

PRODUCT USER GUIDE



*XL-1000 SERIES VEHICLE
DETECTOR*

INSTALLATION AND USER GUIDE

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2 DISCLAIMER

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4 OVERVIEW

The Excel Technology Co XL-1000 is a multi-function vehicle detector and classification device that uses a combination of inductive loop and piezoelectric sensors embedded in the road surface to accurately measure vehicle speed, length, axle position, classification, and weight. The data is processed and presented in real-time and optionally stored for retrieval.

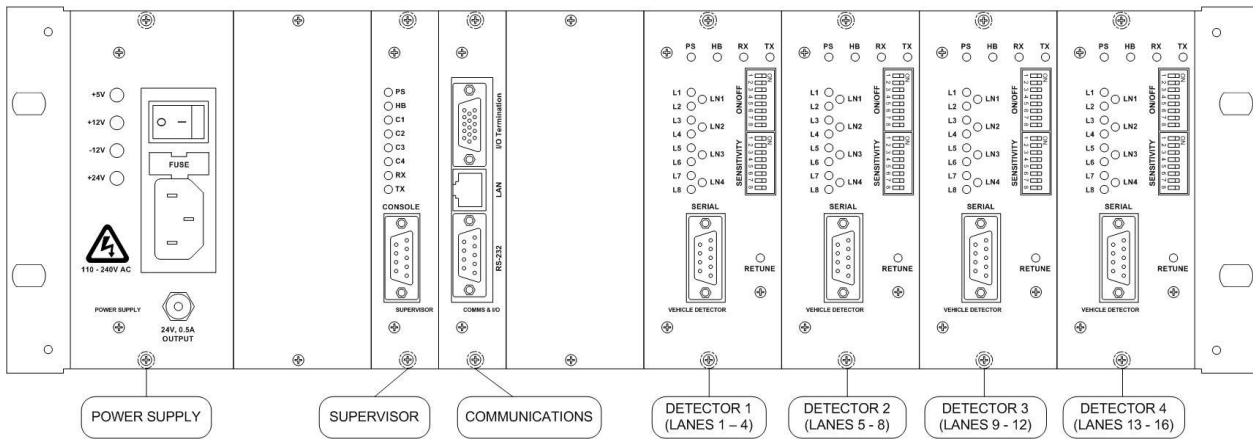
There are four broad configurations available for the XL-1000 that generates a specific set of data based on the intended application:

- XL-1000-W High-speed WiM
- XL-1000-C Vehicle Length and Axle Classifier
- XL-1000-I Vehicle Incident Detection and Length/Metal Mass Classification
- XL-1000-P Vehicle Presence Detector.

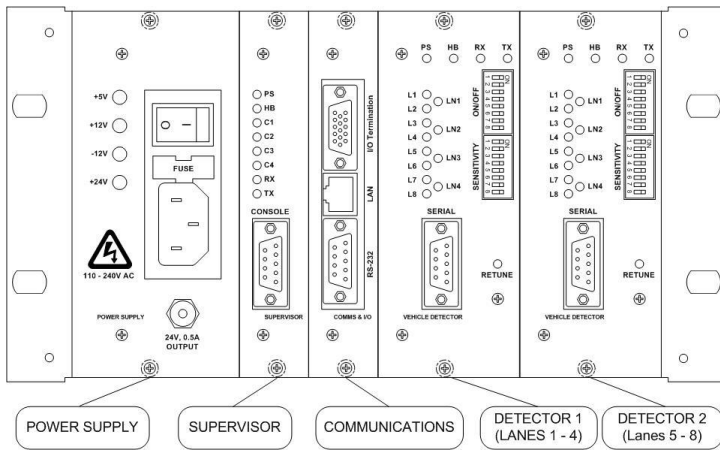
These four configurations are referred to as the functional configuration throughout the documentation.

4.1 PHYSICAL LAYOUT

The XL-1000 is a 3RU height Eurocard format 19-inch chassis system where each card slot corresponds to a different functionality. The modular design allows for cards to be easily exchanged. Cards can be removed from the chassis by unscrewing the thumb screws then firmly pulling the card outward. The detector modules use two card slots and require more force to remove than single cards (Handles are provided to pull the card out to avoid damaging the thumb screws). A typical layout of the chassis is shown below. The enclosure dimensions are 483mm (w) x 330mm (d) x 133mm (h).



A half-width 3RU chassis option is also available, with reduced functionality, for space constrained applications. A typical layout is shown below. The dimensions are 268mm (w) x 330mm (d) x 133mm (h).



4.2 FUNCTIONAL AND SENSOR CONFIGURATIONS

The functional configuration of a XL-1000 unit is selected at the time of purchase and is controlled by a software product key stored within each detector module. The hardware and firmware of a XL-1000 chassis is identical across all functional configurations, so it is therefore possible to change the functional configuration of a unit by purchasing a product key for each detector module. Each individual unit may only operate with detector modules that have identical functional configurations.

For each functional configuration there are a number of options available for the sensor configuration within a lane. The following table outlines these options.

	<i>Loop-Loop</i>	<i>Loop-Piezo-Loop</i>	<i>Loop-Piezo-Piezo-Loop</i>	<i>Piezo-Piezo</i>	<i>Piezo-Loop-Piezo</i>
XL-1000/I	✓				
XL-1000/C	✓	✓	✓	✓	✓
XL-1000/P	✓				
XL-1000/W			✓		✓

The sensor configuration should be specified along with the functional configuration at the time of purchase to ensure that the correct field termination panels are provided with the system.

4.2.1 MODIFYING THE FUNCTIONAL CONFIGURATION

A functional configuration upgrade can be purchased to enable an existing detector module to operate as a different functional configuration. Note down the serial number on the detector module PCB and contact ETC. The serial number will be written on a white background and be in the format ET-yymm-xxx where yymm-xxx are digits. A product key will be issued and needs to be entered via the SERIAL port of the detector module. When a terminal connection has been established, press the <Shift> + <K> keys and then ‘y’ to confirm the update. Enter the provided product key and cycle the power to the unit.

4.3 CUSTOMISATION

Independent of the functional configuration there are a number of card specific variations that are available for customer specific customisation.

- Modular power supply variations:
 - 240Vac line supply
 - 240Vac UPS line supply with external battery (not included)
 - 240Vac UPS monitored line supply with external battery (not included)
 - 12Vdc battery, solar, or DC source
 - 24Vdc battery, solar, or DC source
 - 48Vdc battery, solar, or DC source.
- Communications card variations:
 - Communications card with RS-232, RS-422/RS-485, or Ethernet
 - Server card.
- Optional 17-way Digital I/O card.

One to four detector cards (2-16 lanes depending on sensor configuration).

4.4 POWER CONSUMPTION

The maximum power consumption numbers stated here are measured using the 12Vdc power supply and a supervisor card and show the power variations for different communications card options and detector cards.

		<i>RS-232 comms</i>	<i>Ethernet comms</i>	<i>RS-485/422 comms</i>	<i>Server card</i>
Detector modules	1	8W	12W	9W	8W
	2	13W	18W	14W	14W
	3	19W	24W	21W	20W
	4	26W	31W	28W	27W

4.5 TERMINOLOGY

Inductive loops (also referred to as loops) are coils of wire that are placed in the road surface to generate an electromagnetic field that is used to detect the presence of vehicles as they pass through the field.

Piezoelectric sensors (also referred to as “piezos”) are sensor strips that are placed in or on the road surface and generate an electrical charge when a tyre drives over it. This electrical charge can be used to detect the presence and weight of vehicle axles.

Detector modules (also referred to as detector cards or just detectors) are modules that plug into the XL-1000 19-inch rack chassis and are used to interface with eight inductive loops and eight piezoelectric sensors to detect and measure the passage of vehicles in up to four lanes.

Field termination panels are boards that are separate from the 19-inch rack chassis and are used to connect sensors and actuators (such as inductive loops and piezoelectric sensors) to the 19-inch rack chassis. The field termination panels are connected to the chassis with higher density cabling than is available for the sensors and actuators.

The backplane is the rear side of the 19-inch rack chassis and has eight 16-way IDC connectors that are used to connect the field termination panels for each detector module. The IDC connectors located towards the bottom of the backplane are labelled MAIN and are used to connect the inductive loops from the field termination panel. The IDC connectors located towards the top of the backplane are labelled AUXILIARY and are used to connect the piezoelectric sensors from the field termination panel.

The loop length is defined as the measurement of the loop size in the direction of travel.

The loop spacing is defined as the measurement from the leading edge of one loop to the leading edge of another loop.

It is important to note the units of measurement. Distance is often expressed in either decimetres (dm), which is defined as 1/10th of a meter, or in millimetres (mm). Time is also often expressed in tenths of a second. This is most apparent in vehicle messages where the vehicle length is in decimetres and the headway is in tenths of a second.

The data interface determines what happens with the data that the unit generates. There are two options, a real-time interface, and a data storage interface. A real-time interface communicates with a host system and reports generated data in real-time. A data storage interface records generated data to a Compact Flash drive that allows data to be retrieved at a later time.

5 MODULES

There are two main module options to decide on once the functional and sensor configurations have been decided, the power supply and the data interface. The data interface determines what happens with the data that is generated by the system. The two main options are a real-time data interface, or a stored data interface and the choice depends on the user's needs and infrastructure. A real-time interface will require the communications card, while a stored data interface will require the server card. The server card also has the capability to provide both a real-time interface and a stored data interface.

The power supply options are listed below.

- 240Vac line supply
- 240Vac UPS line supply with external battery (not included)
- 240Vac UPS monitored line supply with external battery (not included)
- 12Vdc battery, solar, or DC source
- 24Vdc battery, solar, or DC source
- 48Vdc battery, solar, or DC source.

5.1 240VAC LINE SUPPLY

The line power supply provides +5Vdc, +12Vdc, -12Vdc and +24Vdc outputs from a 110–240Vac input.

Features:

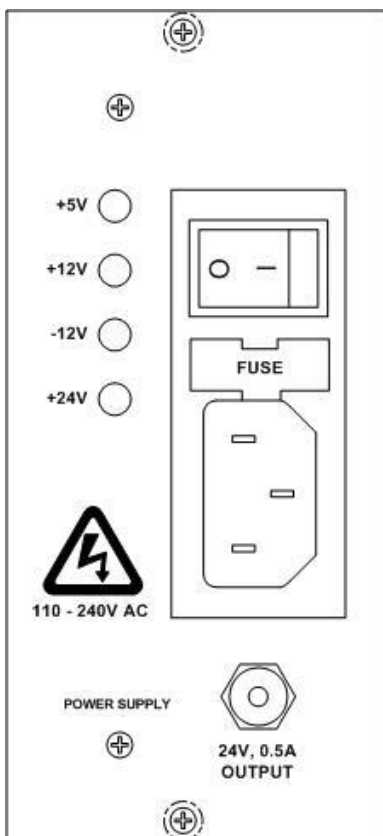
- Meanwell RQ-50D – 50W quad output DC power supply
- 88–264Vac input
- Short circuit, overload, and over-voltage protection with auto-recovery
- 79% efficiency
- C-Tick / CE Approved.

Output Ratings:

- +5Vdc 0.5–6.0A
- +12Vdc 0.2–1.5A
- -12Vdc 0.0–1.0A
- +24Vdc 0.1–1.0A.

5.1.1 FRONT PANEL INTERFACE

The layout of indicators and connectors for the 240Vac line power supply is shown below:



The socket accepts a standard IEC power cable and contains an inbuilt 250Vac / 3A fuse.

The On/Off Switch controls the AC power input and power to the entire rack.

The 24Vdc, 0.5A Output is a 1.3mm DC plug socket supplying 24Vdc at a maximum of 0.5A. Centre pin is +24Vdc, outer ring is 0Vdc.

The +5V LED is lit when +5V DC output is powered.

The +12V LED is lit when +12V DC output is powered.

The -12V LED is lit when -12V DC output is powered.

The +24V LED is lit when +24V DC output is powered.

5.2 240VAC UPS LINE SUPPLY

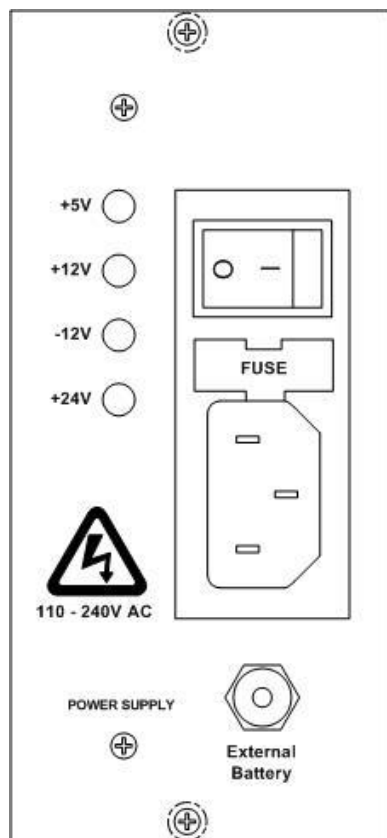
The 240Vac UPS line supply provides +5Vdc, +12Vdc, and -12Vdc outputs from a 110–240Vac input. With the connection of an external battery, it also provides UPS and battery charging functionality. The battery should be sized according to the chassis configuration and the required back up time. This power supply option is combined with an internal (no front panel) 12Vdc power supply card described in *Section 6.4: **Error! Reference source not found.*** It is therefore not available in the half rack chassis.

Features:

- Meanwell AD-55A – 50W single output with battery charger (UPS function)
- 88–264Vac input
- Short circuit, overload, and over-voltage protection with auto-recovery. Battery low protection.
- 71% efficiency
- C-Tick / CE Approved.

5.2.1 FRONT PANEL INTERFACE

The layout of indicators and connectors for the 240Vac UPS line power supply is shown below:



The socket accepts a standard IEC power cable and contains an inbuilt 250Vac / 3A fuse.

The On/Off Switch controls the AC power input and power to the entire rack.

The +5V LED is lit when +5Vdc output is powered.

The +12V LED is lit when +12Vdc output is powered.

The -12V LED is lit when -12Vdc output is powered.

The +24V LED is never lit.

The External Battery socket accepts the provided battery connection cable that is to be connected to the external battery.

5.3 240VAC UPS MONITORED LINE SUPPLY

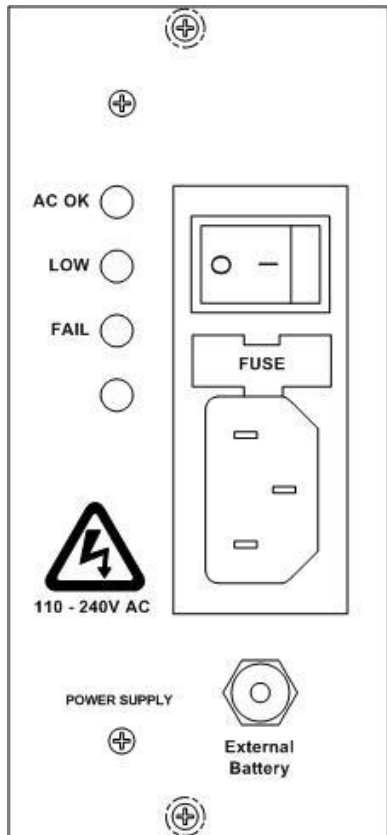
The 240Vac UPS monitored line supply provides +5Vdc, +12Vdc, and -12Vdc outputs from a 110–240Vac input. With the connection of an external battery, it also provides UPS and battery charging functionality. Additionally, monitoring of the AC line supply, battery low, and charger status is provided. The battery should be sized according to the chassis configuration and the required back up time. This power supply option is combined with 12Vdc power supply card described in *Section 6.4: Error! Reference source not found.dc*. It is therefore not available in the half rack chassis.

