ORACLE E SERIES

Rack Mount

2E, 2EC, 2ECX, 4E, 4ECX, 4H, 4HX

Enhanced Loop Monitor

Operations Manual

THIS MANUAL CONTAINS TECHNICAL INFORMATION FOR THE ORACLE 2E, 2EC, 2ECX, 4E, 4ECX, 4H and 4HX, PCB Issue K, Firmware 3.5

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Table of Contents

Section 1 General **1**
1.1 Description 1

Section 2 Functions **2**
2.1 General Functions 2
2.1.1 Front Panel Controls 2
2.1.1.1 Oracle 4H Display Select Control 2
2.1.2 Sensitivity 3
2.1.3 Loop Frequency 3
2.1.3.1 Frequency Stability Graph 3
2.1.3.2 Noise Filter 3
2.1.4 Sensor Modes (Oracle EC Series) 3
2.1.4.1 Probe Mode (Oracle EC Series) 4
2.1.4.2 Rail Mode (Oracle EC Series) 4
2.1.5 Presence / Pulse Modes 4
2.1.6 Delay and Extend Function 4
2.1.6.1 Call Delay Timer 4
2.1.6.2 Call Extension Timer 4
2.1.6.3 Timer Control Inputs 5
2.1.7 Channel Display 5
2.1.7.1 Count down timers 5
2.1.7.2 Loop frequency Display 6
2.1.7.3 Loop Inductance Display 6
2.1.7.4 Vehicle Count Display (Oracle EC Series) 6
2.1.7.5 DEFLECTOMETER® Pie Graph 6
2.1.7.6 DEFLECTOMETER® Streaming Graph 6
2.1.8 Event Log 6
2.1.9 Channel ID 6
2.1.10 Paired Channel Functions 6
2.1.10.1 3rd Car Mode 6
2.1.10.2 Directional Logic 7
2.1.11 Set Factory Default Settings 7
2.2 Operational 7
2.2.1 Channel Output Control 7
2.2.2 LCD Display 8
2.2.3 High Intensity Color-Coded LED Indicators 8
2.2.4 Loop Fault Monitor 8
2.3 Vehicle Counting (Oracle EC Series) 9
2.3.1 Vehicle Counting (*AccurateCount*) Display 9
2.3.2 Vehicle Counting (*AccurateCount*) Mode 9
2.3.3 Vehicle Counting (*AccurateCount*) Loop Configurations 9

Section 3 Programming **10**
3.1 Installation 10
3.1.1 Main Menu 10
3.1.2 Oracle 4H Display Select Control 10
3.2 SET UP Menu 10
3.2.1 Sensitivity 10
3.2.1.1 Adjusting sensitivity using the DEFLECTOMETER® 11
3.2.1.2 Adjusting sensitivity without using the DEFLECTOMETER® 11
3.2.2 Frequency 11
3.2.3 Paired Channel Modes 12
3.2.3.1 3rd Car mode 12
3.2.3.2 Directional Logic mode 12
3.2.4 Operational Modes 12

3.2.4.1 Presence Mode....12
3.2.4.2 Timing....13
3.2.5 Channel ID....14
3.3 Vehicle Counting (Oracle EC Series)....14
3.3.1 Counting Type (*AccurateCount*)....14
3.3.2 Vehicle Counting Output (*AccurateCount*)....14
3.4 Display Modes....14
3.5 Loop Fault Monitor....15
3.6 Event Log....15
3.7 System Menu....15
3.7.1 Run Menu Item....15
3.7.2 System Info Menu Item....15
3.7.3 Temperature and Voltage Menu Item....15
3.7.4 LCD Display Heater Menu Item....15
3.7.5 Options Menu Item (Oracle EC Series)....16
3.7.5.1 Probe Gap Menu Item....16
3.7.5.2 Stream Menu Item (Oracle ECX Series)....16

Section 4 Theory of Operation....17
4.1 General....17
4.2 Trouble Analysis....17
4.2.1 LCD or LED not lit - detector does not operate or have power....17
4.2.2 Fault and Detect LEDs flashing....17
4.2.3 Detector does not detect all vehicles....18
4.2.4 Detector is noisy/chatters/gives false detect CALLs....18
4.2.5 Poor Loop connections....18
4.2.6 Poor Loops....18
4.3 Communications Port Error Display (X series only)....18
4.3.1 Receive....18
4.3.2 Transmit....18
4.3.3 Serial Port Errors....18
4.3.3.1 Framing....19
4.3.3.2 Overrun....19
4.3.3.3 Noise....19
4.3.4 Protocol Errors....19
4.3.4.1 CB - Control Byte Error....19
4.3.4.2 CE - Checksum Error....19
4.3.4.3 CR - CRC Error....19
4.3.4.4 FE - Frame Error....19
4.3.4.5 ME - Missing End....19
4.3.4.6 MS - Missing Start....19
4.3.4.7 PP - Invalid Protocol....19
4.3.4.8 TO - Timeout....19

Section 5 Loop Installation....20
5.1 Loop Design....20

Section 6 Specifications....22
6.1 Mechanical....22
6.2 Environmental....22
6.3 Electrical....22
6.4 Tuning....22
6.4.1 Loop Inductance (Tuning) Range....22
6.4.2 Environmental Tracking....22
6.4.3 Grounded Loop Operation....22
6.4.4 Lead-in Length....22
6.4.5 Loop Input (Lightning Protection)....22
6.4.6 ORACLE 2E, 2EC Response Timing....23

6.4.7 ORACLE 4E, 4EC, 4H Response Timing 23
6.5 Connector Pin Assignments 23
6.5.1 ORACLE 2E, 2EC Pin Assignment.....23
6.5.2 ORACLE 4E, 4EC, 4H Pin Assignment 24
6.5.3 Polarization Keys 25

Section 1
General

1.1 DESCRIPTION

The ORACLE 2E (2EC) and 4E (4EC) Enhanced Loop Monitor series is a full featured two channel and four channel inductive loop vehicle detector conforming to TS1-1989 (R2005), 170/2070 requirements, and TS2-2016. For Nema TS2, the ORACLE 2E (2EC) and 4E (4EC) meet the requirements for a Type C and D configuration respectively. The ORACLE 2ECX and 4ECX meet the requirements for a Type CC and DD configuration respectively. The Oracle 4H is a four channel unit with a half width front panel, providing a compact method for increasing the number of detection channels in a given rack space.

The ORACLE features a front panel mounted multi-line graphic Liquid Crystal Display (LCD) which assists the user in setting up the unit and can display operational parameters and diagnostic information for all channels simultaneously (Oracle 4H only displays two channels simultaneously). A built-in heater is provided to enhance the LCD performance for cold temperature operation. An easy to use natural language menu structure guides the operator through the set up process and features plain English prompts on the LCD to describe functions and parameters. Two toggle switches per channel are used to navigate through the menus and make data entries as required. All programmed settings are stored in non-volatile memory. If power is disrupted or a detector reset occurs the programmed settings will not be altered.

Loop diagnostic capabilities incorporated within the ORACLE enables the diagnosis of shorted or open circuit loops and sudden inductance changes exceeding 25 percent of the nominal value. For each channel, the type of fault is displayed on the LCD and signified by the fault indicator emitting a different flash sequence. The last 25 loop faults are stored in an event buffer and can be reviewed in the Event Log. This information can greatly assist the user in the diagnosis of loop related problems.

The front panel LCD provides the Frequency, Inductance, and Count (2EC, 4EC only) display views. The Loop Frequency, ΔL/L%, Loop Inductance, DEFLECTOMETER® Pie Graph, DEFLECTOMETER® Numeric Value, DEFLECTOMETER® Streaming Graph, Frequency Stability Graph, Sensitivity Level, Mode of Operation, and Vehicle Counting Accumulator can be viewed on the front panel LCD.

The ORACLE offers a unique and very useful feature called the DEFLECTOMETER®. The DEFLECTOMETER® display allows you to use visual and numeric aids to assist in determining the optimum sensitivity setting by showing the change in inductance caused by traffic moving over the loop. The DEFLECTOMETER® aids in setting the detector channels quickly and easily to the most optimum sensitivity level to ensure trouble-free detection of all vehicles, including motorcycles and high bed vehicles (see section 3.2.1). Sensitivity can be adjusted in real-time with a vehicle continuously occupying the detection zone.

