4-3.

![Figure 4-3. Typical 701 Microloop Roadway Installation](image)

4.6 Backfilling and Sawcut Sealing

1. Fill the PVC pipe (or hole) with fine, dry sand, such as sandblasting sand.

2. Slowly lift the probe until the depth marking tape aligns with the bottom of the sawcut. Release the probe.

3. Add more sand and repeat if the sensor falls back down.

4. Repeat until the sensor is stabilized.

5. Fill any excess area around the PVC pipe as well.

6. Fully fill the hole to the bottom of the sawcut.

Complete the installation by filling the tope of the hole and the sawcut with 3M Detector Loop Sealant.
4.7 Splice Lead-in to Home-run Cable

Use of Canoga 30003, a twisted, shielded cable for the home-run cable. The cable is designed for use as home-run cable and for reliable performance.

- Four-conductor #18 AWG shielded cable with a tough, high-density polyethylene jacket.
- Resistant to abrasion damage during pulling through conduit.
- Filled with an amorphous material, which prevents the penetration of water into the cable. This protects the cable and system from environmental factors that might otherwise degrade the cable and impede system performance.

Shielded cable with twisted wires (not twisted pairs) to reject magnetic field induced noise. To achieve this noise rejection, opposite pairs (RED, GREEN) or (BLACK, WHITE) must be used.

1. Connect the first traffic sensor assembly to the opposite pairs (RED, GREEN)
2. Connect the second traffic sensor assembly to the second pair (BLACK, WHITE)
3. Connect each pair of the 30003 cable channels to a single channel of the Canoga C900 vehicle Detector or TMC.
4. Solder, insulate and seal all connections using the 3M™ Scotchcast™ 3832 Buried Service Wire Splice Installation Kit.

<table>
<thead>
<tr>
<th>Measuring Points: Sensor Cable Wire Colors</th>
<th>Correct Resistance: Calculate prior to measuring</th>
</tr>
</thead>
<tbody>
<tr>
<td>RED – to – GREEN</td>
<td>.5 ohms nominal per sensor in assembly (in series) PLUS 3.2 ohms nominal per 100 ft. of interconnecting and lead-in cable</td>
</tr>
<tr>
<td>RED to Earth Ground or GREEN to Earth Ground</td>
<td>Greater than 1 megohm</td>
</tr>
</tbody>
</table>

*Total Resistance = [[(ohms per sensor) + [(ohms per 100 feet)/(100)]]

Table 4-2. Resistance Checks – Expected Reading
4.8 Connecting Microloop Assemblies in Series

701 Microloop sensor assemblies may be connected in series in the pullbox. See Figure 4-4 for connecting several Microloop sensor assemblies in series.

Note that the RED wire from the first sensor assembly connects to RED wire of the home-run cable, GREEN from the first sensor assembly goes to RED wire of the second sensor assembly, etc., and GREEN wire from the sensor assembly goes to GREEN wire of the home-run cable.

Figure 4-4. Connecting Traffic Sensor Assemblies in Series

4.9 Connection to Canoga C900 series vehicle detectors/TMC and Final Checks

4.9.1 Final Resistance Checks

Use an ohmmeter to repeat the resistance checks described in Section 2.5 and Table 5-2. This should detect any wiring errors.

4.9.2 Home-run Cable Connections

Connect the RED and GREEN wires to the inductive loop detector’s loop input.

4.9.3 C900/TMC Vehicle Detector Settings

Set the inductive loop detector controls to the proper settings. For Canoga™ C900/TMC vehicle detector the usual settings are (see C900 Configuration Software):

- LONG LOOP/MICROLOOP TAB:
  1. Select Microloop for each channel
  2. Select the SUGGEST button to set the parameters.

- CHANNEL SETTINGS:
  1. Set sensitivity for each channel.
     Typically 3 for passenger vehicles, trucks, buses; typically 3 or 4 for motorcycles and bicycles.
  2. Set frequencies to LOW, Medium Low, Medium High or to High.
4.9.4 Final Check and Verification

1. Turn on the Canoga C900 and connect a laptop computer running the C900 Configuration Software. Use TMC-CS if you are connecting to a Canoga Traffic Monitoring Card.