Features:

- Meanwell AD-55A – 50W single output with battery charger (UPS function)
- 90–264Vac input
- Short circuit, overload, and over-voltage protection with auto-recovery. Battery low protection.
- 84% efficiency
- C-Tick / CE Approved
- AC OK and Battery Low alarms.

5.3.1 FRONT PANEL INTERFACE

The layout of indicators and connectors for the 240Vac UPS monitored line power supply is shown below:



The socket accepts a standard IEC power cable and contains an inbuilt 250Vac / 3A fuse.

The On/Off Switch controls the AC power input and power to the entire rack.

The AC OK LED is lit when the line power supply is operational.

The LOW LED is lit when the battery has dropped below ~11Vdc.

The FAIL LED is lit when there is a fault with the battery charger.

The External Battery socket accepts the provided battery connection cable that is to be connected to the external battery. It is important to note that the battery must be completely isolated from any other circuitry. There must not be another load connected to the battery and it must not be earthed.

5.4 12VDC

The 12Vdc power supply provides +5Vdc, +12Vdc, and -12Vdc from a 12Vdc solar panel or battery source.

±12Vdc Supply Features:

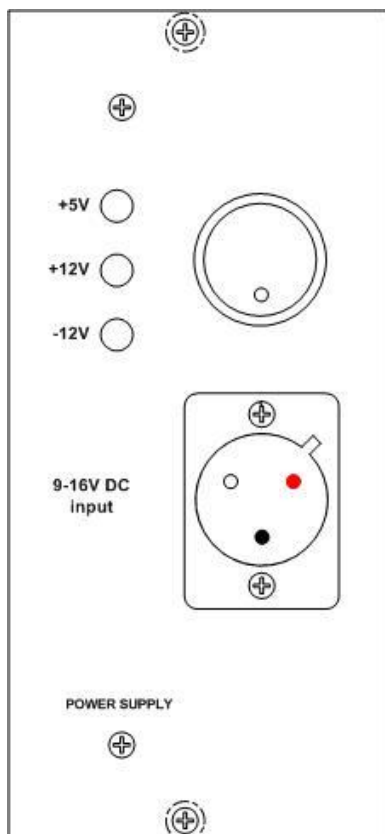
- Meanwell DKA30A-12 30-Watt DC to DC power supply
- 9–18Vdc input
- Short circuit, overload, over-voltage protection, and auto recovery
- 80% efficiency
- C-Tick / CE Approved
- Six-sided shield metal case
- Output Rating ±12Vdc / ±1.25A.

5Vdc Supply Features:

- Meanwell SKA15A-05 15-Watt DC to DC power supply
- 9–18Vdc input
- Short circuit, overload, over-voltage protection, and auto recovery
- 78% efficiency
- C-Tick / CE Approved
- Six-sided shield metal case
- Output Rating +5Vdc/3A.

5.4.1 FRONT PANEL INTERFACE

The layout of indicators and connectors for the 12Vdc power supply is shown below:



The 12Vdc Socket mates with a provided plug and has pin 2 positive (shown as red), pin G common (shown as black).

The On/Off Switch controls the DC power input and power to the entire rack.

The +5V LED is lit when +5Vdc output is powered.

The +12V LED is lit when +12Vdc output is powered.

The -12V LED is lit when -12Vdc output is powered.

5.5 24VDC

The 24Vdc power supply provides +5Vdc, +12Vdc, and -12Vdc from a 24Vdc solar panel or battery source.

±12Vdc Supply Features:

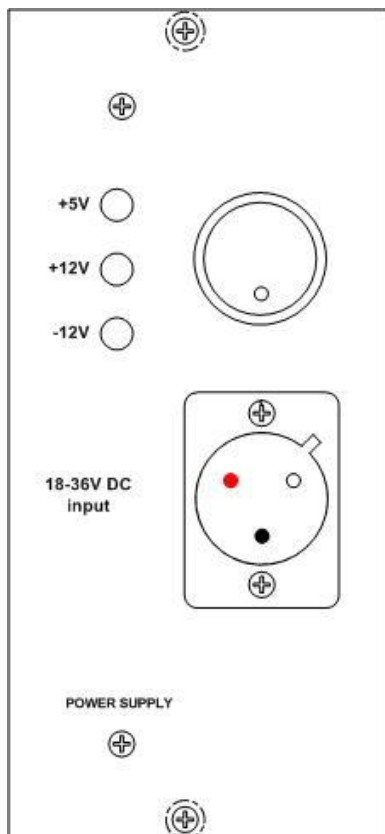
- Meanwell DKA30B-12 30-Watt DC to DC power supply
- 18–36Vdc input
- Short circuit, overload, over-voltage protection, and auto recovery
- 83% efficiency
- C-Tick / CE Approved
- Six-sided shield metal case
- Output Rating ±12Vdc / ±1.25A.

5V DC Supply Features:

- Meanwell SKA15B-05 15-Watt DC to DC power supply
- 18–36Vdc input
- Short circuit, overload, over-voltage protection, and auto recovery
- 78% efficiency
- C-Tick / CE Approved
- Six-sided shield metal case
- Output Rating +5Vdc / 3A.

5.5.1 FRONT PANEL INTERFACE

The layout of indicators and connectors for the 24Vdc power supply is shown below:



The 12Vdc Socket mates with a provided plug and has pin 1 positive (shown as red), pin G common (shown as black).

The On/Off Switch controls the DC power input and power to the entire rack.

The +5V LED is lit when +5Vdc output is powered.

The +12V LED is lit when +12Vdc output is powered.

The -12V LED is lit when -12Vdc output is powered.

5.6 48VDC

The 48Vdc power supply provides +5Vdc, +12Vdc, and -12Vdc from a 48Vdc solar panel or battery source.

±12V DC Supply Features:

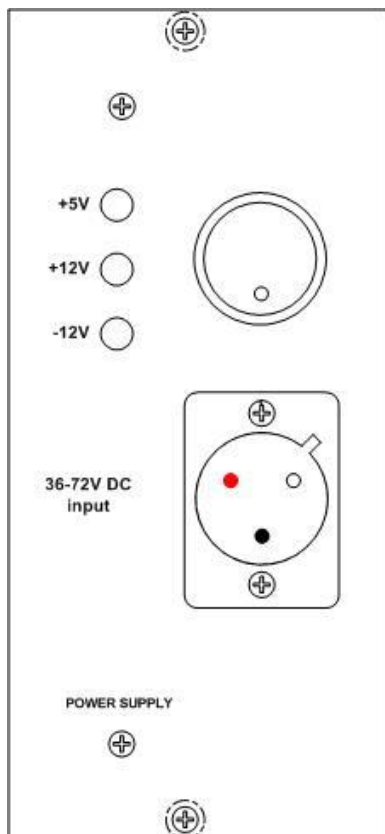
- Meanwell DKA30C-12 30-Watt DC to DC power supply
- 36–72Vdc input
- Short circuit, overload, over-voltage protection, and auto recovery
- 81% efficiency
- C-Tick / CE Approved
- Six-sided shield metal case
- Output Rating ±12Vdc / ±1.25A

5Vdc Supply Features:

- Meanwell SKA15C-05 15-Watt DC to DC power supply
- 36–72Vdc input
- Short circuit, overload, over-voltage protection, and auto recovery
- 80% efficiency
- C-Tick / CE Approved
- Six-sided shield metal case
- Output Rating +5Vdc / 3A.

5.6.1 FRONT PANEL INTERFACE

The layout of indicators and connectors for the 48Vdc power supply is shown below:



The 12Vdc Socket mates with a provided plug and has pin 2 positive (shown as red), pin G common (shown as black).

The On/Off Switch controls the DC power input and power to the entire rack.

The +5V LED is lit when +5Vdc output is powered.

The +12V LED is lit when +12Vdc output is powered.

The -12V LED is lit when -12Vdc output is powered.

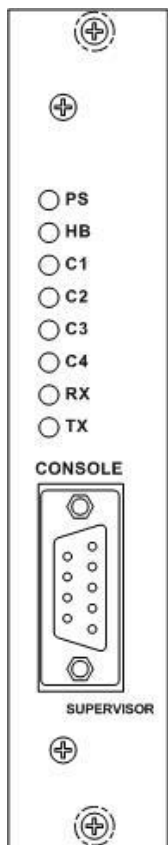
5.7 SUPERVISOR

The supervisor is the heart of the system. It controls the detectors, stores settings, processes detector data, communicates in real-time with a host system, and sends data to the server card for storage. All data generated by the XL-1000 is time stamped by the real-time clock located in the supervisor with a one second resolution. The settings for the XL-1000 are stored in non-volatile flash memory on the supervisor. If the supervisor card is replaced, then the unit will have to be reconfigured.

The console port provides a terminal interface called the console interface which allows manual configuration of all settings and system diagnostics. To use the console interface, a PC with a terminal emulator such as HyperTerminal and a straight through serial cable are required. The connection for the console port is 115200 baud, no parity, 8 data bits, 1 stop bit, and no flow control. Firmware updates can be applied using the console port.

5.7.1 FRONT PANEL INTERFACE

The layout of indicators and connectors for the supervisor is shown below:



The PS LED is lit when supervisor’s processor has power.

The HB LED flashes once per second when supervisor firmware is running normally.

The C1-4 LEDs are lit when the supervisor is communicating with detector modules 1-4, flashing when supervisor cannot communicate with detector modules 1-4, or off when detector modules 1-4 are not used.

The Rx LED flashes when supervisor receives data from communications card/server card.

The Tx LED flashes when supervisor transmits data to the communications card/server card.

The CONSOLE connector is a RS-232 DB-9 female (DCE) serial port for local system configuration (see *Section 13: Console Interface*) and firmware upgrades.

Pin	Description
Pin 2	Transmit
Pin 3	Receive
Pin 5	Signal ground
Pin 9	+12Vdc
Other pins	Not connected

5.8 COMMUNICATIONS CARD

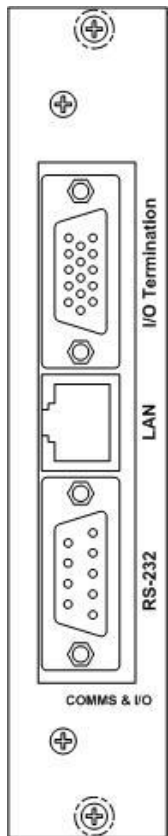
The communications card provides a number of physical communication interfaces to provide access to the host communications protocol running on the supervisor card. No processing on the host communications stream is performed on the communications card other than physically translating the electrical signals to the correct physical interface. An I/O termination port is also provided for connection to the communications card I/O termination panel, which allows connection of two contact closure inputs and output s, and a battery monitoring input.

The possible host communication interfaces are as follows:

- RS-232 with 1200, 2400, 4800, 9600, 14400, 19200, 28800, 38400, 57600, 115200 baud rates, no parity, 8 data bits, 1 stop bit, and no flow control
- TCP/IP Ethernet implemented with a Moxa NE-4100T serial to Ethernet converter
- Isolated or non-isolated RS-422/RS-485

5.8.1 FRONT PANEL INTERFACE

The layout of indicators and connectors for the communications card is shown below:



The I/O Termination connector is not used for the RS-232 and TCP/IP Ethernet options, it is replaced with a DB-9 connector for the RS-422/RS-485 option.

The LAN connector is an RJ-45 socket that provides an Ethernet connection to the internal Moxa NE-4100T serial to Ethernet module (when using Moxa ethernet card, otherwise not connected).

The RS-232 connector is a RS-232, DB-9 female (DCE) serial port. It is not connected for the TCP/IP Ethernet or RS-422/RS-485 options.

Pin	Description
Pin 2	Transmit
Pin 3	Receive
Pin 5	Signal ground
Other pins	Not connected

5.9 SERVER CARD

The server card receives all data from the supervisor and stores it on an internal Compact Flash card. An Ethernet interface is available for remote retrieval of data, communication with a real-time host system, and remote control of the XL-1000 settings. Two optically isolated contact closure inputs and outputs are provided to interface with other equipment.

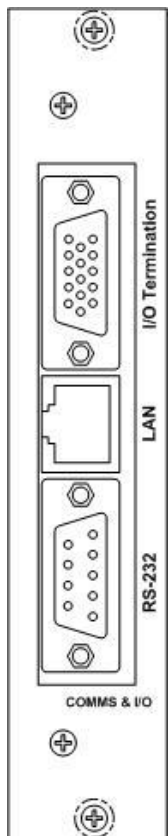
The Ethernet port provides high speed access to the XL-1000 to retrieve data and allow easy connection to an IP based network. The server card acts as a File Transfer Protocol (FTP) server for access to the file system on the internal Compact Flash memory card. It also acts as a Network Time Protocol (NTP) client that is used to keep the time synchronised to a NTP server with 1 second accuracy.

The RS-232 port provides a maintenance terminal interface to view system messages and perform firmware upgrades. To use the RS-232 interface, a PC with a terminal emulator such as HyperTerminal and a straight through serial cable are required. The connection for the port is 115200 baud, no parity, 8 data bits, 1 stop bit, and no flow control. Alternatively the RS-232 port can be used for host communications by removing the card from the chassis and changing the jumpers (located behind the connector from CON [Console] to MOD [modem]). A separate card (available optionally) which is inserted next to the Server card in the chassis provides the MOD connection on a separate DB-9 connector, so that both host communications and console output can be used simultaneously.

The I/O termination port provides a connection to the server termination panel for two contact closure inputs and outputs, a battery monitoring input, and road temperature sensor input.

5.9.1 FRONT PANEL INTERFACE

The layout of indicators and connectors for the server card is shown below:



The I/O Termination connector is a high-density DB-15 female connector that provides a connection to the server card termination panel with a provided high-density DB-15 male-male cable.

The LAN connector is an RJ-45 socket that provides an Ethernet connection for host communications, data retrieval and remote configuration.

The RS-232 connector is a RS-232, DB-9 female (DCE) serial port for viewing system messages and firmware upgrades, or alternatively host communications depending on position of board jumpers.

Pin	Description
Pin 2	Transmit
Pin 3	Receive
Pin 5	Signal ground
Other pins	Not connected

An additional front panel can be supplied to be placed in the adjoining chassis slot for a serial connection to a real-time host system. The RS-232 connector on this front panel is labelled MODEM. This allows terminal and host communications outputs without the need to change jumpers on the PCB.

5.9.2 SERVER TERMINATION PANEL

The battery monitoring input has reverse polarity protection and is capable of measuring battery voltages up to 20V. This limits its use to systems that are operating with 12Vdc batteries.

The road temperature sensor input uses a standard Type K thermocouple.

The two contact closure inputs and outputs are all optically isolated and have the following specifications:

Contact closure inputs:

- No drive signal required, simply contact open / closed
- Contact closed (short-circuit) is logic '1'
- Contact open (open circuit) is logic '0'
- Optically isolated.