The CALL outputs are fail-safe and conform to TS2-2016 standards. Call outputs are optically isolated. The ORACLE detectors 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. Delay, Extend and User-Defined timing functions are included.

The ORACLE 2EC and 4EC models add the *AccurateCount* (Vehicle Counting) feature that enables vehicles to be counted with vehicle totals displayed on the LCD panel. The *AccurateCount* output (ORACLE 2EC only) also provides a secondary output for each channel for every vehicle in the loop zone at the same time. The unit can be programmed on each channel for one loop to eight loops connected together in series.

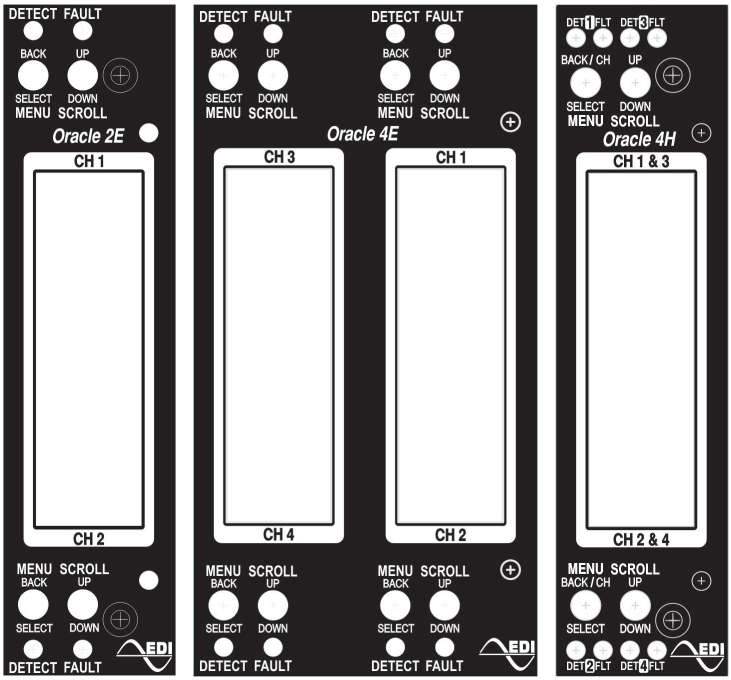
The ORACLE 2ECX, 4ECX, and 4HX provide a front panel mounted EIA-232 communications port. The Oracle X series support the EDI Oracle Serial Protocol. Consult the factory for details and specifications.

Section 2
Functions

2.1 GENERAL FUNCTIONS

2.1.1 FRONT PANEL CONTROLS

Two high-reliability sealed front panel toggle switches for each channel are used to select operational and display settings. One switch is designated “MENU (Back/Select)” and is used to accept the setting displayed and to move to the next menu item or go back to the previously displayed screen. The second switch is designated “SCROLL (Up/Down)” and allows you to move through each selected menu.



2.1.1.1 ORACLE 4H DISPLAY SELECT CONTROL

The ORACLE 4H half width model provides four channel operation, but the LCD will display information for only two selected channels simultaneously. The top half of the display can be programmed to display information for either Channel 1 or Channel 3. The bottom half of the display can be programmed to display information for either Channel 2 or Channel 4. The selected physical channel number is always displayed in the upper right corner of the display in white text on a black field.

To change the channel selected for display, press the MENU switch up to the *Back / CH* position **while in the main display mode** (top level of the menu). This will toggle the selected channel from 1 to 3 on the top display, and from 2 to 4 on the bottom display. For all other menu levels the up position of the MENU switch provides the *Back* function.

The LEDs for the Detect (DET) and Fault (FLT) indicators are provided for all four channels and are always enabled regardless of the channel selected for the LCD display. See section 2.2.3.

2.1.2 SENSITIVITY

There are twenty selectable sensitivity levels per channel. The DEFLECTOMETER® Pie Graph, DEFLECTOMETER® Numeric Value and a DEFLECTOMETER® Streaming Graph, make it easy to set-up and optimize sensitivity for each channel. Sensitivity can be selected from the "SET UP" or "QUIK SET" menus, to optimize vehicle detection on varying loop and lead-in configurations. Sensitivity is stated in terms of ΔL/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.] See section 3.2.1.

Sensitivity	ΔL/L		Sensitivity	ΔL/L
20	0.0035 %		**10**	0.113 %
19	0.005 %		**9**	0.160 %
18	0.007 %		**8**	0.226 %
17	0.010 %		**7**	0.320 %
16	0.014 %		**6**	0.453 %
15	0.020 %		**5**	0.640 %
14	0.028 %		**4**	0.905 %
13	0.040 %		**3**	1.280 %
12	0.057 %		**2**	1.810 %
11	0.080 %		**1**	2.560 %

2.1.3 LOOP FREQUENCY

The LCD screen displays the actual loop frequency to help avoid interference which may occur when loops connected to different detectors are located adjacent to one another. One of eight (8) settings (normally in the range of 20 to 60 kilohertz) may be selected via the "SET UP" or the "QUIK SET" menu options. It is recommended that adjacent loops have a frequency separation of at least 5 KHz.

2.1.3.1 FREQUENCY STABILITY GRAPH

In the Frequency display mode the LCD screen also displays a frequency stability graph and QΔf value that allows you to analyze each frequency level to ensure proper selection of frequency levels. The XY graph displays detector frequency samples with respect to the reference. The channel reference is in the center of the graph. A variation from the center of the graph depicts frequency instability on the channel.

Basically a thin smooth graph offers a more optimum frequency selection over a thick or uneven line. For optimal operation, select the frequency level with the lowest value of QΔf. For values of QΔf higher than 15-20, the Noise Filter option (see Section 2.1.3.2) should be considered.

2.1.3.2 NOISE FILTER

For installations where the effects of cross-talk or resulting frequency instability are higher than normal, additional noise filtering can be applied. Three levels of filtering are provided; Normal, Maximum, and Off. The Maximum level is intended for installations with a high level of cross-talk between loops where the frequency separation between adjacent loops is not adequate for reliable operation. Setting the filter mode to Off is intended only for high speed applications where minimum response time delay is required.

2.1.4 SENSOR MODES (ORACLE EC SERIES)

The Oracle EC series support three different inductive loop types; normal loop, point probe, and rail mode. The Normal sensor mode is used with conventional inductive loops. The Probe mode and Rail mode are for special applications.

2.1.4.1 PROBE MODE (ORACLE EC SERIES)

This mode is intended to support the use of point probe type micro sensors. A probe type micro sensor is a transducer that converts changes in the vertical component of the earth's magnetic field to changes in inductance. The resulting change in inductance can then be sensed by the Oracle EC series detector. Note that when operating in the Probe mode, the 50% pie graph level is reported as a value of 8 instead of 10 (see 2.1.7.5). A gap setting is also provided for optimizing the distinction between closely spaced cars and large trucks, see 3.7.5.1.

2.1.4.1.1 PROBE MODE THRESHOLD

The Probe Mode Threshold allows the user to adjust the hysterisis value for the call to no-call threshold. The default value is 20% of the call strength which is suitable for most probe applications.

2.1.4.2 RAIL MODE (ORACLE EC SERIES)

This mode is intended to support the use of inductive loops in a light rail application. Rail applications often produce residual effects on a train car exit from the detection zone that can cause the detector to remain in the call state. In this case the loop inductance does not immediately return to the tuned reference value for a short time period.

2.1.4.2.1 RAIL MODE THRESHOLD

The Rail mode allows the user to adjust the hysterisis value for the call to no-call threshold. The default value is 20% of the call strength which is suitable for most rail applications.

2.1.5 PRESENCE / PULSE MODES

For each channel, a Presence or Pulse output mode may be selected via the "SET UP" menu. If Presence mode is selected then a choice of Short, Long, or User defined presence can be selected (see 3.2.4.1). Short Presence is defined as 30 minutes and Long Presence is defined as 120 minutes. In User Defined mode, a user setting can be applied. On the expiration of short or long presence time a detect CALL will be reset. In User defined mode, the detect CALL can be selected to reset on timer expiration or at the next End-Of-Green (EOG) signal after the expiration of the timer. The green signal is applied to the Timer Control input via the edge card connector.

In Pulse mode, a 125 ms ± 25 ms width pulse will be output for each vehicle entering the loop. The pulse length can be programmed from 125 ms to 60 minutes.