2. Select the real-time activity screen.

3. Check that each channel with a Microloop connected to it shows proper operation (see Canoga C900 Installation Instructions and Canoga TMC Installation Instructions).
5. Specifications

5.1 Physical Specifications
Assembly shall be sealed against moisture entry.

**Probe:** Cylinder: Gray color, 0.88-in. outside diameter and 3.63-in. long.

**Probe Interconnecting and Lead-in Cable:**
0.20-in. outside diameter, polyurethane jacketed, 4 conductor, #22 AWG, RED, GREEN conductor color coding, bundle twisted at 4 to 6 twists per ft., BLACK, WHITE (present??)

Environmental Specifications

**Temperature Range:** -35°F to +165°F (-37°C to +74°C)

**Humidity:** 0% to 100% relative humidity, including submersion in solutions of chemicals typical of roadway runoff.

**Magnetic Field Noise:** AC magnetic field intensity noise must be less than 10 milloersteds peak-to-peak divided by the number of probes connected in series for most common installation configurations.

**Ambient Magnetic Field Intensity:** 200 to 800 milloersteds operating magnetic field intensity (the polarity must be the same as that of the earth’s magnetic field in the installation area).

5.2 Electrical Specifications

**Inductance:** 25 microhenries nominal per probe plus 21 microhenries nominal per 100 ft. of interconnecting and lead-in cable.

**Resistance:** 0.5 ohms nominal per probe plus 3.2 ohms nominal per 100 ft. of interconnecting and lead-in cable.

**Q:** Nominally 3 at 40 kHz, 400 milloersteds ambient magnetic field intensity, nominally 5 at 100 kHz, 400 milloersteds magnetic field intensity.

**Sensitivity:** 3.5 to 8.0 nanohenries per milloersted at 40 kHz, 400 milloersteds ambient magnetic field intensity. Sensitivity at 100 kHz, 400 milloersteds ambient magnetic field intensity is about 60% of the sensitivity at 40 kHz.
6. Troubleshooting

This section provides guidance on areas to examine, if any tests during installation check-out failed.

Table 6-1 lists the symptoms of 701 Microloop installation problems. The table also shows the possible causes of those problems and suggests actions to correct them.

Many of the actions – check L, ΔL, Loop Frequency, Reference Frequency, fault indications – require use of a Canoga 900 series vehicle detector, a personal computer (PC) and C900 Configuration Software (C900 CS). Consult Canoga™ 900/TMC series Installation Instructions and C900/TMC CS on-line help for directions on using these products.
### Table 6-1. Troubleshooting Symptoms, Possible Causes, and Actions