Contact closure outputs:

- PVAZ172 HEXFET Power MOSFET Photovoltaic Relay
- Logic '1' is contact closed (short-circuit)
- Logic '0' is contact open (open circuit)
- 0–60V (AC peak)
- Maximum load current: 1.0A DC
- Maximum on state resistance: 500mΩ.

5.10 17-WAY DIGITAL I/O CARD

The 17-way Digital I/O card provides up to 17 inputs or outputs to be connected to the unit for interfacing with external equipment. Each pin can be individually configured as either an input or an output and is optically isolated with the following specification:

Contact closure inputs:

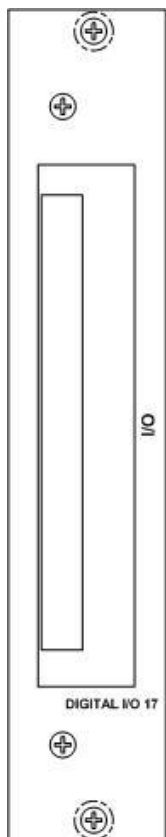
- Requires 5-12Vdc drive signal across a simple contact open / closed
- Contact closed (short-circuit) is logic '1'
- Contact open (open circuit) is logic '0'
- Optically isolated
- Reverse voltage protection.

Contact closure outputs:

- PVAZ172 HEXFET Power MOSFET Photovoltaic Relay
- Logic '1' is contact closed (short-circuit)
- Logic '0' is contact open (open circuit)
- 0–60V (AC peak)
- Maximum load current: 1.0A DC
- Maximum on state resistance: 500mΩ.

5.10.1 FRONT PANEL INTERFACE

The layout of indicators and connectors for the logger card is shown below:



The I/O connector is a 34-way IDC cable that connects to the DIO17 Termination Panel.

5.11 DETECTOR MODULES

Each detector module is capable of monitoring up to four lanes of traffic using a maximum of eight inductive loops and eight piezoelectric sensors. A detector module uses high speed scanning technology to accurately detect vehicles, monitor loop condition, and detect axles in a variety of sensor configurations. Vehicle and traffic measurements are made and passed on to the supervisor for further processing.

The loop sensor interface has the following characteristics:

- High speed loop scan rate of 300 μ s per loop – approximately 2.5ms for all 8 loops on a detector (dependent on loop inductance)
- 50ms retune time
- Open circuit / short circuit detection
- 10-minute automatic retune

The piezoelectric sensor interface is capable of simultaneously detecting the passage of axles across all eight sensors. The detector module provides two different detection algorithms for the piezoelectric sensors, basic and complex. The basic detection algorithm uses a simple threshold detection with hysteresis and an optional timeout window that prevents multiple detections within a set period. The complex detection algorithm is preferred over the basic algorithm and uses a proprietary method involving multiple, time varying, derivative based thresholds. This results in improved small signal detection while providing better ghost axle rejection.

The detector modules can support a number of functional and sensor configurations as described in *Section 5.2: **Error! Reference source not found.*** The sensor configuration will determine the performance and accuracy of the data generated by the detector module. There are a couple of generalisations that can be made about the overall performance for the difference sensor configurations. The presence of a loop will ensure that vehicle volume counts are accurate in stop/start traffic. At least one piezoelectric sensor is required for axle spacing measurements and two piezoelectric sensors will increase the accuracy of the speed and axle spacing measurements, in addition to being required for accurate weigh-in-motion functionality.

Measurement performance:

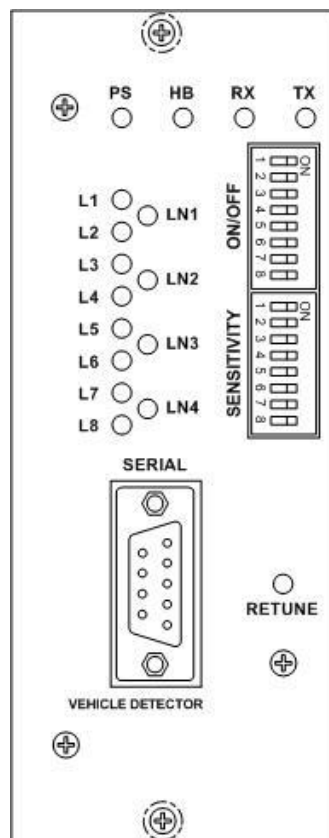
- Speed:
 - ± 1.5 km/h accuracy when using two loops @ 5m spacing
 - Better than ± 1 km/h accuracy when using two piezoelectric sensors
- Length: ± 0.2 m accuracy @ 5m loop spacing
- Headway: 0.1s precision
- Occupancy: 0.1% precision
- Axle spacing:
 - ± 0.05 m accuracy when using a single piezoelectric sensor
 - ± 0.02 m accuracy when using two piezoelectric sensors

Additional features:

- Soft failure. If one loop in a loop pair fails, vehicle headway and occupancy will still be calculated for that lane.
- Dual detection edge processing for greater measurement accuracy

5.11.1 FRONT PANEL INTERFACE

The layout of indicators and connectors for the detector modules are shown below:



The PS LED is lit when the detector module’s processor has power.

The HB LED flashes once per second when detector firmware is running normally.

The Rx LED flashes when the detector receives a message from the supervisor.

The Tx LED flashes when the detector transmits a message to the supervisor.

The L1 – L8 LEDs (Red) change functionality based on the sensor configuration and are described below.

The LN1 – LN4 LEDs (Yellow) change functionality based on the sensor configuration and are described below.

The Retune button retunes all eight inductive loops when pressed.

The ON/OFF DIP switches provide individual on (switched to the right) and off (switched to the left) control for the eight loops. These settings can be overridden via the supervisor console interface.

The SENSITIVITY DIP switches provide individual high (switched to the right, sensitivity 10) and low (switched to the left, sensitivity 8) sensitivity control for the eight loops. These settings can be overridden via the supervisor console interface.

The SERIAL connector is a RS-232 DB-9 female (DCE) serial port for firmware upgrades.

Pin	Description
Pin 2	Transmit
Pin 3	Receive
Pin 5	Signal ground
Other pins	Not connected

The table below shows the function of the L1 – L8 and LN1 – LN4 LEDs for the various sensor configurations.

<i>Sensor configuration</i>	<i>L1-L8 LEDs</i>	<i>LN1-LN4 LEDs</i>
Loop-Loop	Corresponding loop	Valid vehicle
Loop-Piezo-Loop	Corresponding loop	Corresponding piezo
Loop-Piezo-Piezo-Loop	Corresponding loop	The first piezo of the pair
Piezo-Piezo	Corresponding piezo	Valid vehicle
Piezo-Loop-Piezo	Corresponding piezo	Corresponding loop

When a LED corresponds to a loop it has the following behaviour:

- Lit when the loop has a detection
- Off when the loop has no detection
- Continuously flashing when the loop has an open circuit or short circuit condition

When a LED corresponds to a piezoelectric sensor it has the following behaviour:

- Flashes when the piezoelectric sensor has a detection
- Off when the piezoelectric sensor has no detection

When a LED corresponds to a valid vehicle it flashes when a vehicle has been correctly detected and the data is sent to the supervisor.

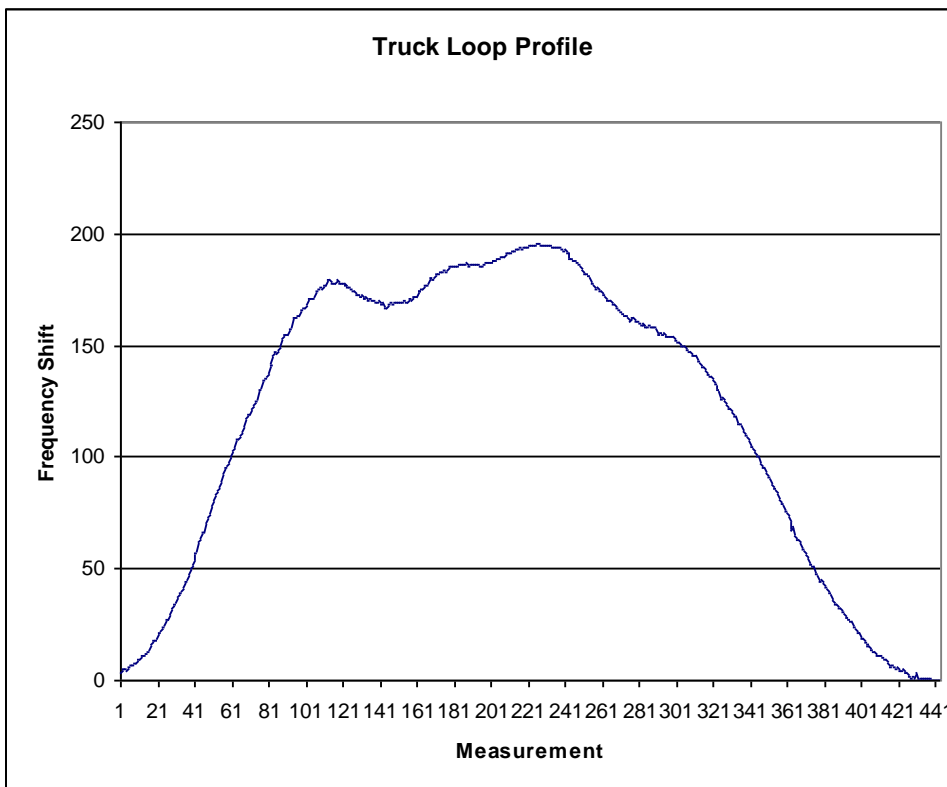
6 INDUCTIVE LOOPS & PIEZOELECTRIC SENSORS

6.1 LOOP OPERATION

6.1.1 ACTUATION

The detector uses inductive loop sensors to detect vehicles. Each detector supports eight loop sensors. Each loop is scanned individually for a change in inductance that signifies a mass of metal (i.e., a vehicle) passing within its field. If the change is above a threshold determined from the sensitivity setting for the loop, an actuation is signalled.

The figure below shows the frequency shift for a truck travelling over a loop:



6.1.2 SCAN RATE

The rate at which the loops are scanned is determined by how many loops are enabled for each card individually, and the inductance of the loops. Typical values are shown below:

<i>Loops enabled</i>	<i>Scan rate</i>
2	0.6ms
4	1.2ms
6	1.8ms
8	2.5ms

6.1.3 CROSSTALK

Because the detector is a scanning detector there is no inter-channel crosstalk. However, inter-card crosstalk may occur if feeder cables for loops of different cards are co-located in the same slot, or loops from different detectors are located adjacent to each other.

Typically, inter-card crosstalk causes loops to lock on, as the loop fields interfere and reduce the stability of the inductance measurement. Decreasing the sensitivity can sometimes rectify this problem, although there will be a corresponding decrease in detector performance.

The best solution is prevention, and therefore loop feeder cable for loops connected to different detector cards should not be laid in the same slot.

6.1.4 PROPERTIES

Loop properties must be within the following ranges:

- 50–700μH loop inductance (100-200μH recommended, depending on feeder length)
- Q between 10 and 30 @ 40kHz (Q 20 recommended).

The Q of the loop is related to the loop's performance:

$$Q = \frac{2\pi \times \text{frequency (Hz)} \times \text{inductance(H)}}{\text{resistance}(\Omega)}$$

Loops with lower Q will be less sensitive, and therefore won't detect a vehicle as quickly. While this will not adversely affect speed measurements, it will affect the length measurements of smaller cars. Loops with long feeder cable lengths may have a higher resistance and therefore lower Q. To compensate these loops should be given a higher inductance (more turns). For existing sites with low Q loops, using the most sensitive detector setting and adjusting the loop length in software will give more accurate measurements. See *Section 0*:

Loop Length for more information on adjusting for low Q loops.

It is not possible to accurately calculate the inductance or Q of a loop prior to installation due to relative permeability of the medium that the loop is installed in. This value can change from site to site depending on the makeup of the road base. There are some guidelines based on previous experience that can be followed to ensure good quality loops.

- A 2m x 2m square loop with 4 turns is recommended
- The feeder length must be less than 200m, but it is recommended to be as short as possible and less than 100m
- If the feeder length is greater than 100m, an additional turn should be added to the loop to compensate for the additional resistance of the feeder
- If the loop is to be located on a bridge or in concrete where there are supporting structures like reinforced steel mesh, consider adding extra turns to the loop to overcome the damping effects of the surrounding structures. Loops should be spaced sufficiently away from metal objects to reduce dampening and crosstalk caused by the metal acting as a conductor between loops.

6.1.5 FAILURE STATE

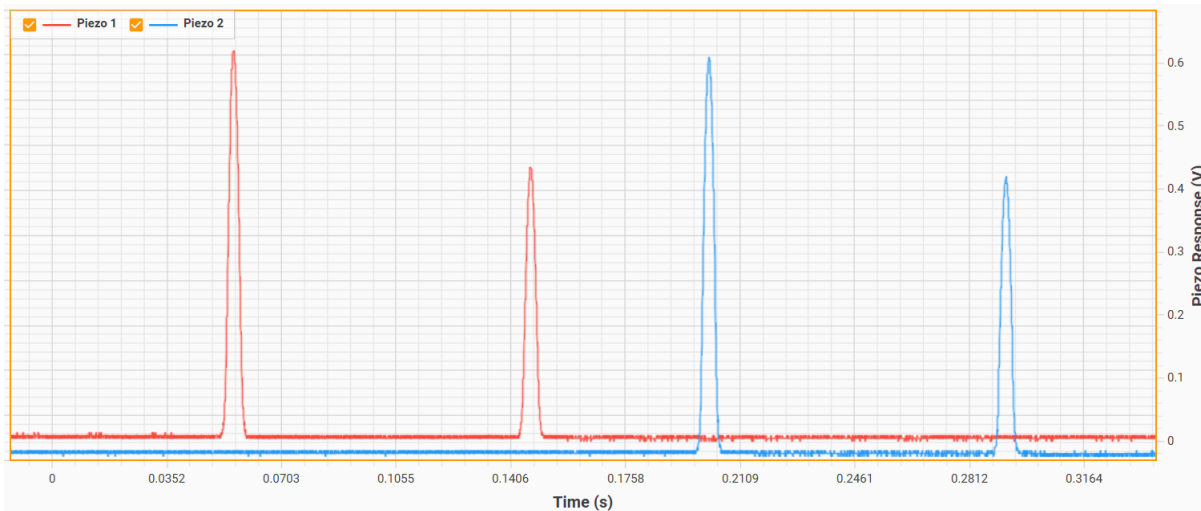
The detector can detect if a loop is open circuit or short circuit. This information is available to the user via the console interface. If a loop is open circuit or short circuit, the corresponding LED on the front panel will continuously flash.

6.2 PIEZOELECTRIC SENSOR OPERATION

6.2.1 ACTUATION

The detector uses piezoelectric sensors to measure vehicle axle spacing. Each detector supports eight piezoelectric sensors which are simultaneously scanned every 100µs for a response that indicates an axle has passed over the sensor. If the change is above the threshold value determined by the detection algorithm and sensitivity, an actuation is signalled.

The image below was recorded using ETCDetectorMonitor software and shows an example of the response for a 2-axle vehicle passing over two piezoelectric sensors.



6.2.2 PROPERTIES

It is recommended that brass linguini style piezoelectric sensors are used. The equipment has been designed and tested to work with these types of sensors and while it is possible that other piezoelectric sensors may work with the XL-1000, they have not been tested and cannot be guaranteed to work with the same accuracy.