2.1.6 DELAY AND EXTEND FUNCTION

2.1.6.1 CALL DELAY TIMER

For each channel, a delay time of 0.1 seconds to 5 minutes can be set via the "SET UP" menu. Call Delay time starts counting down when a vehicle enters the loop detection area. Delay time can be overridden by a green signal at the Timer Control input.

2.1.6.2 CALL EXTENSION TIMER

For each channel, an extension time of 0.1 seconds to 1 minute can be set via the "SET UP" menu. Call Extension time starts counting down when the last vehicle clears the loop detection zone. Any vehicle entering the loop detection zone during the Extension time period causes the channel to return to the DETECT state. The Extension timer can be enabled upon the following options:

2.1.6.2.1 EXTEND ALWAYS MODE (ALWAYS)

When a vehicle leaves the loop zone and the loop zone becomes vacant, then the extend timer will be enabled and CALL output will be maintained until the timer times out.

2.1.6.2.2 EXTEND ON-GREEN MODE (ONGREEN)

If the Timer Control input is inactive and the loop becomes vacant after a vehicle exits, then the Extend timer will not be enabled and the CALL output will be cleared. When the Timer Control input is active and the loop becomes vacant after a vehicle exits, then the Extend timer will be enabled and the CALL output will be maintained until the timer times out. While the timer is running, the DETECT LED will flash 4 times a second. If the timer is running and the Timer Control input becomes inactive, the timer will be disabled and the CALL will be cleared. If the timer is running and a vehicle is detected, the timer will be disabled and the CALL maintained until the loop again becomes vacant, at which point the extend process repeats.

2.1.6.2.3 EXTEND DISCONNECT (DISCNNCT)

While the Timer Control input is inactive, the Extend/Disconnect timer is not used and a CALL is output whenever a vehicle is detected. If the Timer Control input is active and the loop becomes empty after a vehicle exits, then the Extend Disconnect timer will be enabled. While the Extend Disconnect is running, the detect LED will flash 4 times a second. If a vehicle is detected while the Extend Disconnect is running the Extend Disconnect timer will be disabled. If the Extend Disconnect timer times out while the Timer Control input is active, then the CALL output will be disabled and future detects ignored. When the Timer Control input becomes active, the CALL output will be enabled again.

2.1.6.2.4 EXTENSION PLUS DISCONNECT (EXT+DIS)

While the Timer Control input is inactive, the Extend/Disconnect timer is not used and a CALL is output whenever a vehicle is detected. When the Timer Control input becomes active the Extend/Disconnect timer is enabled. While the Extend/Disconnect timer is running, the detect LED will flash 4 times a second. If a vehicle is detected while the Extend/Disconnect timer is running the Extend/Disconnect timer will be disabled. If the Extend/Disconnect timer times out while the Timer Control input is active, then the CALL output will be disabled and future detects ignored. When the Timer Control input becomes active, the CALL output will be enabled again.

2.1.6.3 TIMER CONTROL INPUTS

Timer Control inputs are provided for each channel to modify the operation of the Delay and Extension functions. The application of a True (low) state voltage will inhibit the Delay timing function and/or enable the Extend timing function as described in sections 2.1.6.1 and 2.1.6.2. When the Timer Control input for a channel is active (True) a “G” character is displayed on the main display screen.

Timer Control inputs are primarily provided for downward compatibility. For the ORACLE 4E, 4EC, and 4H models, a Timer Control input is provided for all four channels. For channels 3 and 4, the Timer Control inputs use pins that are defined in Nema TS2 as Detector Unit Address inputs (see 6.6.2). When operating an ORACLE 4E, 4EC, or 4H in a Nema TS2 detector rack, the Delay and Extend functions may not be available for channels 3 and 4 depending on the wiring of the rack.

2.1.7 CHANNEL DISPLAY

During normal operation each channel displays the Channel ID, Sensitivity setting, Countdown timers, the Deflectometer, and the option of Frequency, Inductance, or Count which can be selected by pressing the SCROLL switch Down. When the Timer Control input for a channel is active (True) a “G” character is displayed.

2.1.7.1 COUNT DOWN TIMERS

The countdown timers are automatically displayed when a vehicle is detected, or in the case of the Disconnect timer, when the Timer Control input becomes active. The time remaining is displayed in minutes and seconds. A character is displayed to indicate which

countdown timer is being displayed; “P” for Presence, “D” for Delay, “E” for Extend, and “d” for Disconnect.

2.1.7.2 LOOP FREQUENCY DISPLAY

When in the “Freq” display mode the LCD screen displays the loop frequency in kilohertz (KHz). Note: the loop frequency is displayed in Hertz when setting the loop frequency parameter.

2.1.7.3 LOOP INDUCTANCE DISPLAY

When in the “Induct” display mode the LCD screen displays the equivalent system loop inductance (loop and lead-in inductance) within the range of 20 to 2500 microHenries.

2.1.7.3.1 LOOP INDUCTANCE ΔL/L DISPLAY

When in the “Induct” display mode, the LCD screen displays the percentage of inductance change during the CALL state.

2.1.7.4 VEHICLE COUNT DISPLAY (ORACLE EC SERIES)

When in the “Count” display mode the LCD screen displays the current vehicle count. The count can be reset by pressing the SCROLL switch Up.

2.1.7.5 DEFLECTOMETER® PIE GRAPH

For each channel, the LCD screen displays a pie graph which assists in determining the optimum sensitivity setting by showing the change in inductance caused by traffic moving over the loop and how this graph is affected by the sensitivity selected. Optimum sensitivity setting is reached when the DEFLECTOMETER (numeral to the right of the pie graph) reaches the value of ten (10), based on typical size vehicles (see section 3.2.1). This results is a 50% filled graph. Selecting the optimum sensitivity level insures detection of all vehicles, including motorcycles and hi-bed trucks. This helps to eliminate any further service calls to adjust detector sensitivities.

Note that when operating in the Probe mode (see 2.1.4.1) the 50% optimal pie graph level is reported as a quantitative value of 8 instead of 10.

2.1.7.6 DEFLECTOMETER® STREAMING GRAPH

While the DEFLECTOMETER® displays an instantaneous indication of the current Call strength, the Streaming Graph display graphically shows the Call strength over time. The horizontal axis represents a six second interval. The vertical axis represents Call strength. The graph only streams when there is a Call present and displays approximately six seconds of data.

2.1.8 EVENT LOG

For each channel, the LCD screen can display the last 25 loop fault conditions and power events via the “Event Log” menu. A channel reset will not clear the Event Log from memory. To clear the Event Log memory, select either “Clear Log” or “Clear All” from the “Event Log” menu.

2.1.9 CHANNEL ID

Up to five (5) characters can be selected to identify each channel of detection.

2.1.10 PAIRED CHANNEL FUNCTIONS

2.1.10.1 3RD CAR MODE

Each channel’s “3rd Car” mode setting can be enabled by selecting the “3rd Car” option in the “Paired Channels” menu. This means that it takes two channels to implement the

feature. Therefore, when this feature is enabled in one channel, its paired channel is also set to the same state.

For the ORACLE 2E and 2EC model, 3rd Car mode links channels 1 and 2 together. For the ORACLE 4E, 4EC, and 4H models, 3rd Car mode links channels 1 and 2 together, and links channels 3 and 4 together. When a vehicle is detected on only one of the two linked channels, the DETECT LED will flash 10 times a second. The "3rd Car" mode is intended to be used in Protected / Permissive left turn situations. The likely installation is a stop bar loop for the left turn lane connected to one channel, a queue detection loop (with a small amount of delay time programmed) for the left turn lane connected to the other channel, and the output of either channel connected to the Vehicle Call input for the protected movement of the traffic controller.

As the first vehicle enters the left turn lane it will drive over the queue detection loop. Since there is no vehicle over the stop bar loop, there is no call output generated. When the vehicle advances to the stop bar loop, still no output is generated because there is now no vehicle over the queue detection loop. When traffic in the left turn lane backs up and occupies both the queue detection loop and the stop bar loop this will cause the detector to generate a CALL to the traffic controller to service the protected movement for the left turn. The spacing between the stop bar loop and the queue detection loop controls the size of the queue needed to generate a call to the protected movement of the controller. The delay time on the queue detection loop should be sufficient that a vehicle physically overlapping this loop and the stop bar loop do not generate a CALL.