<table>
<thead>
<tr>
<th>Symptom</th>
<th>Possible Cause</th>
<th>Solution</th>
</tr>
</thead>
<tbody>
<tr>
<td>DC resistance too high.</td>
<td>Home-run/lead-in may be connected to a different sensor than specified.</td>
<td>Confirm that the detector channel is connected to the proper sensor by inserting the Canoga 900 or TMC vehicle detector into its’ rack slot and monitoring the Call indicator LED for this channel. You should see a Call only when a vehicle passes over the Microloop to which the tested channel should be connected. If the vehicles and calls don’t correlate, determine which 702 Microloop is connected to the channel and correct the wiring.</td>
</tr>
<tr>
<td>Home-run/lead-in is longer than anticipated.</td>
<td></td>
<td>Determine actual routing of home-run/lead-in cable and that routing is acceptable. Correct as required.</td>
</tr>
<tr>
<td>Home-run/lead-in wire gauge is smaller than anticipated.</td>
<td></td>
<td>Determine AWG of home-run/lead-in wire. It is normally OK if the size of the wire is 22 AWG or larger for lengths of less than 1000 feet (300 m).</td>
</tr>
<tr>
<td>Microloop sensor assembly contains more sensors than anticipated.</td>
<td>Connect a Canoga C900 or TMC vehicle detector to the Microloop being checked. First check that vehicles are being sensed (calls occur). Using the Activity screen, check the channel L. If it is one or more increments of 56 μH more than expected, it is likely that the sensor assembly contains additional sensors. Then monitor the ΔL caused by autos and compare it to that given in Table 9-3. Each additional sensor will add approximately the ΔL of a single sensor. Correct as required.</td>
<td></td>
</tr>
<tr>
<td>Symptom</td>
<td>Possible Cause</td>
<td>Solution</td>
</tr>
<tr>
<td>-----------------------------------------</td>
<td>----------------------------------------------------</td>
<td>------------------------------------------------------------------------------------------------------------------------------------------</td>
</tr>
</tbody>
</table>
| DC resistance too high. (Cont.)         | Poor wiring connection.                            | 1. Flex, jar or otherwise manipulate each connection point, one connection point at a time. If the resistance changes, the connection is faulty. Repair it.  
2. Connect a Canoga 900 or TMC vehicle detectors to the sensor being checked. Using the Activity screen, check the channel Loop Frequency. If the Loop Frequency does not return to the Reference Frequency after each vehicle or it strays several Hertz from the Reference Frequency when no vehicles are near, there is a possibility that a poor connection is being manipulated by vehicle induced vibrations. Recheck all splices and connections. Repair if required. |
<p>| DC resistance too low.                  | Home-run/lead-in may be connected to a different Microloop sensor than specified. | Confirm that the detector channel is connected to the proper sensor by inserting the Canoga 900 or TMC vehicle detector into its rack slot and monitoring the Call indicator LED for this channel. A Call should occur only when a vehicle passes over the 701 Microloop to which the tested channel should be connected. If the vehicles and calls don’t correlate, determine which 701 Microloop is connected to the test channel and correct the wiring. |
| Home-run/lead-in is shorter than anticipated. |                                           | Determine actual routing of home-run/lead-in cable and that routing is acceptable. Correct as required.                                   |
| Home-run/lead-in wire gauge is larger than anticipated. |                                           | Determine AWG of home-run/lead-in wire. It is normally OK if the size of the wire is larger than specified.                            |
| Microloop sensor assembly contains fewer sensors than anticipated or sensors are connected in parallel. |                                           | Connect a vehicle detector to the sensor being checked. Using the Activity screen, check the channel L. If it is one or more increments of 56 μH less than expected, it is likely that the sensor assembly contains fewer sensors than anticipated. Then monitor the ΔL caused by autos and compare it to that given in Table 9-3. Each missing sensor will cause a reduction in ΔL of approximately the ΔL of a single sensor. Correct as required. If the L is about ½ of that expected and the ΔL is about ¼ of that expected, the sensor assembly is likely connected in parallel. Correct by splicing in series. |</p>
<table>
<thead>
<tr>
<th>Symptom</th>
<th>Possible Cause</th>
<th>Solution</th>
</tr>
</thead>
<tbody>
<tr>
<td>DC resistance too low. (Cont.)</td>
<td>Short circuit in system.</td>
<td>Connect a Canoga 900 or TMC vehicle detector to the 701 Microloop sensor assembly being checked. First check that vehicles are being sensed. If vehicles are being sensed, it is unlikely that there is a short in the wiring. Most shorts will be directly indicated by the C900/TMC fault indicators and on the Activity screen.</td>
</tr>
<tr>
<td>Megohmmeter resistance too low.</td>
<td>One of the following:</td>
<td>Test to determine the causes.</td>
</tr>
<tr>
<td></td>
<td>• Lead-in cable insulation damaged.</td>
<td></td>
</tr>
<tr>
<td></td>
<td>• Home-Run cable insulation damaged.</td>
<td></td>
</tr>
<tr>
<td></td>
<td>• Home-Run cable water-logged.</td>
<td></td>
</tr>
<tr>
<td></td>
<td>• Splice poorly insulated or water-logged.</td>
<td></td>
</tr>
<tr>
<td></td>
<td>• Dirty terminal block-home-run cable connections.</td>
<td></td>
</tr>
<tr>
<td></td>
<td>• Vehicle detector connected to the sensor.</td>
<td></td>
</tr>
<tr>
<td></td>
<td>• Microloop sensor(s) failed.</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
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</tr>
<tr>
<td></td>
<td></td>
<td>1. Ensure that a detector is not attached to the home-run cable. Retest. If the results are OK, the problem is likely that the detector was plugged in.</td>
</tr>
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<td></td>
<td></td>
<td>2. Determine whether the sensor is working properly (e.g. inductance is OK, ΔL caused by vehicles is OK, and the oscillation frequency is stable). If all functional parameters are as expected, decide whether to fix the low resistance problem. If one or more functional parameters are unacceptable, most likely oscillator stability, the problem must be fixed.</td>
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<td>3. Determine whether the problem is in the cabinet or external to the cabinet by detaching the lead-in wires from the terminal block. Retest the lead-in. If the results are OK, the problem is in the cabinet and vice-versa.</td>
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<td>4. If testing indicates the problem is not in the cabinet containing the vehicle detector, go to the first splice to the lead-in of the Microloop sensor assembly, remove the splice, and retest the Microloop sensor assembly and the home-run cable.</td>
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<td>5. Correct the problem indicated by testing. Replace either the Microloop sensor assembly, the home-run cable, or the splice.</td>
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</tbody>
</table>
### Table 6-1. Troubleshooting Symptoms, Possible Causes, and Actions (Cont.)