For classification purposes Class 2 sensors are suitable, however it is recommended that for Weigh-in-Motion functional configuration the Class 1 sensors are used. The Class of a sensor refers to its uniformity and quality of output signal.

6.2.3 FAILURE STATE

The detector is not capable of sensing a failure in the piezoelectric sensor by any means other than a lack of response to the passage of an axle. Failure must be observed from a constant lack of piezoelectric sensor LED illumination on the detector or no measured axles in the vehicle data. A piezoelectric sensor status is also provided in the data generated by the supervisor. This value can range from 'G' for good, 'W' for weak, and 'F' for failure. It is calculated by examining the vehicle detections from the inductive loop sensors and verifying if there also was piezoelectric sensor activity. This is monitored over a window of previous vehicles and piezoelectric sensor activity increases the failure state from 'F' to 'W' to 'G' while a lack of activity will decrease the failure state from 'G' to 'W' to 'F'.

6.3 SENSOR CONFIGURATIONS

As described in *Section 5.2: **Error! Reference source not found.***, there are a number of different sensor configurations that the XL-1000 can operate with. The only choices for sensor configurations exist in the classifier (XL-1000/C) and Weigh-in-Motion (XL-1000/W) functional configurations.

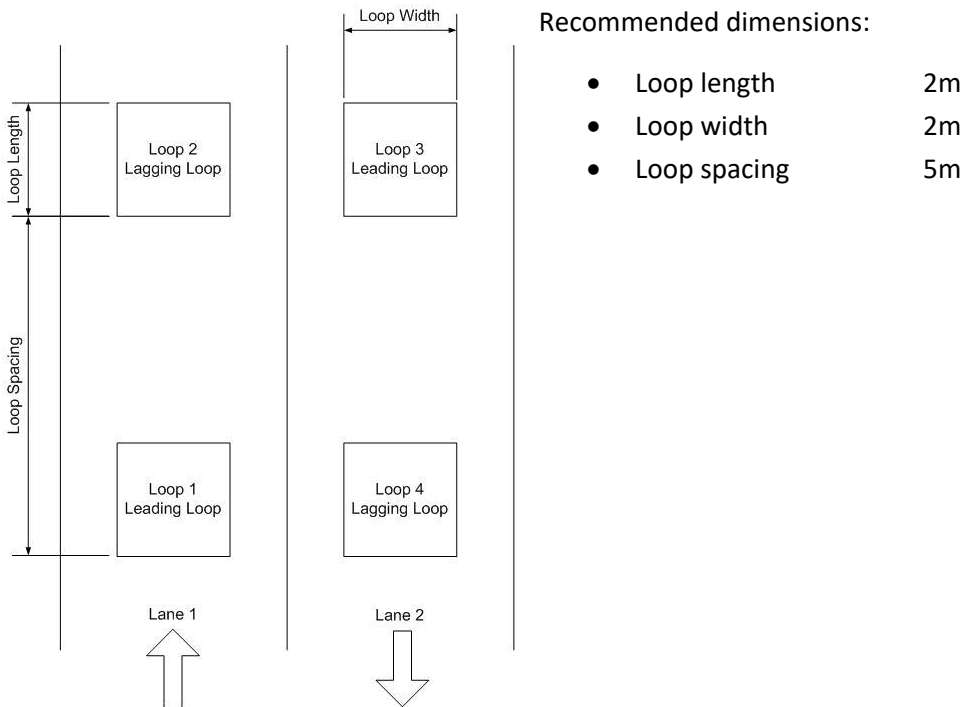
The recommended axle classifier sensor configuration is Loop-Piezo-Loop, which provides the best trade-off for accuracy and installation cost of the in-road sensors. The Loop-Piezo-Piezo-Loop sensor configuration can be used if increased axle spacing accuracy is required at the cost of installing an extra piezoelectric sensor. The Piezo-Piezo configuration should only be used if this sensor configuration is already installed in the road and additional loops cannot be installed. This configuration will have decreased volume and classification accuracy than the other configurations that use a loop.

The recommended weigh-in-motion sensor configuration is Piezo-Loop-Piezo. Loop-Piezo-Piezo-Loop is also possible but less desirable because of the reduced spacing between the piezo sensors, which diminishes the benefits of averaging readings across two sensors to eliminate the effects of vehicle dynamics.

The same sensor dimensions must be used across all lanes. The leading and lagging loops and piezoelectric sensors must also be aligned across all lanes.

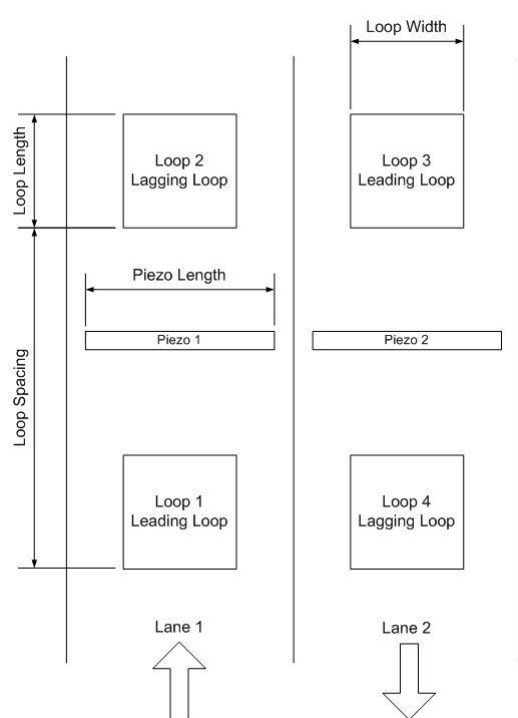
6.3.1 LOOP-LOOP SENSOR LAYOUT

The figure below shows a typical layout for a Loop-Loop sensor configuration including the relevant dimensions. The loops should be located in the centre of the lane.



6.3.2 LOOP-PIEZO-LOOP SENSOR LAYOUT

The figure below shows a typical layout for a Loop-Piezo-Loop sensor configuration including the relevant dimensions. The loops should be located in the centre of the lane and the piezoelectric sensors located halfway between the two loops.

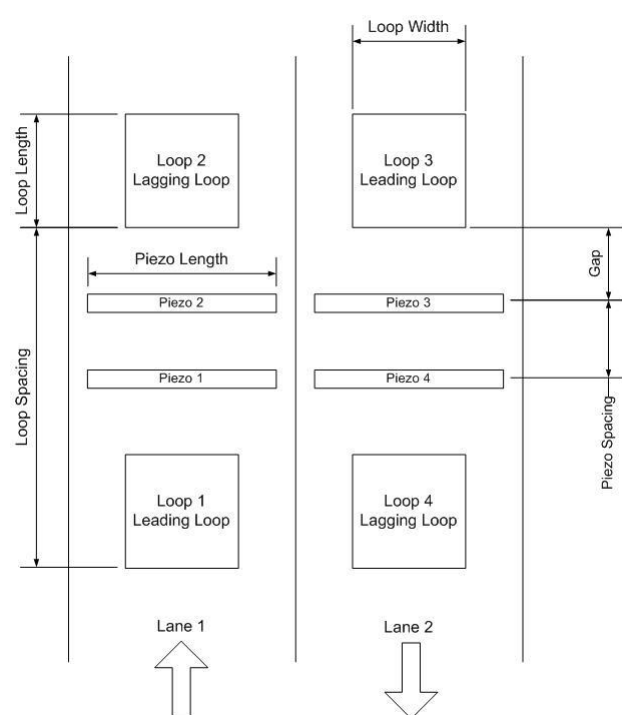


Recommended dimensions:

- Loop length 2m
- Loop width 2m
- Loop spacing 5m
- Piezo Length < lane width

6.3.3 LOOP-PIEZO-PIEZO-LOOP SENSOR LAYOUT

The figure below shows a typical layout for a Loop-Piezo-Piezo-Loop sensor configuration including the relevant dimensions. The loops should be located in the centre of the lane.

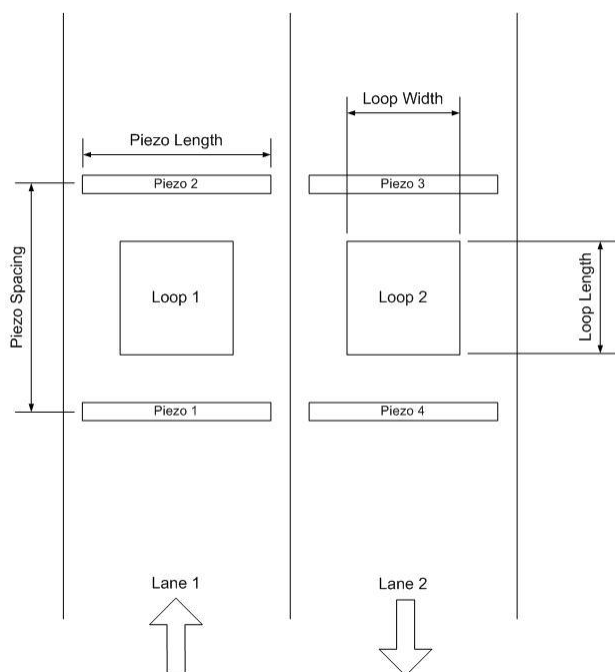


Recommended dimensions:

- Loop length 2m
- Loop width 2m
- Loop spacing 5m
- Piezo length < lane width
- Piezo spacing 1m
- Gap 1m

6.3.4 PIEZO-LOOP-PIEZO SENSOR LAYOUT

The figure below shows a typical layout for a Piezo-Loop-Piezo sensor configuration including the relevant dimensions. The loops should be located in the centre of the lane.



Recommended dimensions:

- Loop length 2m
- Loop width 2m
- Loop spacing 5m
- Piezo length < lane width
- Piezo spacing 3.0m

7 VEHICLE DETECTION

The detector module processes sequences of actuations from inductive loops and piezoelectric sensors to measure the passage of vehicles. Multiple time measurements are taken between the activation and deactivation of an individual sensor and between pairs of sensors. These measurements allow speed and distance calculations to be performed on the vehicle which can be further used to classify the vehicle according to a number of schemes.

7.1 GENERAL MEASUREMENTS

7.1.1 SPEED

Vehicle speed is calculated using the spacing between two identical sensors and the time between their actuation for a vehicle travelling in that lane.

$$Speed (s) = \frac{Sensor\ spacing (d)}{Time\ between\ actuations (t)}$$

When there are two loops in the lane, two-time measurements are used. These are the time between the activation of the leading and lagging loops and the deactivation of the same loops. These two measurements are averaged to calculate the reported speed of the vehicle.

The accuracy is ±1.5km/h when calculated using two loops @ 5m spacing or better than ±1km/h when using two piezoelectric sensors. The precision is 1km/h.

7.1.2 LENGTH

Vehicle length is calculated using the occupied time over an inductive loop, the previously calculated vehicle speed, and the length of the loop.

$$Length (l) = \left(\frac{Speed (s)}{Occupied\ time (t)} \right) - Loop\ length$$

A length calculation is performed for each loop in the lane and averaged to report the final length measurement.

The accuracy is $\pm 0.2\text{m}$ when calculated using two loops @ 5m spacing with a precision of 0.1m.

7.1.3 HEADWAY

Headway (sometimes referred to as 'gap') for a vehicle, is the measured time between when the previous vehicle cleared the lagging loop (or piezo if no loops are present) and the current vehicle actuated the lagging sensor.

The accuracy is $\pm 0.05\text{s}$ with a precision of 0.1s.

7.1.4 ERROR

The error value is the possible error range of the speed measurement in km/h. For more information on error in speed and length measurement, please read *Section 15*:

Error Analysis.

7.1.5 AXLE SPACING

The axle spacing between each axle and the following axle is calculated using a time measurement between successive axle actuations on a single piezoelectric sensor, and the previously calculated vehicle speed.

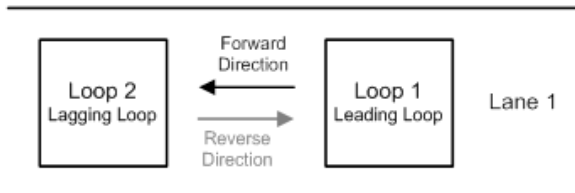
$$\text{Axle spacing } (d) = \text{Speed } (s) \times \text{Time between acutations } (t)$$

When two piezoelectric sensors are present in a lane the time measurements for each sensor are averaged to calculate the reported axle spacing values.

The accuracy is $\pm 0.05\text{m}$ when a single piezoelectric sensor is present or $\pm 0.02\text{m}$ when two piezoelectric sensors are present with a precision of 0.001m .

7.2 LANE DIRECTION

There are a number of options for how the detector module treats vehicles travelling in different directions within a single lane. There are three options for the lane direction setting that determine which direction the vehicles must be travelling in order to be registered as valid data. The forward setting requires that the vehicle travel over the leading sensor first, while the reverse setting requires that the vehicle travel over the lagging sensor first. The leading sensor is always the lower number sensor in a pair (e.g., loop 1 is the leading sensor and loop 2 is the lagging sensor). If the vehicle does not satisfy the correct direction requirement it is not counted as a valid vehicle.



The third lane direction option is tidal flow. In this case vehicles travelling in both directions are counted as valid vehicles. Vehicles travelling in the reverse direction are marked with a negative speed value. When using two loops in the sensor configuration there is a requirement that five vehicles travelling in the reverse direction are detected in a row before reverse vehicles are recorded as valid. This is to overcome problems with vehicles changing lanes causing false detection of reverse vehicles. If two piezoelectric sensors are used the five-vehicle requirement is not present and individual reverse vehicles can be correctly detected.

7.3 CLASSIFICATION

There are a number of vehicle classification schemes available that use a variety of different methods. The inductive loops can be used to classify vehicles based on the vehicle's length or their electromagnetic profile. The piezoelectric sensors can be used to classify vehicles based on their axle spacing measurements. The vehicle incident detection functional configuration (XL-1000/I) only has the inductive loop-based classification available but axle classifier and WiM functional configurations generate both the inductive loop classification and the piezoelectric axle classification.

Note: Classification functions are not available on the XL-1000/P.

7.3.1 LOOP CLASSIFICATION

The classification of a vehicle according to its length and electromagnetic profile peaks is referred to as the loop classification. The loop classification supports a maximum of seven classification types with an additional eighth class for vehicles that do not conform to the classification scheme. A vehicle can only be classified as belonging to a single class. When a vehicle fits multiple classification definitions, the lowest class number takes precedence. The four parameters that define each class are the minimum length, maximum length, minimum number of loop profile peaks, and the maximum number of loop profile peaks.