2.1.10.2 DIRECTIONAL LOGIC

Each channel's Directional Logic setting can be enabled by selecting the "Direction" option in the "Paired Channels" menu. This means that it takes two channels to implement the feature. Therefore, when this feature is enabled in one channel, its paired channel is also set to the same mode. Channel 1 is paired with Channel 2. In the ORACLE 4E, 4EC, and 4H models Channel 3 is also paired with Channel 4.

Directional logic starts with a CALL on one channel. This channel will go into a pending state, DETECT LED flashing 10 times a second and NO output call. When both of the paired channels have detection, the last channel to have detection will output a CALL until the detection for the last channel ends, even if the detection ends for the first channel.

This feature is intended to be used in freeway ramps for wrong way detection and left turn lanes where other movements in the intersection tend to clip the detection zone of the left turn lane. The likely installation is two loops, one after the other in the same lane, spaced anywhere from slightly overlapping to 5 or 6 feet apart. Under normal conditions both outputs can never be on at the same time. However, if one of the loops faults, the output for the faulted loop will come on and stay on until the failure is corrected, and the loop without the fault will output a call whenever it is occupied. The channel which received the loop failure will indicate the type of loop fault on the FAULT LED (See section 2.2.4).

2.1.11 SET FACTORY DEFAULT SETTINGS

Simultaneously pressing the Channel 1 "UP/DOWN" switch Down and the Channel 2 "UP/DOWN" switch Up while cycling power will reset the detector to factory default positions.

2.2 OPERATIONAL

2.2.1 CHANNEL OUTPUT CONTROL

Each channel has one of four output modes to choose from in the SET UP menu; Off, On, Call, or Disabled.

Off: When set to the "Off" mode, the channel output is set continuously in the No Call state regardless of the presence or absence of vehicles over the loop. The loop oscillator is

disabled. TS-2 Channel Status is reported as state #2 (detector not installed). This mode is indicated by "*OFF*" on the LCD.

On: When set to the "On" mode, the channel output is enabled and menu set-up navigation is enabled.

Call: When set to the "Call" mode, the channel output is continuously in the Call state regardless of the presence or absence of vehicles over the loop. The loop oscillator is disabled. This mode is indicated by "*CALL*" on the LCD. This option is can be useful for checking controller response and other troubleshooting activities.

Disabled: When set to the "Disabled" mode, the channel output is set continuously in the No Call state regardless of the presence or absence of vehicles over the loop. The loop oscillator is disabled. TS-2 Channel Status is reported as state #1 (Normal). This mode is indicated by "Channel Disabled" on the LCD.

2.2.2 LCD DISPLAY

The Liquid Crystal Display (LCD) incorporates a white LED backlight. The backlight is energized when any switch is actuated and remains On for one hour after the last switch actuation. The backlight improves visibility in poor lighting conditions. A built-in heater is provided to enhance the LCD performance for cold temperature operation. See Section 3.7.4 for heater operation details.

2.2.3 HIGH INTENSITY COLOR-CODED LED INDICATORS

Red DETECT Indicator:

- Vehicle Detection = Solid ON
- Delay Timing = 2 Hz flash rate.
- Extension Timing = 4 Hz flash rate.
- Pending Call in 3rd Car Mode = 10 flashes per second.
- Pending Call in Directional Logic Mode = 10 flashes per second.
- Open Circuit = 1 single flash followed by a pause.
- Shorted Circuit = 2 flashes followed by a pause.
- 25% Change in Inductance = 3 flashes followed by a pause.

Yellow FAULT Indicator:

- Open Circuit = 1 single flash followed by a pause.
- Shorted Circuit = 2 flashes followed by a pause.
- 25% Change in Inductance = 3 flashes followed by a pause.

2.2.4 LOOP FAULT MONITOR

The detector continuously checks the integrity of the loop. The system is able to detect open circuit loops, shorted loops, or sudden changes in inductance exceeding 25% of the nominal inductance. If a fault is detected, both the DETECT (Red) and FAULT (Yellow) LEDs continuously emit a sequence of flashes. Each type of fault is identified by a different flash sequence:

Flash Sequence	Fault
1 flash (per second)	Open Circuit Loop (or Inductance too high)
2 flashes (per second)	Shorted Circuit Loop (or inductance too low)
3 flashes (per second)	25% Change in Inductance

In addition to the LED flash sequence, the LCD will display the type of fault condition during the fault state. If the fault condition is removed, the LCD "Fault" indication and the DETECT

(Red) LED will return to normal operation. The FAULT (Yellow) 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 (possible loss of a loop within a series of loops), the unit will log the fault and retune to the new inductance after a period of two seconds. The logged fault will be stored in the Event Log memory.

2.3 VEHICLE COUNTING (ORACLE EC SERIES)

2.3.1 VEHICLE COUNTING (*ACCURATECOUNT*) DISPLAY

If *AccurateCount* (Enable Vehicle Counting) mode is enabled, the LCD will reflect actual counts from the secondary "Count" outputs. For each channel, when a vehicle occupies the loop zone, the LCD counter accumulates one vehicle count per output. The counter is capable of accumulating 999,999 vehicle counts per channel before rolling over to zero.

2.3.2 VEHICLE COUNTING (*ACCURATECOUNT*) MODE

For each channel of the Oracle 2EC model only, the *AccurateCount* (Enable Vehicle Counting) output feature can be enabled via the "SET UP" menu to produce a secondary output in addition to the primary CALL output for every vehicle entering the loop zone. Each vehicle entering the loop will cause an output pulse of 125ms ± 25ms from the secondary "Count" output on pin S (Channel 1) and pin Y (Channel 2), irrespective of the size of the loop. See section 3.3.2.

When the Secondary outputs are enabled for counting, the Secondary Status outputs on pin 16 (Channel 1) and pin 22 (Channel 2) will be set to the True state (TS2 state #1).

2.3.3 VEHICLE COUNTING (*ACCURATECOUNT*) LOOP CONFIGURATIONS

For each channel, when the *AccurateCount* (Enable Vehicle Counting) feature is enabled, a loop configuration must be selected, via the "Set up Counting Type" menu for either a single loop or up to eight loops connected together in series. For the single loop case, a Short or Long configuration is also provided. See section 3.3.

Section 3
Programming

3.1 INSTALLATION

Make connections to power and the loop. The input power supply level should be between 10.8 and 28.8 VDC. The detector has no DIP switches or jumpers to set. If the installation is of a unit previously installed in another location, it may be advisable to reset the detector to the factory defaults (see section 2.1.11).

3.1.1 MAIN MENU

The ORACLE has two bidirectional toggle switches per channel marked “MENU” (Back / Select) and “SCROLL” (Up / Down). The “MENU” (Back / Select) switch is used to move to the next parameter in the menu and select the values that have been chosen. The “SCROLL” (Up / Down) switch is used to change the chosen parameter to the desired value. Pressing the “MENU” (Back / Select) switch while the ORACLE is in normal operation will cause the LCD to display the MAIN MENU. The dark navigation bar may be moved to the desired function using the “SCROLL” (Up / Down) switch. When the desired function is high-lighted by the navigation bar the “MENU” (Back / Select) switch may be pressed to select the function.

The following functions are available for each channel:

RUN:	Returns to the operating screen and resumes operation as before.
RESET:	Returns to the operating screen, resets the detector, retunes to the loop.
SET UP:	Enters the set-up sequence.
QUIK SET:	Enters selected Set-up options that are used most frequently.
EVENT LOGS:	Displays the event log screen.

3.1.2 ORACLE 4H DISPLAY SELECT CONTROL

The ORACLE 4H half width model provides four channel operation, but the LCD will display information for only two selected channels simultaneously. The top half of the display can be programmed to display information for either Channel 1 or Channel 3. The bottom half of the display can be programmed to display information for either Channel 2 or Channel 4. The selected physical channel number is always displayed in the upper right corner of the display in white text on a black field.

To change the channel selected for display, press the MENU switch Up to the *Back / CH* position **while in the main display mode** (top level of the menu). This will toggle the selected channel from 1 to 3 on the top display, and from 2 to 4 on the bottom display. For all other menu levels the Up position of the MENU switch provides the *Back* function.