<table>
<thead>
<tr>
<th>Symptom</th>
<th>Possible Cause</th>
<th>Solution</th>
</tr>
</thead>
<tbody>
<tr>
<td>L (inductance) is too high or too low.</td>
<td>Lead-in and/or home-run cables longer than anticipated.</td>
<td>If the inductance and the resistance are greater than expected, the lead-in and/or home-run cable routing is acceptable. Verify that desired functionality is occurring, e.g. ΔLs caused by vehicles are OK and that the Loop Frequency is stable and returns to the same value after each vehicle. If there is a very long cable to the Microloop sensor assembly, e.g. 2500 feet (762 m) or greater, the oscillator may be very unstable.</td>
</tr>
<tr>
<td>Lead-in and/or home-run cables shorter than anticipated.</td>
<td>If the inductance and the resistance are less than expected, the lead-in and/or home-run cable is shorter than anticipated. Shorter cable runs are not a problem.</td>
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<tr>
<td>Lead-in and/or home-run cable open.</td>
<td>Use a Canoga 900 or TMC vehicle detector. If there is an open in the cable to the sensor, the detector will indicate an open unless the lead-in/home-run cable length is very long, e.g. &gt;2500 feet (762 m). The problem should have been found by the test with the ohmmeter.</td>
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<tr>
<td>Microloop sensor count is different than expected.</td>
<td>If there are fewer sensors than expected, the sensor L will be low by ≈56 μH per Microloop and the sensor ΔL readings for vehicles will be much lower than expected. The reverse is true, if there are extra sensors. Check the splicing and the sensor assembly.</td>
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<tr>
<td>Microloop Sensor failed.</td>
<td>Microloop Sensors can fail in two ways.</td>
<td>1. Failure Mode: The L will be ≈500 μH larger than expected. While the failed Microloop will not detect, if it is one sensor of a multiple sensor assembly, detection will still occur at a lower than expected ΔL.</td>
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<td>2. Failure Mode: Open connection that should be indicated by the fault status of the detector. This may be confirmed by measuring a very large resistance with an ohmmeter when the detector is not attached to the sensor. The open may be somewhere in the home-run or in the sensor assembly. To determine that the open is in the sensor assembly requires a resistance reading taken with the sensor assembly lead-in disconnected from the home-run cable. If a defective sensor assembly is indicated, replace it and retest.</td>
</tr>
<tr>
<td>Symptom</td>
<td>Possible Cause</td>
<td>Solution</td>
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<tr>
<td>L (inductance) is too high or too low. (Cont.)</td>
<td>Microloop sensors wired in parallel rather than in series.</td>
<td>If a Microloop is connected in parallel in a sensor assembly, ΔL readings for vehicles, as well as the L reading, will be much lower, one quarter or less, than expected. Check the splicing and the traffic sensor assembly.</td>
</tr>
<tr>
<td>ΔL (change in inductance) is too high or too low.</td>
<td>Incorrect Microloop sensor depth.</td>
<td>ΔL readings increase as Microloop sensor depth decreases and vice versa. Review the conduit depth plot. The installation contractor can check conduit depth using his depth measuring equipment. Have the contractor correct problems as required.</td>
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<tr>
<td>Sensors spliced in parallel rather than in series.</td>
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<td>L readings may be about ½ that expected and ΔL readings may be about ¼ of that expected. Examine the splice. Fix as required.</td>
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<tr>
<td>Incorrect Microloop sensor count.</td>
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<td>The ΔL readings will increase if there are more Microloop sensors than expected and ΔL readings will decrease if there are fewer Microloops than expected. Check the number of Microloops in a sensor assembly by removing all sensors and carriers from the conduit. Carefully record the number of carrier sections from the conduit end and each Microloop in each sensor assembly. Correct any problems found.</td>
</tr>
<tr>
<td>Symptom</td>
<td>Possible Cause</td>
<td>Solution</td>
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<tr>
<td>(\Delta L) (change in inductance) is too high or too low. (Cont.)</td>
<td>Microloop sensors installed near pavement reinforcement rod (or other ferromagnetic structure).</td>
<td>The (\Delta L) readings may be smaller than expected, if the sensor is in a very high or very low magnetic field. Measure the magnetic field directly above the sensor location using a magnetometer, such as Meda Model (\mu)MAG. If the magnetic field strength measured is significantly above or below the vertical component of Earth magnetic field at that general location, a problem may exist. Move the measuring probe 6 inches (15 cm) to the left and right (across the traffic lane). If the measured field is constant over this 1-foot (30 cm) distance, there is unlikely a problem. If it varies significantly, look for a position to the left or right of the original sensor location (in the direction of the conduit) that has a constant magnetic field. Change the specified Microloop location to this constant field location. (Fields must be between 200 and 800 milloerstads or gauss.)</td>
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<tr>
<td>Incorrect sensor-to-lane location.</td>
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<td>The (\Delta L) may be smaller than expected or adjacent lane calls may occur, if the Microloop(s) are at the wrong location.</td>
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</tbody>
</table>
| Loop Frequency (\(F\)) and/or Reference Frequency (\(F_{ref}\)) is unstable, e.g. false calls or missed calls or Loop Frequency doesn’t return to same value between vehicles. | Cross-talk. | 1. Attach the Microloop sensor assemblies to the same Canoga 900 series vehicle detector.  
2. Ensure that the frequency at which a different detector is driving its sensor assembly is separated by more than 10,000 Hz from the frequency at which the other detector is driving its 702 Microloop sensor assembly. |
### Table 6-1. Troubleshooting Symptoms, Possible Causes, and Actions (Cont.)