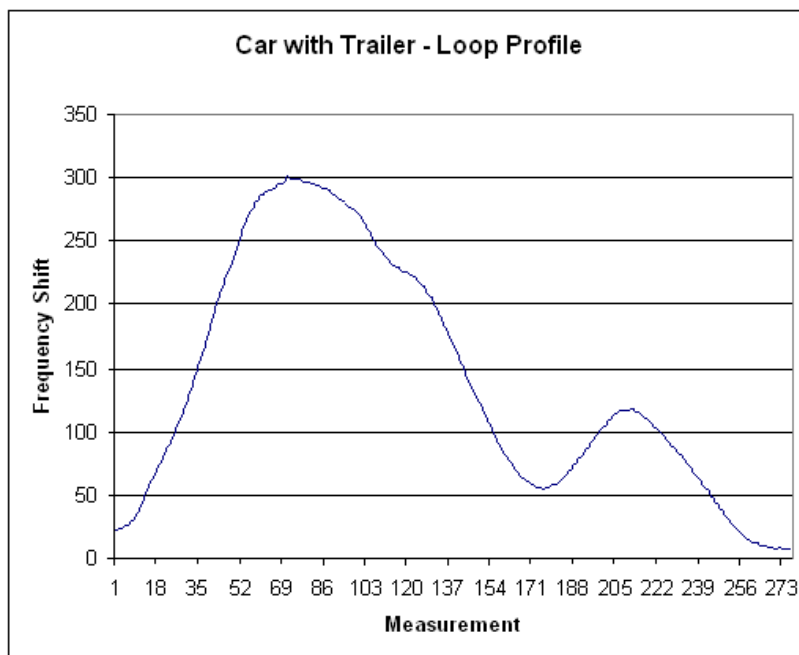
7.3.1.1 LENGTH BASED LOOP CLASSIFICATION

While the loop classification calculation is performed using both the vehicle's length and electromagnetic profile it can be configured to only use the vehicle length. This is achieved by setting the minimum number of profile peaks to zero and the maximum number of profile peaks to sixteen for each class definition.

7.3.1.2 ELECTROMAGNETIC LOOP PROFILE

The electromagnetic loop profile is used to determine the number of loop profile peaks for a vehicle, which is the value used in the classification definition.

The loop profile is the change in resonant frequency of the loop as the vehicle passes over the loop. The figure below shows the loop profile for a car towing a trailer.



The figure shows two local maximum (300 and 120) and one local minimum (50). The maximums are referred to as peaks and the minimums as troughs.

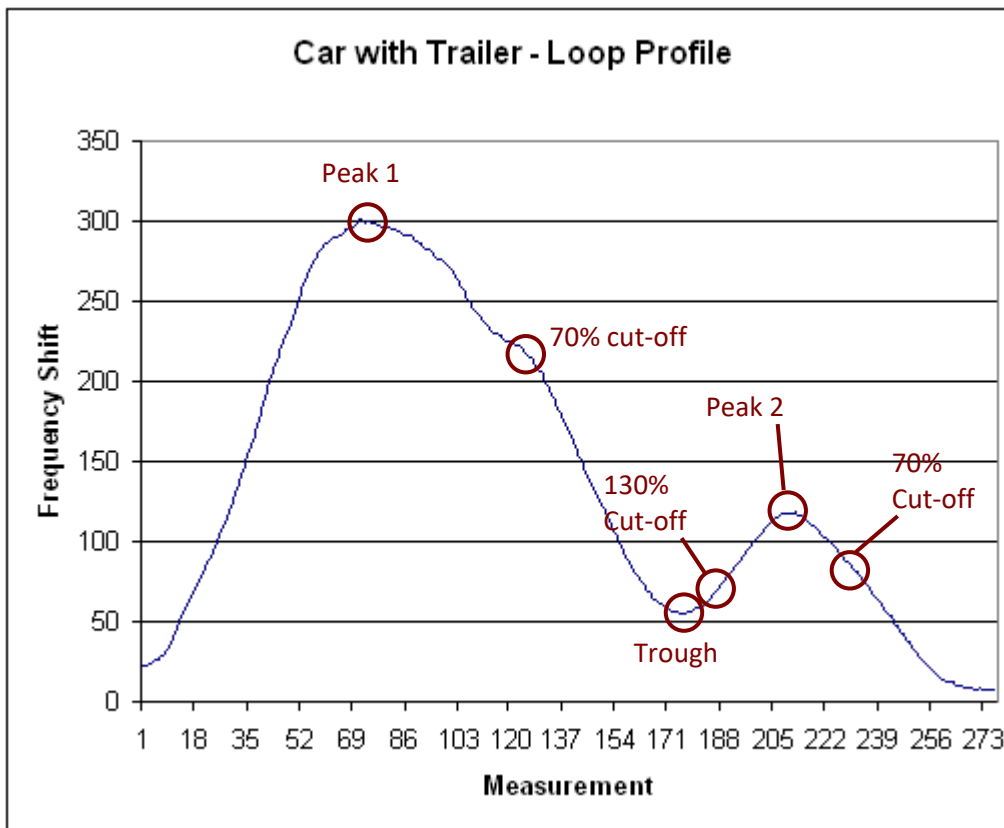
7.3.1.3 PEAKS AND TROUGHS

Peaks correspond to increased concentrations of metal over the loop (or metal closer to the loop). Thus, a car towing a trailer will have two peaks, a normal truck may have one peak, and an articulated truck will have 2 or more peaks.

A peak is counted if the frequency shift falls below a percentage of the last maximum level. This percentage is the post peak cut-off. A trough is counted if the frequency shift rises above a percentage of the last minimum level. This percentage is the post trough cut-off.

Typical values are 70% for post peak cut-off and 130% for post trough cut-off. The closer these values are to 100% the more sensitive the peak counting, and vice versa. These values will change depending on the site and loop size.

For example, in the figure below the level rises to a maximum of 300. With a post peak cut-off of 70% the level must fall to 210 before the peak is counted. Once the level falls below 210 it falls to a minimum of 50. With a post trough cut-off of 130% the level must rise to 65 before the trough is counted and the system starts looking for a peak again. The level then rises to a new maximum of 120 and must fall below 84 to be counted as a peak.



If the post trough cut-off was 250% the second peak would not be counted as the level would have had to rise above 125 for the trough to be counted such that the system would start looking for a peak again.

7.3.1.4 PRE-SET LOOP CLASSIFICATION SCHEMES

The XL-1000 comes with two default loop classification schemes, a length only based Austroads scheme and a default loop profiling scheme. In addition to the two defaults a custom scheme can be used. The following two tables show the values for the Austroads and loop profiling schemes respectively.

<i>Class</i>	<i>Length</i>	<i>Peaks</i>
1	0 – 6m	0 – 16
2	6 – 13m	0 – 16
3	13 – 21m	0 – 16
4	21 – 99.9m	0 – 16
5	0 – 0m	0 – 0
6	0 – 0m	0 – 0
7	0 – 0m	0 – 0
8	N/A	N/A
Post Peak Cut-off:		70%
Post Trough Cut-off:		130%

<i>Class</i>	<i>Length</i>	<i>Peaks</i>	<i>Description</i>
1	0 – 2m	0 – 16	Motorbike
2	2 – 5.5m	0 – 16	Car / light van
3	5.5 – 7.5m	0 – 1	LGV
4	11.5 – 14m	0 – 1	Bus
5	7.5 – 99.9m	0 – 1	HGV
6	14 – 99.9m	0 – 16	HGV articulated
7	5.5 – 14m	2 – 16	Car/ light van towing trailer
8	N/A	N/A	All other vehicles
Post Peak Cut-off:		70%	
Post Trough Cut-off:		130%	

7.3.2 AXLE CLASSIFICATION

The classification of a vehicle according to its axle spacing values is referred to as the axle classification. The axle classification supports a maximum of 128 classes with an additional class for vehicles that do not conform to the scheme. As with the loop classification, a vehicle can only be classified as one class and the lowest numbered classification definition will take precedence. While a maximum of 128 class definitions are supported, most classification schemes will utilise 12–15 class definitions.

Both pre-set and user definable custom axle classification schemes are available. The pre-set classification schemes are hard coded in the firmware and allow for much more detailed class definitions than the user definable custom scheme. Each of the custom axle classes are defined by the following parameters:

- Minimum and maximum axle count
- Minimum and maximum axle group count
- Minimum and maximum axle spacing between axle one and two
- Minimum and maximum axle spacing between axle two and three.

An axle group is defined as the set of all axles where the spacing between two adjacent axles is less than the axle group definition. The axle group definition is user definable and by default is 2.1m. Using the group definition, the commonly used group configuration can be determined. The group configuration provides a brief textual representation of the axle spacing structure for a vehicle. Each character in the group configuration string represents the number of axles in each axle group. For example, if a vehicle has 9 axles that are split into three axle groups with 1 axle in the first group, 2 axles in the second group, and 3 axles in the third group, the group configuration would be represented as '123'. Similarly, a vehicle with 2 axles split in 2 groups is represented as '11'.

The pre-set classification schemes are currently, Austroads, Port of Brisbane (POB) and South Africa. Additional pre-set classification schemes can be requested and added to the firmware.

In addition to the defined classes listed for a particular scheme there are two other possible values, 0 and one more than the maximum class number. A classification value of 0 is the result of a vehicle being detected with less than 2 axles, which can happen when using two inductive loops in the sensor configuration. This will normally only occur for some very light vehicles such as motorcycles and is due to trade-offs made in balancing the sensitivity for accurately measuring heavy vehicles. A classification value of one more than the maximum class number is the result of the measured vehicle not fitting any of the class definitions.

7.3.2.1 AUSTROADS AXLE CLASSIFICATION DETAILS

A copy of the Austroads classification scheme is included in **Error! Reference source not found.:**
Error! Reference source not found..

7.3.2.2 PORT OF BRISBANE (POB) CLASSIFICATION DETAILS

The Port of Brisbane classification scheme is identical to the Austroads scheme but has an additional two classes that take precedence over the Austroads classes.

- Class 13: an A-Double that is defined as having a group configuration of '12323' OR '12333'
- Class 14: A light or heavy Super B-Double that are defined as having group configurations of '1122' OR '1222' and '1243' OR '1244' respectively.

7.3.2.3 SOUTH AFRICA CLASSIFICATION DETAILS

The South Africa classification scheme is much more complicated than Austroads. It uses a third axle spacing value for the distance between axles 3 and 4. It also uses the loop profile to determine if a vehicle is a bus or a truck with a similar axle configuration. It has 17 classes in total, although class 10 is currently not used.

The scheme is as follows:

Axles	Groups	Spacing (1-2)	Spacing (2-3)	Spacing (3-4)	Bus
CLASS 1 - Motorcycle					
2	NA	<=2m			
CLASS 2 – Car					
2	NA	<=3.2m			
3	2	2.1m - 3.2m			
CLASS 3 – Car Towing					
3 - 5	3	2.1m – 3.2m			
CLASS 4 – Bus (two axles)					
2	NA	>3.2m			YES
CLASS 5 – Truck (two axles)					
2	NA	>3.2			
CLASS 6 – Bus (three axles)					
3	2				YES
CLASS 7 – Truck (two axles) with trailer					
3 - 4	3	>3.2m	>=2.1m	Note: Sp(1-2) > Sp(2-3)	
CLASS 8 – Truck (three axles) with trailer					
3	2				
4	3	Note: Sp(1-2) > Sp(3-4)			
CLASS 9 – Generic three or four axle including with trailer					
3-4	>=2				
CLASS 10 – Bus (five or six axles) **NOT USED**					
5-6					YES
CLASS 11 – Truck (three axles) with trailer (more than 4 axles total)					
5	3	>=3.2m	<2.1m		
CLASS 12 – Generic five axle including with trailer					
5	3-4				
CLASS 13 – Generic six axle including with trailer					
6	3				
CLASS 14 – Generic five axle including with multiple trailers					
5	5				
CLASS 15 – Generic six axle including with multiple trailers					
6	>3				
CLASS 16 – Generic seven axle including with multiple trailers					
7					
CLASS 3 – Generic eight axle or more including with multiple trailers					
>=8					

8 TIME

The supervisor contains a one second precise real-time clock that is used to timestamp all data generated by the system. The real-time clock has a backup power supply in the form of a CR2032 coin cell battery that will provide 20+ years of backup power. If the supervisor does not retain the correct time when the power to the unit has been lost, then this battery should be replaced.

The real-time clock contains a temperature-controlled oscillator that accurately maintains the time to within ± 2 minutes per year over all operating temperatures. Leap year compensation is also supported. In order to maintain the time more accurately it will require either manual or automatic updating (via the Network Time Protocol described in the following section).

The remainder of this chapter details the Network Time Protocol and daylight savings features, which are only present with the inclusion of the server card.

8.1 NETWORK TIME PROTOCOL

NTP (Network Time Protocol) is a standard protocol for synchronising time between devices over a network. In order for the XL-1000 to use the NTP, the server card option is required. When the Ethernet port of the server card is connected to a network or modem that allows access to a NTP server it can be used to synchronise the local time. A 10 second timeout is allowed for a response from the specified NTP server. If a response is not received in this time the local time is not updated.

The NTP protocol provides UTC (Coordinated Universal Time) information which has no time zone information. In order for NTP updates to match the local time for the unit's location, a time zone setting is required in the XL-1000. The time zone setting should match the location's UTC offset. For location's that use daylight savings to change the time zone offset from UTC a daylight savings mode is provided by the unit as described in *Section 9.2: Daylight Savings*.

The unit can be configured to periodically request a time update with a frequency that can range from 1 minute to 24 hours provided that it divides wholly into either 1 hour or 1 day. The update frequency is selected with two parts to the setting, a time range, and the period. The time range setting selects the units of the period as being either minutes or hours.

8.2 DAYLIGHT SAVINGS

In locations where daylight savings is used an option is provided to change the time zone offset in all timestamps to match the adjusted UTC offset. Since different locations utilise different start and end dates for daylight savings a user configurable solution is provided. This involves creating a text file containing start and end dates for each year and uploading it to the server card via FTP. In the XL-1000 daylight savings always starts at 2:00 AM on the start date where the clock is put forward an hour and ends at 3:00 AM where the clock is put back an hour. When daylight savings ends there would be data generated between 2:00 AM and 3:00 AM twice. This data is distinguished by the time zone information attached to each timestamp.

8.2.1 FILE FORMAT

The file that stores the daylight savings start and end dates must be named “daylight_savings.txt” and stored in the “System” directory on the file system. Each line of the file must contain a start and end date separated by a comma. The dates are in the DD/MM/YYYY format. Below is an example of the daylight savings file.

```
04/10/2009,04/04/2010
03/10/2010,03/04/2011
02/10/2011,01/04/2012
07/10/2012,01/04/2013
```

9 DATA INTERFACE

The two options relating to what happens with the data that the system generates are either a real-time interface, data storage interface, or both. A real-time interface does not record any data locally in non-volatile memory and uses a communications protocol to send data to a host system. The data storage option allows for all generated data to be locally recorded in non-volatile memory and retrieved in the future.

9.1 REAL-TIME INTERFACE

Communication between the XL-1000 and a third party (often referred to as a ‘host’) uses a choice of host protocols over a number of different physical channels. This is facilitated by the communications card which offers a choice of RS-232, RS-422/RS-485, and Ethernet physical channels. The real-time interface can alternatively be provided by the server card which allows for both a real-time interface and a data storage interface. However, the server card only allows for RS-232 and Ethernet physical channels.

All data that is sent over the physical channel is dictated by the host protocol that has been selected for use. The host protocol defines the rules for communication between the two devices. Currently supported protocols are:

- ETG Communications Protocol v3.2.0
- RMS (TSI-SP-026)
- SICE
- STREAMS.

The ETG Communications Protocol is an open and freely available protocol that can be used to communicate with the XL-1000. All other supported protocols are defined by other organisations and their documentation is not supplied by ETC. Additional communications protocols can be requested for implementation in future firmware releases.