3.2 SET UP MENU

Moving the navigation bar to “SET UP” and pressing the “MENU” (Back / Select) switch down will begin the set-up sequence. The set-up sequence is context sensitive, i.e. the value of a parameter that is selected may affect which parameter is next in sequence. For example, if the “Channel Output” is set to “Off” which turns off call and status outputs, then all other operational parameters are skipped and only the “Channel ID”, and “Display Mode” can be set-up. This eliminates the need to set parameters that are not relevant to the desired configuration of the detector.

3.2.1 SENSITIVITY

Sensitivity may be set to any value between 1 and 20. Sensitivity 1 is the least sensitive and 20 the most sensitive. A DEFLECTOMETER® pie graph and numeric value are located

in the middle of the screen showing both graphically and numerically the change in inductance strength as vehicles pass over the loop.

3.2.1.1 ADJUSTING SENSITIVITY USING THE DEFLECTOMETER®

The DEFLECTOMETER® Pie Graph and Numeric Indicator should be blank with no vehicle over the roadway loop. When a typical vehicle is completely in the detection zone (DETECT indicator On), the sensitivity should be adjusted up or down until the DEFLECTOMETER® Pie Graph is shaded to the halfway position and the DEFLECTOMETER® Numeric Indicator (right side of the Pie Graph) is displaying the value Ten (10). The detector is now set to the most optimum sensitivity level for the existing loop network.

NOTE: The DEFLECTOMETER® Streaming Graph is another visual aid when setting sensitivity to the most optimum position. This is located below the DEFLECTOMETER® Pie Graph and Numeric Indicator. Whether the Pie Graph or Numeric Indicator was used to reach the optimum sensitivity value, the Streaming Graph is now equal to the dotted reference line.

If a typical vehicle located over the roadway loop causes the value of “12” to be displayed on the DEFLECTOMETER®, the sensitivity should be decreased two levels. This can be done by pressing the front panel “SCROLL (Up/Down) toggle switch DOWN two times. The DEFLECTOMETER® Pie Graph and Streaming Graph are visually showing that the detector is now set to the most optimum sensitivity level.

If a typical vehicle located over the roadway loop causes the value “5” to be displayed on the DEFLECTOMETER®, the sensitivity should be increased five levels. This can be done by pressing the front “SCROLL (Up/Down)” toggle switch UP button five times. The DEFLECTOMETER® Pie Graph and Streaming Graph are visually showing that the detector is now set to the most optimum sensitivity level.

- NOTE -

THE DEFLECTOMETER® DYNAMICALLY UPDATES AFTER EACH SENSITIVITY LEVEL CHANGE, ALLOWING CHANGES TO THE SENSITIVITY SETTINGS WHILE A VEHICLE REMAINS IN THE LOOP DETECTION ZONE.

Note that when operating in the Probe mode (see 2.1.4.1) the 50% pie graph level is reported as a value of 8 instead of 10.

3.2.1.2 ADJUSTING SENSITIVITY WITHOUT USING THE DEFLECTOMETER®

The ORACLE offers 20 levels of sensitivity (1 to 20). Level 20 is the highest sensitivity. From the “SET UP” or “QUIK SET” menu options, sensitivity can be selected and manually set to any desired level by pressing the front panel “SCROLL (Up/Down) toggle up or down. The new sensitivity value will be displayed on the LCD. The factory default Sensitivity setting is level 10.

3.2.2 FREQUENCY

The LCD screen displays the actual loop frequency to help avoid interference which may occur when loops connected to different detectors are located adjacent to one another. One of eight (8) settings (normally in the range of 20 to 60 kilohertz) may be selected via the “SET UP” or the “QUIK SET” menu options. The LCD screen also displays a frequency stability meter (XY Graph) that allows you to analyze each frequency level to ensure proper selection of frequency levels. The XY graph displays samples with respect to the reference. The channels reference is in the center of the graph. A variation from the center of the

graph depicts frequency instability on the channel. Basically a thin smooth graph offers a more optimum frequency selection over a thick uneven line.

3.2.3 PAIRED CHANNEL MODES

3.2.3.1 3RD CAR MODE

This setting can be enabled by selecting the "3rd Car" option in the "Paired Channels" menu. When this feature is enabled in one channel, its paired channel is also set to the same state. In the ORACLE 2E and 2EC models, 3rd Car mode links Channels 1 and 2 together. In the ORACLE 4E, 4EC, and 4H models, 3rd Car mode also links Channels 3 and 4 together When a vehicle is detected on only one of the two linked channels, the channel with the detected vehicle will enter a pending call state with the DETECT LED flashing 10 times a second and NO call output.

3.2.3.2 DIRECTIONAL LOGIC MODE

This setting can be enabled by selecting the "Direction" option in the "Paired Channels" menu. When this feature is enabled in one channel, its paired channel is also set to the same state. In the ORACLE 2E and 2EC models, Channel 1 is paired with Channel 2. In the ORACLE 4E, 4EC, and 4H models, Channel 3 is also paired with Channel 4. Directional logic starts with a CALL on one channel. This channel will go into a pending state with the DETECT LED flashing 10 times a second and NO call output. When both of the paired channels have detection, the last channel to have detection will output a CALL until the detection for the last channel ends, even if the detection ends for the first channel

3.2.4 OPERATIONAL MODES

Two operational modes are available, Presence and Pulse. In Presence mode the channel will produce a call as long as the vehicle is within the detection zone. In Pulse mode, the channel output will produce a 125 ms pulse for each vehicle that enters the detection zone.

3.2.4.1 PRESENCE MODE

Presence is defined as the maximum period for which the channel will detect a vehicle within the zone of detection before retuning to the loop and dropping any CALL that may exist on the channel. Presence mode may be set to Short, Long, or User Defined. If User Defined is selected, the User Defined Presence time is the next parameter to set, followed by the time-out mode. If Short or Long is set then the next parameter is Timing. Short Presence is 30 minutes, Long Presence is 120 minutes.

When the unit is in the Call state, the display will show the value of the Presence timer in the following format:

Seconds only (ex: 59") for timer values less than 1 minute

Minutes and Seconds (ex: 99'59") for timer values of 1 minute to 100 minutes

Hours and Minutes (ex: 17:59") for timer values of 100 minutes to 18 hours

3.2.4.1.1 USER DEFINED PRESENCE

Each channel may be set to a value between 5 seconds and 96 hours.

3.2.4.1.2 USER DEFINED PRESENCE TIME-OUT MODES

Each channel may be set to either End-of-Green (Grn Ends) or Immediate (Immed). In the "Grn Ends" mode a detection that remains after the presence time has expired will be reset at the next end of green (i.e. the next time the Timer Control input goes from ON to OFF. In the "Immed" time-out mode, a detection that remains after the presence time has expired will be reset immediately.

3.2.4.2 TIMING

Each channel may be set to either YES or NO. If YES is selected, then DELAY or EXTEND times may be entered.

3.2.4.2.1 DELAY

Delay time from 0.1 seconds to 5 minutes may be entered. If a delay time is set then the output CALL in response to a vehicle entry is delayed for the specified time. If the vehicle leaves before expiration of the delay, NO CALL is produced. A Timer Control signal input will inhibit the delay function.

3.2.4.2.2 EXTEND

Extend time from 0.1 seconds to 1 minute may be entered. If an extension time greater than zero is entered, the output CALL will be extended for the specified time after the vehicle has left the detection zone. If the extension time is zero the next item to set will be Vehicle Counting. Note: when pulse mode is enabled, the extension time extends the length of the pulse being output.

3.2.4.2.2.1 EXTEND TIMING MODE

Extend Always Mode (Always): When a vehicle exits the loop zone and the zone remains vacant, the extend timer will be enabled and CALL output will be maintained until the timer times out.

Extend On-Green Mode (OnGreen): The Extend on Green mode extends a call only when the timer input is active. If this feature is enabled and the Timer Control input is active when the loop becomes empty after a vehicle exits, then the extend timer will be enabled and the CALL output will be maintained until the timer times out. If the Timer Control input is inactive when the loop becomes empty after a vehicle exits, then the extend timer will not be enabled and the CALL output will be cleared. While the timer is running, the DETECT LED will flash 4 times a second. If the timer is running and the Timer Control input becomes inactive, the timer will be disabled and the CALL will be cleared. If the timer is running and a vehicle is detected, the timer will be disabled and the CALL maintained until the loop again becomes empty, at which point the extend process repeats its self.