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<td>Loop Frequency (F) and/or Reference Frequency (Fref) is unstable, e.g. false calls or missed calls or Loop Frequency doesn’t return to same value between vehicles. (Cont.)</td>
<td>Line frequency magnetic interference.</td>
<td>Turn on 60 Hz or 50 Hz filtering. If the calls disappear, they were caused by line frequency magnetic interference. Turning on line filtering is a method of distinguishing crosstalk from line frequency magnetic interference. <strong>NOTE:</strong> Detection tasks that require rapid measurement response, such as speed measurement, vehicle travel direction detection and occupancy measurement of high speed vehicles, are adversely affected when line filtering is turned on.</td>
</tr>
<tr>
<td>Poor connection to Microloop sensor.</td>
<td>1. Flex, jar or otherwise manipulate each connection point, one connection point at a time. Changing resistance will cause calls, just like inductance changes. If the resistance changes, the connection is faulty. Repair it. 2. If the Loop Frequency does not return to the same value after each vehicle, there is still a possibility that there is a poor connection that is being manipulated by vehicle induced vibrations. Recheck each connection.</td>
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<tr>
<td>Inconsistent resistance to Earth.</td>
<td>See “Megohmmeter resistance too low”.</td>
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<tr>
<td>Microloop sensor physical rotational movement.</td>
<td>Check conduits mounted underneath bridges or other structures for movement and stabilize as required.</td>
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<tr>
<td>Incorrect Microloop sensor location.</td>
<td>To help prevent calls from tall tractors or trucks to a sensor set located in an adjacent lane, install the sensor sets on East-West roads with an offset of one (1) foot (30cm) north of lane center. Correct sensor position as required.</td>
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</tr>
<tr>
<td>Microloop sensors spliced in parallel rather than in series.</td>
<td>Examine the splice. Fix as required.</td>
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</tr>
<tr>
<td>Incorrect Microloop sensor count.</td>
<td>Check the number of Microloops in a sensor assembly by removing all Microloops and carrier sections from the conduit. Carefully record the number of carrier sections from the conduit end and each Microloop in each sensor assembly. Correct any problems found.</td>
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</tbody>
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