9.2 DATA STORAGE INTERFACE

Data can be internally stored in situations where a real-time communication link or supporting host system is not available, this is facilitated by the server card. The server card stores the data on an internal Compact Flash card and provides an FTP (File Transfer Protocol) server on the Ethernet port to retrieve it.

All data is recorded in the format defined by the selected data file type, which are:

- ETG Data File Format v1.3.0
- Queensland Traffic Data Format v1.02

The ETG Data File Format is a freely available format that can be used to record all possible data generated by the unit in a default format. All other supported data formats are defined by other organisations and their documentation is not supplied by ETC. Additional data formats can be requested for implementation in future firmware releases.

9.2.1 FILE COMPRESSION

A data compression option exists to allow files that are generated on the server card to be compressed using the bzip2 library compression algorithm. Ratios of approximately 20:1 can be achieved for compressing the data files depending on the size and content of the file. Upon completion of the file's time period, it will be compressed (if the option is enabled) and a new file of the same name with a ".bz2" extension will be created. A standard file archive program such as 7-Zip can be used to decompress this file.

10 MOXA CONFIGURATION

The TCP/IP Ethernet communications card uses a Moxa NE-4100T serial to Ethernet converter to provide the Ethernet interface. This chapter is not relevant to the configuration of the Ethernet port on the server card. The Moxa device acts as a TCP/IP server and accepts connections from the host real-time system. A program from Moxa called the Network Enabler Administrator is used to configure the moxa unit. It can be supplied by ETC or downloaded directly from www.moxa.com and should be installed before continuing.

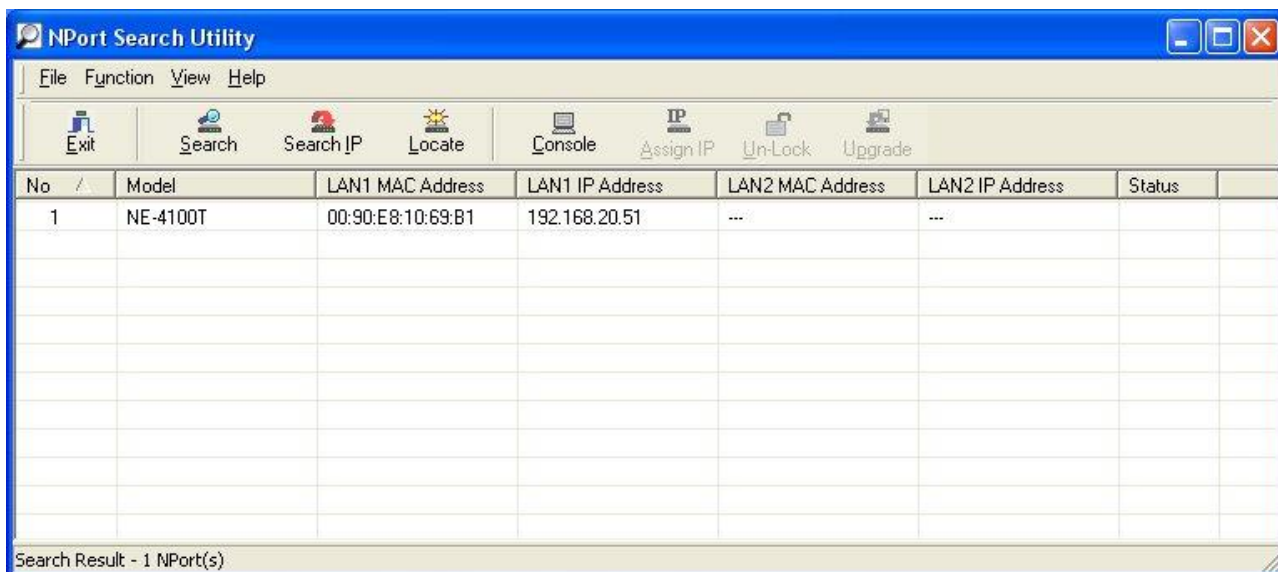
10.1 SETUP

The following equipment is required to configure the Moxa device:

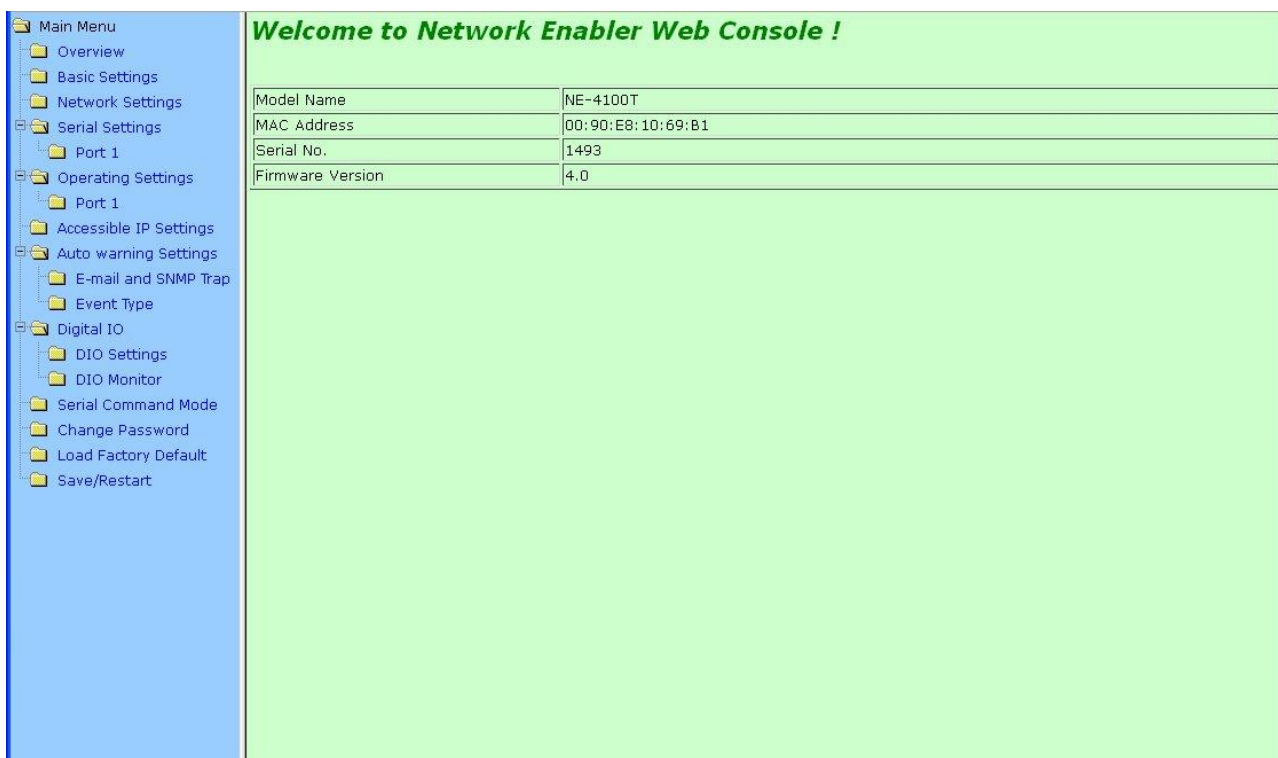
- A powered XL-1000 chassis with communications card (Ethernet version).
- Ethernet cable
- PC with Moxa Network Enabler Administrator installed.

The following steps outline the procedure for changing the Moxa settings.

1. Connect the Ethernet cable between the PC and the LAN Ethernet port of the communications card and ensure the chassis is powered.
2. Start the Moxa Network Enabler Administrator.
3. Click the Search button at the top of the program. Once the search has completed, the details of the Moxa device will be listed.



4. To modify the settings of the Moxa device, the IP address of the PC that is being used needs to be configured to be on the same subnet as the found device. Please refer to the application note “How to Configure a Computer’s IP Address” if this is unfamiliar.
5. Click on the Console button at the top of the program. This will launch the default web browser on the computer and display a similar page as below.



6. The three groups of settings that need to be examined are the serial settings, the operating settings, and the network settings. By default, the serial settings should be as shown below with a baud rate of 115200, 8 data bits, 1 stop bit, no parity, and no flow control. Press the submit button at the bottom of the page to save the settings.

<ul style="list-style-type: none"> Main Menu Overview Basic Settings Network Settings Serial Settings <ul style="list-style-type: none"> Port 1 Operating Settings <ul style="list-style-type: none"> Port 1 Accessible IP Settings Auto warning Settings <ul style="list-style-type: none"> E-mail and SNMP Trap Event Type Digital IO <ul style="list-style-type: none"> DIO Settings DIO Monitor Serial Command Mode Change Password Load Factory Default Save/Restart 	Serial Settings		
	Port=01		
	Port Alias	<input type="text"/>	
	Serial Parameters		
	Baud Rate	115200	
	Data Bits	8	
	Stop Bits	1	
	Parity	None	
	Flow Control	None	
	FIFO	<input type="radio"/> Disable <input checked="" type="radio"/> Enable	
	Interface	RS-232 Only	
	<input type="checkbox"/> Apply the above settings to all serial ports		
	<input type="button" value="Submit"/>		

- The operating settings should reflect the below image. All the settings should be the default values except for the local TCP port value which should reflect the TCP port that is used to connect to the XL-1000. In this example the TCP port is 5001. Press the submit button at the bottom of the page to save the settings.

<ul style="list-style-type: none"> Main Menu Overview Basic Settings Network Settings Serial Settings <ul style="list-style-type: none"> Port 1 Operating Settings <ul style="list-style-type: none"> Port 1 Accessible IP Settings Auto warning Settings <ul style="list-style-type: none"> E-mail and SNMP Trap Event Type Digital IO <ul style="list-style-type: none"> DIO Settings DIO Monitor Serial Command Mode Change Password Load Factory Default Save/Restart 	Operating Settings		
	Port=01		
	Operation mode	TCP Server Mode	
	TCP alive check time	7 (0 - 99 min)	
	Inactivity time	0 (0 - 65535 ms)	
	Max connection	1 (1 - 4)	
	Data Packing		
	Delimiter 1	0 (Hex) <input type="checkbox"/> Enable	
	Delimiter 2	0 (Hex) <input type="checkbox"/> Enable	
	Force transmit	0 (0 - 65535 ms)	
	TCP Server Mode		
	Local TCP port	5001	
	<input type="checkbox"/> Apply the above settings to all serial ports		
	<input type="button" value="Submit"/>		

- The network settings need to be configured to match the host network that the unit is being connected to. Importantly the IP address, netmask, and gateway are specific to the network. The IP configuration should also be set to static. The image below shows an example where the IP address is 192.168.20.51, the netmask is 255.255.255.0, and the gateway is 192.168.20.1. Press the submit button at the bottom of the page to save the settings.

Network Settings	
IP address	192.168.20.51
Netmask	255.255.255.0
Gateway	192.168.20.1
IP configuration	Static
DNS server 1	
DNS server 2	
SNMP Setting	
SNMP	<input checked="" type="radio"/> Enable <input type="radio"/> Disable
Community name	public
Contact	
Location	
IP Address report	
Auto report to IP	
Auto report to TCP port	4001
Auto report period	10 seconds
<input type="button" value="Submit"/>	

- Now that all the settings have been configured choose the save/restart option from the left menu and press the submit button on that page to restart the Moxa device with the new settings. The Moxa device will likely now be unreachable by the PC if you have changed the IP address to a different subnet but is ready for connection to the host real-time network.

11 CONSOLE INTERFACE

The supervisor card provides a terminal interface called the console interface to perform local configuration and diagnostic operations. The console interface is accessed by connecting to the console port on the supervisor using a terminal emulator. It consists of several menu driven screens allowing the user to view and edit settings, see individual vehicle data, and diagnose problems.

The console port on the supervisor is a RS-232 DCE (Female) DB-9 connector that operates at 115200 baud rate, with no parity, 8 data bits, 1 stop bit, and no flow control. The terminal interface follows the ASCII emulation.

The console interface is dynamic and will vary for different functional and sensor configurations. Additionally, there are some settings that are only shown when dependent settings are enabled. Both factors mean that some of the following screen listings will not be presented exactly as the user might see them; however, the tables that describe the settings will include all possible values the user may encounter.

11.1 ENTERING SETTINGS

While editing settings using the console interface, you will be prompted to enter values for each setting. This is performed by typing the value and pressing enter. Characters may be deleted by pressing the backspace key. If you wish to leave a setting unchanged, simply press enter without typing anything, or delete what you have typed, and press enter. Within any of the settings menus and screens there are a few common operations. To change any settings press E then follow the prompts at the bottom of the screen. To return to the settings menu press B or press Q to quit the console.

11.2 CONNECTION

To connect to the console interface, a computer with an RS-232 port and a terminal emulation program such as HyperTerminal is needed. The following directions show how to setup a connection using HyperTerminal on Microsoft Windows XP:

1. Connect the computer's serial port to the console port of the supervisor card via a straight-through serial cable. If your computer doesn't have a serial port, a USB to Serial Converter may be used instead.
2. Start-up windows and point to Start > Programs > Accessories > Communications.
3. Click the HyperTerminal icon to start the program.
4. The Connection Description screen will now be displayed, enter a name for the connection. For example, 'XL-1000 and click OK.
5. The Connect To screen will now be displayed, choose the correct COM port from the drop-down box, and click OK.
6. The COM Properties screen will now be displayed. Set bits per second to 115200, data bits to 8, parity to none, stop bits to 1, and very importantly flow control to none. Click Ok.
7. HyperTerminal should now be connected. Rather than perform this setup process every time, save the connection by clicking File > Save As and choosing an easy to remember location. Next time you want to connect to the XL-1000, open the saved connection description instead and the HyperTerminal will start with all the old settings.
8. If the connection was successful a rotating cursor will be displayed. If not, try pressing Q.
9. Press any key to bring up the main menu.

Note: The console interface will quit to the start-up screen after 5 minutes of no user interaction.

11.2.1 START-UP

If connected to the console interface when the XL-1000 is switched on, a start-up message will appear. The start-up message displays the site name of the XL-1000 and initialisation messages. For example, the listing below displays the successful start-up messages for an XL-1000 with the site name “testrack”:

```
+-- -
| ETG Vehicle Detector - Build: 22.09.07           14:25:33 - 23/09/22
+-- -

Startup, testrack

- Detector comms initialised
- Host comms initialised
- Statistics initialised

/
```

11.3 MAIN MENU

The main menu looks like:

```
+-- -
| ETG Vehicle Detector - Build: 22.09.07           14:25:59 - 23/09/22
+-- -
| Main menu:
+-- -
| (S) - Settings
| (P) - Populated cards
| (D) - Load settings
| (V) - Vehicle transactions
| (L) - Lane transactions
| (F) - Filtered transactions
| (R) - Real time clock
| (Q) - Quit
+-- -
```

The build version of the supervisor firmware and the current date and time are shown on the top line of the display. In the example above, the build version is 22.09.07, and the time is 2:25:59 PM on the 23rd of September 2022.

11.3.1 SETTINGS

Press S to show the settings menu. The settings menu allows the viewing and editing of system settings and values, as well as several diagnostic utilities.

11.3.2 POPULATED CARDS

Press P to list the populated cards and their PCB/firmware versions. This menu does not list the Server Comms Card even if it is installed.

11.3.3 LOAD SETTINGS

Press D to perform a bulk settings upload. This will initiate a YMODEM upload that will allow a binary settings file to be uploaded and configure every setting.