Extend Disconnect (Discnnct): The Disconnect mode disables the output of calls if the loop is empty for the specified period of time. Disconnect only occurs when the Timer control input is active. While the Timer Control input is inactive, the Extend/Disconnect timer is not used and a CALL is output whenever a vehicle is detected. If the Timer Control input is active and the loop becomes empty after a vehicle exits, then the disconnect timer will be enabled. While the timer is running, the detect LED will flash 4 times a second. If a vehicle is detected while the timer is running the disconnect timer will be disabled. If the disconnect timer times out while the Timer Control input is active, then the CALL output will be disabled and future detects ignored. When the Timer Control input becomes active, the CALL output will be enabled again.

Extension plus Disconnect (Ext+Dis):

The Extend plus Disconnect mode generates a call whenever the Timer Control input becomes active and then disables the call output if the loop is empty for the specified period of time. While the Timer Control input is inactive, the Extend/Disconnect timer is not used and a CALL is output whenever a vehicle is detected. When the Timer Control input becomes active the Extend/Disconnect timer is enabled. While the Extend/Disconnect is running, the detect LED will flash 4 times a second. If a vehicle is detected while the Extend/Disconnect is running the Extend/Disconnect timer will be disabled. If the Extend/Disconnect timer times out while the Timer Control input is active, then the CALL output will be disabled and future detects ignored. When the Timer Control input becomes active, the CALL output will be enabled again.

3.2.5 CHANNEL ID

A five characters ID name can be set to any alphanumeric character A through Z, 0 through 9 or space to custom label each channel of detection. Using the “MENU (Back/Select)” switch, pressing “Select” causes the cursor to move to the next digit to the right and pressing “Back” causes the cursor to move to the next digit to the left. To edit each digit, use the “SCROLL (Up/Down)” switch and press DOWN or UP keys accordingly. Continue until all of the digits are set and then press the “MENU (Back/Select)” switch down until the screen highlights OK to confirm and save.

3.3 VEHICLE COUNTING (ORACLE EC SERIES)

Each channel Count Mode may be set to YES or NO. If YES is selected then the “SET UP Counting Type” and “Enable Count Output” can be set.

3.3.1 COUNTING TYPE (*ACCURATECOUNT*)

The “Counting type” can be selected to be either on one loop or up to eight loops connected in series. The “one loop” setting includes all loop configurations, square or rectangle, where a single loop is connected to the loop inputs. The “Loop Length” setting should be selected to optimize counting accuracy. A “Short” length is typically considered as a 6’ long loop. The “Long” length is typically considered as a loop 10’ or greater in length.

On the two to eight loop setting the Count must be derived from a configuration of individual loops (6’ x 6’ square or round loops on 12’ to 15’ centers) connected in series within a single lane. Each vehicle that enters the detection zone will be counted irrespective of whether vehicles are already present. Accuracy is dependent on the type and volume of traffic and loop configurations, high long term accuracies are possible.

3.3.2 VEHICLE COUNTING OUTPUT (*ACCURATECOUNT*)

For the ORACLE 2EC, 4EC models only, the Vehicle Counting output may be set to NO or YES. If Count Outputs are set to NO then the secondary outputs on the edge card connector are disabled, Count information will then only be available on the front panel LCD. If YES is selected, then a secondary output will be produced in addition to the primary CALL output for every vehicle entering the loop zone. Each vehicle entering the loop will cause an output pulse of 125ms ± 25ms from the respective secondary “Count” output on pin S (Channel 1) and pin Y (Channel 2). These pins are typically assigned to Channel 3 and 4 in the rack.

3.4 DISPLAY MODES

Each channel display (view) can be set to either Frequency (Freq), Inductance (Induct), or Count (2EC, 4EC). This sets the screen that is displayed when the detector starts up or when RUN is selected.

The Frequency (Freq) view displays the channel ID, sensitivity level, and loop frequency when there is no vehicle in the loop zone. When a vehicle enters the loop zone, the channel ID, count down timer (Presence mode only), loop frequency, DEFLECTOMETER® Pie Graph, Numeric Indicator, and Streaming Graph are displayed and active.

The Inductance (Induct) view displays the channel ID, sensitivity level, and loop inductance when there is no vehicle in the loop zone. When a vehicle enters the loop zone, the channel ID, count down timer (Presence mode only), $\Delta L/L\%$ value, DEFLECTOMETER® Pie Graph, Numeric Indicator, and Streaming Graph are displayed and active.

The Count view (2EC, 4EC) displays the channel ID and current count accumulated since the channel was last reset along with the loop frequency. To reset the count accumulator use the SCROLL (Up) switch.

NOTE: You can toggle between each of the three (3) views using the SCROLL (Down) switch at any time during detector operation.

3.5 LOOP FAULT MONITOR

The ORACLE constantly monitors each channel loop(s) and responds to faults in several ways to allow the operator to pinpoint loop related problems. Three types of loop related faults can be detected: Open Circuit Loop or loop inductance above rated range, Short Circuit Loop or loop inductance below rated range, and 25% change from nominal (tuned) inductance.

When a fault is detected on either channel the ORACLE responds by outputting a detection CALL. It flashes both DETECT and FAULT LEDs with a flash sequence denoting the type of fault and also displays the type of fault on the LCD screen. The LED flash sequence is common with all EDI Loop Monitor products. A single flash for open circuit loops, double flash for short circuit and a triple flash for a 25% change of inductance.

3.6 EVENT LOG

The ORACLE features a fault log which retains the last twenty-five (25) faults that have occurred on each channel. From the main menu select “EventLog” to view the Event Logs menu options. Select “View Log” to view and scroll through the last 25 Events. To review details of an individual Event, select (highlight) an event and press the “MENU (Select)” switch. Details including the elapsed time since the Event are displayed. Each time a new fault is logged the previous logs are moved down one. To clear an individual log or all logs, go to the Event Log menu and select either “Clear Log” or “Clear All” and respond appropriately to the next screen.

3.7 SYSTEM MENU

Some global settings are applied in the System menu. To access the System menu press the Channel 1 MENU and SCROLL switches to the Up position (*Back, Up*) simultaneously.

3.7.1 RUN MENU ITEM

Selecting the *Run* item exits the System menu level and returns to the main display.

3.7.2 SYSTEM INFO MENU ITEM

Selecting the *SysInfo* item displays the firmware revision level, HDLC slot address, and channel configuration.

3.7.3 TEMPERATURE AND VOLTAGE MENU ITEM

Selecting the *Temp,VDC* item displays the current temperature and the voltage applied to the Detector Unit DC Supply (pin B).

3.7.4 LCD DISPLAY HEATER MENU ITEM

Selecting the *Heater* item displays the state of the front panel LCD display heater. Selecting Off disables the heater function under all conditions (default). Selecting On will enable the heater function under the following conditions; the temperature is less than 32 degrees F (0 degrees C), AND any of the front panel switches has been activated. The heater and LCD backlight will then remain On for 60 minutes following a switch activation.

A “H” character will be displayed next to the DEFLECTOMETER when the LCD heater is activated.

Warning

The LCD Heater function consumes approximately 3 watts for an Oracle 2E, and 6 watts for an Oracle 4E. Activating the LCD Heater function on multiple Oracle units in the cabinet simultaneously can add a significant amount of load current being required from the Cabinet Power Supply.

To temporarily turn off the heater function before the 60 minute time-out occurs, press the MENU button Up (*Back* position) while in the main display level. The heater function and backlight will be turned off until the next switch activation. This over-ride function is not available on the Oracle 4H model.

3.7.5 OPTIONS MENU ITEM (ORACLE EC SERIES)

For the Oracle 2EC and 4EC models, selecting the Option menu item provides access to the Probe Gap and Stream control items.

3.7.5.1 PROBE GAP MENU ITEM

The *Probe Gap Between Vehicles* item allows a user to specify the minimum gap between vehicles passing through the detection zone only when operating in the Probe Mode. The entry range is 150 milliseconds to 500 milliseconds. This setting helps to optimize the distinction between closely spaced vehicles and large trucks.

3.7.5.2 STREAM MENU ITEM (ORACLE ECX SERIES)

For the Oracle 2ECX and 4ECX models this option enables a serial communication function to stream signature data to a recording station.

Section 4
Theory of Operation

4.1 GENERAL

The ORACLE Loop Monitor works on the principle of measuring the period of a pre-determined number of cycles from an oscillator whose frequency is directly related to the inductance of the loop to which the unit is connected. The measurement is done by counting the number of cycles of a stable crystal reference that occur during the period to be measured. This scheme provides a high resolution measurement in a short period of time. Consecutive measurements can be compared with each other to determine whether or not the frequency of the loop oscillator has changed sufficiently to indicate the presence of a vehicle.