11.3.4 VEHICLE TRANSACTIONS

Press V to show individual vehicle transactions. In vehicle transaction mode, every time a vehicle is detected, the vehicle data is printed to the screen. Each functional configuration will produce slightly different vehicle transactions. An example listing for a XL-1000/C is shown below. The following table describes all possible fields even if they are not shown in the example listing.

```

+- -
| ETG Vehicle Detector - Build: 22.09.07           14:29:55 - 23/09/22
+- -

Vehicle transaction mode. Press any key to quit.

VEH: 14:29:56 L: 2   S: 99   Ln: 180 Hd: 144 AC: 15 A: 6 LC: 5 E: 0
      GVM: 19190 WC: 0
VEH: 14:30:03 L: 1   S: 99   Ln: 180 Hd: 140 AC: 15 A: 6 LC: 6 E: 0
      GVM: 66573 WC: 0
VEH: 14:30:11 L: 2   S: 99   Ln: 180 Hd: 140 AC: 15 A: 6 LC: 6 E: 0
      GVM: 68839 WC: 0
    
```

Field	Description
VEH	Indicates a vehicle record, and is followed by the current time
L	Lane the vehicle is travelling in
S	Speed of the vehicle (km/h)
Ln	Length of the vehicle (dm)
Hd	Headway since the last vehicle (1/10s)
AC	The axle classification of the vehicle
A	The number of axles the vehicle has
LC	The loop classification of the vehicle
E	The error in speed measurement (km/h)
GVM	The gross vehicle mass (kg)
WC	0 or 1 to indicate if the vehicle is over the weight threshold set for its axle class

Note: Vehicle Transaction mode will quit after 15 minutes of no user interaction.

11.3.5 LANE TRANSACTIONS

Press L to show the lane transactions screen. In lane transaction mode each time a vehicle is detected it is printed to a fixed screen position based on its lane, overwriting the previous event for that lane. For example:

```

+- -
| ETG Vehicle Detector - Build: 22.09.07           14:30:34 - 23/09/22
+- -
| Lane transaction mode. Press any key to quit.
+-----+-----+-----+-----+-----+-----+-----+-----+-----+
| Ln. | Time | Speed | Len | Hd | L Cls | Error | A Cls | Axles | GVM | WCl |
+-----+-----+-----+-----+-----+-----+-----+-----+-----+
| 1 | 14:30:35 | 99 | 35 | 169 | 2 | 0 | 1 | 2 | 1624 | 0 |
| 2 | 14:30:42 | 99 | 35 | 310 | 2 | 0 | 1 | 2 | 1679 | 0 |
+-----+-----+-----+-----+-----+-----+-----+-----+-----+
    
```

11.3.6 FILTERED TRANSACTIONS

Press F to display the filtered transactions screen. The filtered transactions screen is identical to the vehicle transaction mode but will only display vehicle events for a single lane. After pressing F, a prompt will appear requesting the entry of the lane to filter. Following this the screen is identical to the vehicle transactions screen but only shows the filtered lane.

11.3.7 REAL-TIME CLOCK

The real time clock is used for time-stamping all collected data, and it is important that it is set accurately. The real time clock menu allows you to set the date and time of the XL-1000.

Enter in a value for the date and time fields or leave them blank to leave the field unchanged. For example, the screen below shows setting the time to 15:45:30 and date to 7/11/2011. Note that the date format is dd/mm/yyyy.

```

+- -
| ETG Vehicle Detector - Build: 11.09.14, Rev: 1822          15:45:01 - 07/11/11
+- -
| Set real time clock
+- -

Date and time is: 07/11/11 15:45:01

Enter day: 7
Enter month: 11
Enter year: 11
Enter hours: 15
Enter minutes: 45
Enter seconds: 30

Date and time is now: 07/11/11 15:45:30

Setup complete

+- Press any key to continue
    
```

11.4 SETTINGS MENU

The settings menu varies slightly for each functional configuration as shown in the following sub sections. If the supervisor detects that the detector modules are not all the same functional configuration or that a two-lane detector module is present but not located in the last enabled detector module slot, the settings menu will only contain the system settings menu.

11.4.1 XL-1000/I SETTINGS MENU

```

+- -
| ETG Vehicle Detector - Build: 22.09.07          14:33:39 - 23/09/22
+- -
| Settings and data:
+- -
| (1) - Station settings          (5) - Output settings
| (2) - Loop settings            (6) - Logger card settings
| (3) - Lane settings
| (4) - Loop class settings
|- -
| (X) - Reset card
| (R) - Retune loop
| (M) - Get loop level
| (Y) - Refresh screen
| (V) - Vehicle transactions
| (L) - Lane transactions
| (F) - Filtered transactions
| (B) - Back
| (Q) - Quit
+- -
    
```

11.4.2 XL-1000/C SETTINGS MENU

```
+-- -
| ETG Vehicle Detector - Build: 22.09.07                14:33:39 - 23/09/22
+-- -
| Settings and data:
+-- -
| (1) - Station settings                                (6) - Axle class settings
| (2) - Loop settings                                  (7) - Output settings
| (3) - Piezo settings                                 (8) - Server settings
| (4) - Lane settings                                  (9) - File settings
| (5) - Loop class settings
+-- -
| (X) - Reset card
| (R) - Retune loop
| (V) - Vehicle transactions
| (L) - Lane transactions
| (F) - Filtered transactions
| (B) - Back
| (Q) - Quit
```

11.4.3 XL-1000/W SETTINGS MENU

```
+-- -
| ETG Vehicle Detector - Build: 22.09.07                14:33:39 - 23/09/22
+-- -
| Settings and data:
+-- -
| (1) - Station settings                                (6) - Axle class settings
| (2) - Loop settings                                  (7) - Weight class settings
| (3) - Piezo settings                                 (8) - Output settings
| (4) - Lane settings                                  (9) - Server settings
| (5) - Loop class settings                            (A) - File settings
+-- -
| (X) - Reset card
| (R) - Retune loop
| (V) - Vehicle transactions
| (L) - Lane transactions
| (F) - Filtered transactions
| (B) - Back
| (Q) - Quit
```

11.5 STATION SETTINGS

The listing below shows the Station settings screen.

```

+- -
| ETG Vehicle Detector - Build: 22.09.07                14:36:03 - 23/09/22
+- -
| System settings:
+- -
| Name: testrack                                     +-----+
| Description: Benchtop Test Rack                    | AC Mains:      - |
| Cards: 1                                           | Battery low:   - |
| Maximum lanes: 2                                   | Charger status: - |
| Units: Metric                                       | Battery voltage: - |
| Address: 1                                          | Cabinet temperature: - |
| Host protocol: ETG v3.2.x                          | Road temperature: - |
| Host medium: Ethernet
| Host TCP port: 5001
| Piezo detector type: Complex                       +-----+-----+
| Sensor configuration: PPLPP                       | Card slot | Configuration |
| Loop scan mode: Normal                            +-----+-----+
| Lane mapping: Disabled                             | Comms      | Server      |
+- -                                                 | Detector 1 | 4 lane WIM |
| Detector 2 | Disabled                             | Detector 2 | Disabled   |
| Detector 3 | Disabled                             | Detector 3 | Disabled   |
| Detector 4 | Disabled                             | Detector 4 | Disabled   |
+-----+-----+

```

> Press (B) for menu, (E) to edit, (Q) to quit

The table below explains each of the parameters above:

Parameter	Description	Editable
Name	The 8-character alphanumeric name of the unit used to individually identify it.	Yes
Description	The 64-ASCII character long description of the unit.	Yes
Cards	The number of detector cards that are present in the system.	Yes
Maximum lanes	The maximum number of lanes that the unit can support as determined by the number of detector cards and their configuration.	No
Units	Units of measurement for the settings and display of vehicle data.	Yes
Address	An address value used by the host protocol to identify the unit in a multi-drop situation.	Yes
Host protocol	The host protocol definition used by the unit.	Yes
Host medium	The host protocol physical interface used by the server card.	Yes
Host baud	The host protocol serial baud rate used by either the communications card or the server card.	Yes
Host TCP port	The host protocol TCP port the server card listens on for host protocol connections.	Yes
Piezo detector type	The piezoelectric sensor detection algorithm used by the detector card. This is only visible if piezoelectric sensors are supported by the functional configuration.	Yes
Sensor configuration	The sensor configuration for a lane. L stands for loop and P stands for piezo. Only visible if the functional configuration supports multiple sensor configuration options.	Yes
Cabinet temperature	The temperature of the cabinet. The value will be '-' if the associated hardware is not connected to the unit.	No
Road temperature	The temperature of the road. The value will be '-' if the associated hardware is not connected to the unit.	No

Battery voltage	The external battery voltage. The value will be '-' if the associated hardware is not connected to the unit.	No
Card Slot/Configuration	The Comms card slot is required to be configured as either plain (communications card) or server (server card) depending on the card that is present in the communications card slot. The Detector entries represent the functional configuration of each detector module as read by the supervisor.	N/A

11.6 LOOP SETTINGS

The listing below shows the loops settings screen.

```

+- -
| ETG Vehicle Detector - Build: 22.09.07                14:38:35 - 23/09/22
+- -
| Loop settings:
+-----+-----+-----+-----+-----+
| No. | State | Op | Len | Freq | Sen |
| 1:  | On   | G | 2000 | 44301 | 10 |
| !2: | On   | O | 2000 |      0 | 10 |
+-----+-----+-----+-----+-----+

> Press (B) for menu, (E) to edit, (Q) to quit
    
```

The table below explains each of the parameters above:

Parameter	Description	Editable
No.	The loop number the parameters refer to. A '!' in the No. column indicates if the corresponding loop has failed. i.e., loop 2 in the above example.	N/A
State	State of the loop – on or off.	Yes
Op	Operational status of each loop: G: Loop is functioning normally O: Loop is open circuit S: Loop is short circuit C: There are no communications with the detector card for this loop	No
Len	Length of the loop (mm)	Yes
Freq	The frequency of the loop signal (Hz)	No
Sen	The sensitivity of the loop from 1 (minimum) to 10 (maximum) 10 is the recommended setting.	Yes

11.7 PIEZO SETTINGS

The two listings below show the two different possibilities for the piezo settings screen depending on the piezo detector type selected. The first shows the basic detector type and the second shows the complex detector type.

```

+- -
| ETG Vehicle Detector - Build: 11.09.14, Rev: 1822          08:00:02 - 08/11/11
+- -
| Piezo settings:                                          ok
+-----+-----+-----+-----+-----+
| No.|State|Op| Thresh | Hyst | Tout |
| 1:| On | G| 100 | 10 | 100 |
| 2:| On | G| 100 | 10 | 100 |
| 3:| On | G| 100 | 10 | 100 |
| 4:| On | G| 100 | 10 | 100 |
+-----+-----+-----+-----+-----+
> Press (B) for menu, (E) to edit, (Q) to quit
    
```

```

+- -
| ETG Vehicle Detector - Build: 22.09.07                    14:23:01 - 23/09/22
+- -
| Piezo settings:
+-----+-----+-----+-----+-----+
| No.|State|Op|Temp Probe|Min Sen|Max Sen|
| 1:| On | G| 1 | 6 | 4 |
| 2:| On | G| 2 | 6 | 4 |
| 3:| On | G| 3 | 6 | 4 |
| 4:| On | G| 4 | 6 | 4 |
| 5:| On | G| 5 | 6 | 4 |
| 6:| On | G| 6 | 6 | 4 |
| 7:| On | G| 7 | 6 | 4 |
| 8:| On | G| 8 | 6 | 4 |
+-----+-----+-----+-----+-----+
> Press (B) for menu, (E) to edit, (T) for Temperature Menu, (Q) to quit
    
```

The table below explains each of the parameters above:

Parameter	Description	Editable
No.	The piezo number the parameters refer to. A '!' in the No. column indicates if the corresponding piezo has failed. i.e., piezo 4 in the above example.	N/A
State	State of the piezo – on or off.	Yes
Op	Operational status of each loop: G: Piezo is functioning normally W: Piezo is partially operating F: Loop is not operating correctly C: There are no communications with the detector card for this piezo	No
Temp Probe	The temperature probe number to use for WiM compensation on the piezo OR 0 for no compensation	Yes

Thresh	The voltage threshold of the piezo used for the basic detector type (mV)	Yes
Hyst	The hysteresis value of the piezo used for the basic detector type (mV)	Yes
Tout	A timeout window of the piezo where subsequent detections are not registered (ms)	Yes
Min Thresh	The minimum sensitivity value of the piezo from 1 (minimum) to 10 (maximum) 6 is the recommended setting	Yes
Max Thresh	The maximum sensitivity value of the piezo from 1 (minimum) to 10 (maximum) 4 is the recommended setting	Yes

11.8 LANE SETTINGS

The listing below shows the lane settings screen when the sensor configuration is PPLPP. The L Spacing and P Spacing columns may or may not be present depending on whether there is more than one loop or piezo in the sensor configuration.

```

+- -
| ETG Vehicle Detector - Build: 22.09.07                14:40:55 - 23/09/22
+- -
| Lane settings:
+-----+-----+-----+
| No.| Dir | P Sp|
| 1:|Forward| 4000|
| !2:|Forward| 4000|
+-----+-----+-----+

> Press (B) for menu, (E) to edit, (Q) to quit
    
```

The table below explains each of the parameters above:

<i>Parameter</i>	<i>Description</i>	<i>Editable</i>
No.	The lane number the parameters refer to. A '!' in the No. column indicates if one of the sensors in that lane has failed. i.e., lane 2 in the above example.	N/A
Direction	Direction of the lane – forward, reverse, or tidal.	Yes
Pairing	Pairing of the loop pair for that lane – single or paired. The loop pairing should always be set to paired for vehicle detection.	Yes
L Spacing	Leading edge to leading edge loop spacing (mm).	Yes
P Spacing	Piezo spacing (mm).	Yes

11.9 LOOP CLASS SETTINGS

The listing below shows the loop classification screen for the default Austroads scheme.

```

+- -
| ETG Vehicle Detector - Build: 22.09.07                14:45:01 - 23/09/22
+- -
| Loop class settings:
+-----+
| Scheme: Custom |
+-----+
| Post peak cutoff:      70% |
| Post trough cutoff:   130% |
+-----+
|Class| Length (dm) | Peaks |
| 1:| 0 - 60 | 0 - 16 |
| 2:| 60 - 130 | 0 - 16 |
| 3:| 130 - 210 | 0 - 16 |
| 4:| 210 - 999 | 0 - 16 |
| 5:| 0 - 0 | 0 - 0 |
| 6:| 0 - 0 | 0 - 0 |
| 7:| 0 - 0 | 0 - 0 |
+-----+

> Press (B) for menu, (E) to edit, (Q) to quit
    
```

The table below explains each of the parameters above:

<i>Parameter</i>	<i>Description</i>	<i>Editable</i>
Scheme	The classification scheme that the class bins represent. It can be either the default 4 bin length only based Austroads classification scheme, the default loop profiling scheme, or a custom scheme.	Yes
Post peak cut-off	Post peak cut-off used in loop profiling.	Yes
Post trough cut-off	Post peak cut-off used in loop profiling.	Yes
Class	The class number the parameter refers to.	N/A
Length	Minimum and maximum length for a vehicle to be classified into a certain class.	Yes
Peaks	Minimum and maximum number of loop profile peaks for a vehicle to be classified into a certain class.	Yes