The ORACLE circuitry can be broken down into four major blocks. The loop oscillator, digital processing circuitry, switch controls and outputs/indicators. The oscillator input incorporates a transformer to isolate the loop from the internal oscillator circuitry and a surge protector is used to protect the unit from transient damage. The loop oscillator frequency may be modified by switching capacitors in or out of the oscillator circuit in order to affect crosstalk avoidance. The output signal from the oscillator is fed through a squaring circuit and provided to the digital processing section.

The microcontroller uses a high speed crystal clock count to calculate the loop inductance, frequency and percentage of inductance change. The values are displayed on the front panel LCD. The microcontroller also processes the toggle switch selections and stores the operating parameters in non-volatile memory. The operational mode determines whether the detection CALLS are to be Presence or Pulse and the sensitivity setting determines the number of loop oscillator cycle “blocks” to use in the period measurement process. The microcontroller then begins the measurement process by energizing the loop oscillator for the channel to be measured.

During period measurement the microcontroller counts the number of cycles of the crystal based reference frequency. When the period ends, the count is compared with a stored reference and detection decisions are made. Small changes which occur over a relatively long period of time are considered due to the changing environment, and the stored reference is modified accordingly by the microcontroller.

Detection CALLS are made via the optically isolated transistor. These isolate the traffic controller input from the ORACLE circuitry. Output CALL and loop fault monitor status are indicated by both the front panel LCD and high intensity LEDs.

4.2 TROUBLE ANALYSIS

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

4.2.1 LCD OR LED NOT LIT - DETECTOR DOES NOT OPERATE OR HAVE POWER.

Power supply fault: The ORACLE detectors require a 10.8 to 28.8 VDC nominal supply. The detector consumes approximately 50 mA per channel. The ORACLE will operate at a voltage as low as 10.8 Vdc. Supply voltages below this may result in the unit entering a reset state. In this case, the unit will appear to be non-functional.

4.2.2 FAULT AND DETECT LEDS FLASHING

Loop or lead-in wiring has a fault: Check the type of fault being indicated on the LCD or by the number of flashes on the Fault LED. 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 (see section 3.5).

4.2.3 DETECTOR DOES NOT DETECT ALL VEHICLES

Sensitivity too low: Select sensitivity by utilizing the LCD DEFLECTOMETER® visual aids (see section 3.2.1). Using the DEFLECTOMETER® visual aids insures that all vehicles, including motorcycles and hi-bed trucks will be detected. You can also manually increase sensitivity to a desired level.

4.2.4 DETECTOR IS NOISY/CHATTERS/GIVES FALSE DETECT CALLS

Two or more detector units are interfering with each other (crosstalk). Check frequency settings on detectors which are connected to loops closest to the ORACLE exhibiting crosstalk; several may be showing signs of crosstalk themselves. Adjust the frequency levels utilizing the LCD (SET UP Freq menu) and front panel toggle switches on all units affected so that the largest possible margin exists between frequencies of loops positioned the closest. The rule of thumb is to separate the loop frequency by at least 5 kilohertz. When in the "SET UP Freq" menu, not only can you review the actual frequency, but see a frequency stability graph below the frequency. When changing frequencies, a thinner line on the graph mean less interference is being seen by the detector and a thicker or uneven line represents more interference being seen by the detector.

Basically a thin smooth graph offers a more optimum frequency selection over a thick or uneven line. For optimal operation, select the frequency level with the lowest value of QΔf. For values of QΔf higher than 15-20, the Noise Filter option (see Section 2.1.3.2) should be considered.

4.2.5 POOR LOOP CONNECTIONS

Loop connections are very important to the satisfactory operation of the ORACLE. 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.

4.2.6 POOR LOOPS

Loops that have become degraded due to the passage of traffic may cause the ORACLE 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.

4.3 COMMUNICATIONS PORT ERROR DISPLAY (X SERIES ONLY)

During normal operation transmit and receive status are displayed along with an "**F**" for front panel serial port, or a "**B**" for backplane serial port.

4.3.1 RECEIVE

When a character is received an "**R**" is displayed along with the port it was received on. "**R F**" indicates that a character was received on the front panel serial port. "**R B**" indicates that a character was received on the backplane serial port.

4.3.2 TRANSMIT

When a character is transmitted a "**T**" is displayed along with the port it was transmitted out of. "**T F**" indicates that a character was transmitted out of the front panel serial port. "**T B**" indicates that a character was transmitted out of the backplane serial port.

4.3.3 SERIAL PORT ERRORS

Serial port errors are displayed as a single reversed character along with an "**F**" for front panel serial port, or a "**B**" for backplane serial port.

4.3.3.1 FRAMING

When a framing error is received an "**F** " is displayed along with the port it was received on. "**F F**" indicates that a framing error was received on the front panel serial port. "**F B**" indicates that a framing error was received on the backplane serial port.

4.3.3.2 OVERRUN

When an overrun error is received an "**O** " is displayed along with the port it was received on. "**O F**" indicates that an overrun error was received on the front panel serial port. "**O B**" indicates that an overrun error was received on the backplane serial port.

4.3.3.3 NOISE

When noise is received an "**N** " is displayed along with the port it was received on. "**N F**" indicates that noise was received on the front panel serial port. "**N B**" indicates that noise was received on the backplane serial port.

4.3.4 PROTOCOL ERRORS

Protocol errors are displayed as two reversed characters. Note: The port is not displayed for protocol errors.

4.3.4.1 CB - CONTROL BYTE ERROR

If the control byte of a received frame is invalid than a "**C B** " is displayed.

4.3.4.2 CE - CHECKSUM ERROR

When the checksum of a received frame is invalid a "**C S** " is displayed.

4.3.4.3 CR - CRC ERROR

When the CRC of a received frame is invalid a "**C R** " is displayed.

4.3.4.4 FE - FRAME ERROR

If a received frame is too long or too short, or a buffer overflow error occurs than with an "**F E** " is displayed.

4.3.4.5 ME - MISSING END

When a received frame is missing the end of frame character an "**M E** " is displayed.

4.3.4.6 MS - MISSING START

When the start of frame character is missing from a received frame an "**M S** " is displayed.

4.3.4.7 PP - INVALID PROTOCOL

The front panel serial port can receive either an HDLC frame or a PPT frame (Point to Point Transfer). The backplane serial port however can only receive an HDLC frame. If a PPT frame is received on the backplane serial port a "**P P** " is displayed.

4.3.4.8 TO - TIMEOUT

After receiving the start of a frame, a timer is used to stop the looking for an end of the frame. If the time between received characters of a frame is greater than 1 second a "**T O** " is displayed.

Section 5
Loop Installation

5.1 LOOP DESIGN

The typical sensing height is 2/3 of the shortest leg of a loop (in feet). Therefore a 4' x 8' loop typically has a detection height of 2.6'.

The inductance of a conventional four-sided loop can be estimated using the formula:

$L = P \times (T^2 + T) / 4$ Where L = Loop Inductance in microHenries
P = Loop Perimeter in feet
T = Number of wires in saw slot

Therefore a 4' x 8' loop with 3 turns would be:

$L = (4 + 8 + 4 + 8) \times (3^2 + 3) / 4$

$L = 24 \times (9 + 3) / 4$

$L = 24 \times 12 / 4$

$L = 72$ microHenries

Note: Loop feeder cable typically adds 0.22 microHenries of inductance per foot of cable.

The following are suggested guidelines for loop installation with the ORACLE Vehicle Detector.

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 2.0 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 12 feet require 5 turns of wire, 12 to 60 feet require 3 to 4 turns of wire, loops with greater circumference lengths should have 2 to 3 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 insulation, which 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. The inductance of the loop itself should be at least 50% of the sum of loop inductance plus lead-in inductance.

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.

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 instructions concerning setting time should be noted especially when determining the length of time to wait before allowing vehicles to cross the loop area.

Consult the Eberle Design web site at www.editraffic.com for further application information regarding loop design.

Section 6
Specifications

6.1 MECHANICAL

Height ..... 4.50 inches
Width (2E, 2EC, 4H) ..... 1.14 inches
Width (4E, 4EC) ..... 2.3 inches
Depth (excluding handle) ..... 6.875 inches

6.2 ENVIRONMENTAL

Storage Temperature Range ..... -45 to +85 °C
Operating Temperature Range ..... -34 to +74 °C
LCD Operating Temperature Range ..... -20 to +74 °C
Humidity Range (non-condensing) ..... 0 to 95% Relative

6.3 ELECTRICAL

DC Supply Voltage Minimum ..... 10.8 Vdc
DC Supply Voltage Maximum ..... 28.8 Vdc
DC Supply Current Maximum at 12Vdc (ORACLE 2E, 2EC) ..... 100 mA
DC Supply Current Maximum at 12Vdc (ORACLE 4E, 4EC, 4H) ..... 175 mA
DC Supply Current for LCD Heater Maximum at 12Vdc (ORACLE 2E, 2EC, 4H) .. 250 mA
DC Supply Current for LCD Heater Maximum at 12Vdc (ORACLE 4E, 4EC) .... 500 mA
DC Inputs
- True (low) ..... less than 8 Vdc
- False (high) ..... greater than 16 Vdc

Optically Isolated Outputs
- True (low, 50 mA) ..... less than 1.5 Vdc
- Maximum Leakage Current (Vout = 24Vdc) ..... less than 120 uA
- Maximum Current ..... 100 mA

Relay Outputs
- AC Contact Rating ..... 5A @ 120 Vac
- DC Contact Rating ..... 5A @ 30 Vdc

6.4 TUNING

6.4.1 LOOP INDUCTANCE (TUNING) RANGE

The detector will automatically tune to a loop and lead-in combination within the tuning range of 20 to 2500 microHenry with a Q factor greater than 5.

6.4.2 ENVIRONMENTAL TRACKING

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

6.4.3 GROUNDED LOOP OPERATION

Each detector channel will operate when connected to poor quality loops including those that have a short to ground at a single point.

6.4.4 LEAD-IN LENGTH

The unit will operate with lead-in (feeder) lengths up to 5,000 feet (1,524 m.) with appropriate loops and proper lead-in cable.

6.4.5 LOOP INPUT (LIGHTNING PROTECTION)

The loop input incorporates lightning and transient protection devices and the loop oscillator circuitry is transformer-isolated for each channel. The lightning protection will

withstand the discharge of a 10 uF capacitor charged to 2,000V across the loop inputs or between a loop input and Earth Ground for each channel. The transformer isolation allows operation with a loop which is grounded at a single point.

6.4.6 ORACLE 2E, 2EC RESPONSE TIMING

Response times based on two channel solid state operation with both channels set to the same sensitivity.

	Response Time (ms)						
	Noise Filter				Noise Filter		
Sensitivity	Off	Normal	Max	Sensitivity	Off	Normal	Max
1	4-7	16-28	54-89	**11**	8-14	16-28	54-89
2	4-7	16-28	54-89	**12**	8-14	16-28	54-89
3	4-7	16-28	54-89	**13**	8-14	16-28	54-89
4	4-7	16-28	54-89	**14**	12-21	16-28	54-89
5	4-7	16-28	54-89	**15**	12-21	16-28	54-89
6	4-7	16-28	54-89	**16**	16-28	16-28	54-89
7	4-7	16-28	54-89	**17**	24-41	25-41	54-89
8	4-7	16-28	54-89	**18**	32-55	33-55	54-89
9	4-7	16-28	54-89	**19**	43-76	46-75	54-89
10	4-7	16-28	54-89	**20**	59-104	62-103	62-103

6.4.7 ORACLE 4E, 4EC, 4H RESPONSE TIMING

Response times based on four channel solid state operation with all channels set to the same sensitivity.

	Response Time (ms)						
	Noise Filter				Noise Filter		
Sens	Off	Normal	Max	Sens	Off	Normal	Max
1	8-13	16-26	58-91	**11**	8-13	16-26	58-91
2	8-13	16-26	58-91	**12**	16-26	16-26	58-91
3	8-13	16-26	58-91	**13**	16-26	16-26	58-91
4	8-13	16-26	58-91	**14**	25-39	25-39	58-91
5	8-13	16-26	58-91	**15**	25-39	25-39	58-91
6	8-13	16-26	58-91	**16**	33-52	33-52	58-91
7	8-13	16-26	58-91	**17**	49-78	50-78	58-91
8	8-13	16-26	58-91	**18**	66-104	66-104	64-103
9	8-13	16-26	58-91	**19**	91-143	91-142	87-142
10	8-13	16-26	58-91	**20**	124-195	124-195	119-194

6.5 CONNECTOR PIN ASSIGNMENTS

6.5.1 ORACLE 2E, 2EC PIN ASSIGNMENT

Pin	Function	Pin	Function
A	Logic Ground	**1**	Channel 1 Timer Control Input
B	Detector Unit DC Supply	**2**	Channel 2 Timer Control Input
C	External Reset	**3**	Detector Address Bit #3
D	Channel 1 Loop Input	**4**	Channel 1 Redundant Loop Input
E	Channel 1 Loop Input	**5**	Channel 1 Redundant Loop Input
F	Channel 1 Output (+)	**6**	Detector Address Bit #0
H	Channel 1 Output (-)	**7**	Channel 1 Status Output

Pin	Function	Pin	Function
J	Channel 2 Loop Input	**8**	Channel 2 Redundant Loop Input
K	Channel 2 Loop Input	**9**	Channel 2 Redundant Loop Input
L	Chassis Ground	**10**	Detector Address Bit #1
M	Reserved	**11**	Reserved
N	Reserved	**12**	Reserved
P	Reserved	**13**	Reserved
R	Reserved	**14**	Reserved
S	Channel 1 Secondary Output (+)(2EC)	**15**	Detector Address Bit #2
T	Channel 1 Secondary Output (-)(2EC)	**16**	Channel 1 Secondary Status Output (2EC)
U	Reserved	**17**	Reserved
V	Reserved	**18**	Reserved
W	Channel 2 Output (+)	**19**	Data Transmit Output (TX)
X	Channel 2 Output (-)	**20**	Channel 2 Status Output
Y	Channel 2 Secondary Output (+)(2EC)	**21**	Data Receive Input (RX)
Z	Channel 2 Secondary Output (-)(2EC)	**22**	Channel 2 Secondary Status Output (2EC)

6.5.2 ORACLE 4E, 4EC, 4H PIN ASSIGNMENT

Pin	Function	Pin	Function
A	Logic Ground	**1**	Channel 1 Timer Control Input
B	Detector Unit DC Supply	**2**	Channel 2 Timer Control Input
C	External Reset	**3**	Detector Address Bit #3 (Channel 3 Timer Control Input)
D	Channel 1 Loop Input	**4**	Channel 1 Redundant Loop Input
E	Channel 1 Loop Input	**5**	Channel 1 Redundant Loop Input
F	Channel 1 Output (+)	**6**	Detector Address Bit #0
H	Channel 1 Output (-)	**7**	Channel 1 Status Output
J	Channel 2 Loop Input	**8**	Channel 2 Redundant Loop Input
K	Channel 2 Loop Input	**9**	Channel 2 Redundant Loop Input
L	Chassis Ground	**10**	Detector Address Bit #1 (Channel 4 Timer Control Input)
M	Reserved	**11**	Reserved
N	Reserved	**12**	Reserved
P	Channel 3 Loop Input	**13**	Channel 3 Redundant Loop Input
R	Channel 3 Loop Input	**14**	Channel 3 Redundant Loop Input
S	Channel 3 Output (+)	**15**	Detector Address Bit #2
T	Channel 3 Output (-)	**16**	Channel 3 Status Output
U	Channel 4 Loop Input	**17**	Channel 4 Redundant Loop Input
V	Channel 4 Loop Input	**18**	Channel 4 Redundant Loop Input
W	Channel 2 Output (+)	**19**	Data Transmit Output (TX)
X	Channel 2 Output (-)	**20**	Channel 2 Status Output
Y	Channel 4 Output (+)	**21**	Data Receive Input (RX)
Z	Channel 4 Output (-)	**22**	Channel 4 Status Output

6.5.3 POLARIZATION KEYS

Pin 1 through 22 is on the top (component) side and pin A through Z is on the bottom (solder) side. Polarization keys are located at three positions:

Between B/2 and C/3
Between M/11 and N/12
Between E/5 and F/6