11.10 AXLE CLASS SETTINGS

The two listings below show the axle classification screen when the default Austroads scheme and custom scheme are selected.

```

+- -
| ETG Vehicle Detector - Build: 22.09.07                14:46:28 - 23/09/22
+- -
| Axle class settings (pg 1/2):
+- -
| Group definition: 2100
+-----+-----+-----+-----+
| No  | Axles | Groups |      D12      |      D23      |
| 1:  | 1 - 25 | 1 - 9  | 0 - 10000    | 0 - 10000    |
| 2:  | 1 - 25 | 1 - 9  | 0 - 10000    | 0 - 10000    |
| 3:  | 1 - 25 | 1 - 9  | 0 - 10000    | 0 - 10000    |
| 4:  | 1 - 25 | 1 - 9  | 0 - 10000    | 0 - 10000    |
| 5:  | 1 - 25 | 1 - 9  | 0 - 10000    | 0 - 10000    |
| 6:  | 1 - 25 | 1 - 9  | 0 - 10000    | 0 - 10000    |
| 7:  | 1 - 25 | 1 - 9  | 0 - 10000    | 0 - 10000    |
| 8:  | 1 - 25 | 1 - 9  | 0 - 10000    | 0 - 10000    |
| 9:  | 1 - 25 | 1 - 9  | 0 - 10000    | 0 - 10000    |
| 10: | 1 - 25 | 1 - 9  | 0 - 10000    | 0 - 10000    |
| 11: | 1 - 25 | 1 - 9  | 0 - 10000    | 0 - 10000    |
| 12: | 1 - 25 | 1 - 9  | 0 - 10000    | 0 - 10000    |
| 13: | 1 - 25 | 1 - 9  | 0 - 10000    | 0 - 10000    |
+-----+-----+-----+-----+
> Setup complete. Press (B) for menu, (E) to edit, (Q) to quit+- -
    
```

The table below explains each of the parameters above:

Parameter	Description	Editable
Scheme	The classification scheme that the class bins represent. It can be either the Austroads scheme, the Port of Brisbane (POB) scheme, or a custom scheme.	Yes
Number bins	The number of custom class bins to define.	Yes
Group definition	The distance that determines whether two successive axles belong to the same axle group.	Yes
Class	The class number the parameter refers to.	N/A
Axles	Minimum and maximum axles for a vehicle to be classified into a certain class.	Yes
Groups	Minimum and maximum axle groups for a vehicle to be classified into a certain class.	Yes
D12	Minimum and maximum axle spacing between the first two axles for a vehicle to be classified into a certain class.	Yes
D23	Minimum and maximum axle spacing between the second and third axles for a vehicle to be classified into a certain class.	Yes

If there are more than 13 custom classes, multiple pages within this screen can be navigated with the N and P keys. The current page can be seen at the top of the screen.

11.11 WEIGHT CLASS SETTINGS

The listing below shows the weight class settings screen. For each of the corresponding axle classes an upper weight threshold can be specified. Vehicles over this weight threshold will be marked with a 1 in their weight class field.

```

+- -
| ETG Vehicle Detector - Build: 22.09.07                14:48:24 - 23/09/22
+- -
| Weight class settings (pg 1/1):
+-----+-----+
|A Class| Weight |
|   1:  |  3500 |
|   2:  |  5000 |
|   3:  |  8000 |
|   4:  | 10000 |
|   5:  | 10000 |
|   6:  | 15000 |
|   7:  | 15000 |
|   8:  | 20000 |
|   9:  | 30000 |
|  10:  | 40000 |
|  11:  | 50000 |
|  12:  | 60000 |
|  13:  |    0  |
|  14:  |    0  |
+-----+-----+

> Press (B) for menu, (E) to edit, (Q) to quit, (N) next page, (P) last page
    
```

The table below explains each of the parameters above:

<i>Parameter</i>	<i>Description</i>	<i>Editable</i>
Weight	The vehicle weight threshold in kilograms. Vehicles equal to or lower than this value will have a WC value of 0, larger than this value will have a value of 1.	Yes

11.12 OUTPUT SETTINGS

The listing below shows the output trigger settings screen.

```

+- -
| ETG Vehicle Detector - Build: 22.09.07                14:51:03 - 23/09/22
+- -
| Output settings:
+- -
| Output active state:   Closed
| Output pulse duration: 1.0s
+-----+-----+-----+-----+-----+
|No| Lane| Trigger | Class | Spd | Len|
| 1| 1-16|Weight Cls| 0-128| 40-100| 130|
| 2| 1-16|Weight Cls| 0-128| 40-100| 130|
+-----+-----+-----+-----+-----+

> Press (B) for menu, (E) to edit, (Q) to quit
    
```

The table below explains each of the parameters above:

Parameter	Description	Editable
Output active state	Whether the contact closure output is actively open or closed.	Yes
Output pulse duration	The pulse duration the output is held in the active state	Yes
Output	The output number the parameter refers to.	N/A
Lane	Minimum and maximum lane for a vehicle to trigger an output.	Yes
Trigger type	The property of a vehicle to match to trigger an output.	Yes
Class	Minimum and maximum class for a vehicle to trigger an output.	Yes
Speed	Minimum and Maximum speed for a vehicle to trigger an output.	Yes
Length	Minimum length for a vehicle to trigger an output.	Yes

The following trigger types are available:

Trigger Type	Description
Loop Class	Trigger based on the loop class of the vehicle.
Axle Class	Trigger based on the axle class of the vehicle.
Weight Class	Trigger if the vehicle is over the weight threshold set for its axle class.
Speed	Trigger if the vehicle speed is within the range specified.
Length	Trigger if the vehicle length is greater than the value specified.
Presence	Trigger when any of the lanes in the range specified have an occupied loop.
System	Pulses every 0.5s under normal conditions. Remains ON if there are any failed loops or piezo sensors.
Lead Loop Presence	Trigger when any of the lanes in the range specified have their lead loop occupied.
Loop Presence	Triggers when any of the loops in the range specified for the lane parameter are occupied. I.e., if lane parameter is 4-6 then this trigger will apply to loops 4-6.

11.13 SERVER SETTINGS

The following listing shows the server settings screen and is only available if the communications card setting is server card.

```

+- -
| ETG Vehicle Detector - Build: 22.09.07                14:52:01 - 23/09/22
+- -
| Server settings:
+- -
| MAC Address: 02:45:54:03:02:07
| IP Address: 10.77.0.66
| IP Netmask: 255.255.255.0
| IP Gateway: 10.77.0.1
| External IP: 10.77.0.66
| Access Port: 10
+- -
| FTP Control Port: 21
| FTP Data Port: 5003
| FTP Username: user
| FTP Password: pass
+- -
| NTP update enabled: No
| NTP IP Address: 203.12.160.2
| NTP request period: 24 hours
| Timezone: +10:00
| Adjust for daylight savings: No
+- -
> Press (B) for menu, (E) to edit, (Q) to quit
    
```

The table below explains each of the parameters above:

<i>Parameter</i>	<i>Description</i>	<i>Editable</i>
MAC Address	The MAC address of the server card	No
IP Address	The statically assigned IP address of the server card	Yes
IP Netmask	The subnet mask for the server card	Yes
IP Gateway	The gateway for the server card	Yes
External IP	The IP address to insert into FTP messages. Should be the same as the IP Address unless a Network Address Translation (NAT) device is used.	Yes
Access Port	The TCP port used by the ETG Site Monitor Program to connect to the server card	Yes
FTP Control Port	The TCP port used by the FTP server to listen for connections	Yes
FTP Data Port	The TCP port used by the FTP server for data connections	Yes
FTP Username	The username to log into the FTP server	Yes
FTP Password	The password to log into the FTP server	Yes
NTP update enabled	Whether the local clock should be synchronised with the NTP server	Yes
NTP IP Address	The IP address to request NTP updates from	Yes
NTP request period	The time period to request NTP updates	Yes
Time zone	The UTC time zone of the LPVD	Yes
Adjust for daylight savings	Whether daylight savings is adjusted for	Yes

11.14 FILE SETTINGS

The listing below shows the file settings screen and is only available if the communications card setting is set to server card.

```

+- -
| ETG Vehicle Detector - Build: 22.09.07                14:53:20 - 23/09/22
+- -
| File settings:
+- -
| Folders enabled: No
| File header enabled: Yes
| File type: ETG DFF v1.3.x
| Verbose: Off
| Data compression: Off
| Keep uncompressed: No
| Vehicle file period: 24 hours
| Status logging period: 1 minutes
+- -

> Setup complete. Press (B) for menu, (E) to edit, (Q) to quit
    
```

The table below explains each of the parameters above:

<i>Parameter</i>	<i>Description</i>	<i>Editable</i>
Folders enabled	When folders are enabled, a folder is created each day to store that day's files. When disabled all files are stored in the root directory.	Yes
File Header enabled	Enables whether the file header is included before the file data on the server card.	Yes
File Type	The format that files are written according to.	Yes
Verbose	Should always be set to Off	Yes
Data Compression	When enabled, files are compressed with the bzip2 algorithm when the time period for the file's data is finished.	Yes
Keep Uncompressed	Selects whether the uncompressed files are kept or deleted.	Yes
Vehicle File Period	The time period that each individual vehicle file is created.	Yes
Status Logging Period	The periodicity with which status events are logged.	Yes

12 INSTALLATION

Each installation site requires the following equipment provided by Excel Technology Co:

- XL-1000 Vehicle Detector Chassis
- Field termination panel(s) to suit the chosen sensor configuration
- Field termination Panel connection cable(s)

The following outlines the steps required for installing the XL-1000.

1. Sensor installation
2. Sensor termination
3. Chassis connection
4. Chassis configuration
5. Verification.

12.1 INDUCTIVE LOOP INSTALLATION

Correct loop installation is essential to good vehicle measurement, in particular vehicle length. Ideally all loops should exhibit the following characteristics:

- Similar inductance: 150 μ H to 250 μ H
- Similar resistance: < 2.5 Ohms
- Q: ~20 @ 40kHz
- Length in the direction of travel: 2m
- Depth beneath road surface: 40mm for cut loops
- Spacing between loop pairs: 5m

A loop tester is available from Excel Technology Co to check loop installations.

12.1.1 ROAD CUT INDUCTIVE LOOPS

Road cut loops are typically installed in existing road surface. If a road is being newly constructed, then it is better to use preformed loops as they have a longer life.

1. Loops will be 2m x 2m in size for typically free flowing roads (\geq 100 km/h), however 1.5m x 1.5m sized loops may be considered for roads that are typically slower with more congestion. This will reduce the accuracy of the loop however tail gating cars are more likely to be detected individually.
2. The cut is a saw cut, typically with width 10mm and depth 40mm. The loops should be centred in the lane and aligned with the road direction. Sharp corners should be avoided where possible by cutting a 30cm corner cut across the square corner.
3. The wires should be wound into (inserted) in the slot using a 'rounded' piece of metal. The wires should always be wound in the same direction for each loop i.e., always clockwise. Typical formats for square loops are either 4 or 5 turns. Inductance and resistance must be measured on completion to ensure that the values are within recommended specifications.
4. Loop pairs will be separated by a distance of 5m from leading edge to leading edge. This can be shortened but will affect speed measurements, see *Section 8.1.1: Speed* for details. Lagging edge to lagging edge should also be the same distance. Loops should be ordered so that the lower numbered loop is the leading loop in the lane.

5. The lead-ins can be co-located as long as the loops are used on the same detector card i.e., lead-ins for loops 1 – 8 cannot be located in the same cut as loops 9 to 16. Excessive lead-in cable must be avoided. When loop cable terminates to a pit, its length in the pit should be less than 2m long. Lead-ins should be twisted together 10 times per metre.
6. Termination to the loop feeder cable is performed by soldering the wires together and sealing the join using heat shrink or epoxy.
7. The loops should have a conductive insulation breakdown to earth test (usually know as a 'megger' or conduction to earth test) – the resistance to earth should be 'infinity' when tested at 250Vac-100MΩ scale.
8. Loop wire size: single core insulated wire (preferably polypropylene) with a cross sectional copper diameter of 1.5mm squared.
9. Feeder cable: screened, twisted balanced twin feeder cable (suitable frequency 20kHz to 70kHz), insulation – polypropylene, copper size –1.5mm squared, metallic screen aluminium or copper tape thickness – 0.075 - 0.025mm, and twist or lay-up helical not to exceed 50mm.

12.1.2 PRE-FORMED INDUCTIVE LOOPS

Preformed loops are best used if the road is being newly constructed. Detailed installation instructions are provided by manufacturers.

1. The preformed pavement loops are in a semi-rigid preformed 2m x 2m shape. The loops include a 'lead-in' semi-flexible conduit which is either 4m or 8m in length allowing for kerb and far vehicle lane installation. Each loop includes a loop start wire (red) and finish wire (white).
2. Loop pairs will be separated by a distance of 5m from leading edge to leading edge. This can be shortened but will affect speed measurements, see *Section 8.1.1: Speed* for details. Each loop should be centred in the lane. Loops should be ordered so that the lower numbered loop is the leading loop in the lane.
3. A permanent physical record (other than paint) should be applied to the road surface border to indicate the position of the loop edge.
4. Subject to confirmation the loops are laid on the 'levelling course' of road base. The loops are secured with a simple rubber strap or other similar means to ensure fixed location during the laying of the road surface.
5. Loop lead-ins are transferred to the roadside pit via flexible high-pressure conduit. The loop tails are twisted 10 times per metre within the conduit. The loop lead-ins are connected to the loop feeder cable in the roadside pit. Long term reliability is secured by soldering connections and sealing with heat shrink or epoxy. The loop feeder cable is typically a black/white pair, and connections should be **black-red** and **white-white** to ensure a uniform loop field polarity.
6. The loops should have a conductive insulation breakdown to earth test (usually know as a 'megger' or conduction to earth test) – the resistance to earth should be 'infinity' when tested at 250Vac-100MΩ scale.

Feeder Cable: screened, twisted balanced twin feeder cable (suitable frequency 20kHz to 70kHz), insulation – polypropylene, copper size –1.5mm squared, metallic screen aluminium or copper tape thickness 0.075 - 0.025mm, and twist or lay-up helical not to exceed 50mm.

12.1.3 DIMENSIONS

The recommended loop dimensions are:

<i>Dimension</i>	<i>Value</i>
Loop Width	2m*
Loop Length	2m
Loop Spacing	5m
Loop Location	Centred in lane

* Adjust the loop width of overly narrow or wide lanes accordingly.

12.2 PIEZOELECTRIC SENSOR INSTALLATION

Correct piezoelectric sensor installation is critical to the performance of measuring axles. It is recommended that brass linguini style piezoelectric sensors are used and that the recommended installation instructions are followed.

The XL-1000 can operate with either half or full lane width sensors. Full lane width sensors are strongly recommended to be used because a stronger signal is produced and will result in more accurate measurement of axles. For Weigh-in-Motion full lane width sensors are required.

For classification purposes Class 2 sensors are suitable, however it is recommended that for Weigh-in-Motion functional configuration Class 1 sensors are used.

The connection point of the piezoelectric sensor should be terminated with a BNC plug connector to mate with the BNC socket connector located on the field termination panel.

12.3 RECOMMENDED SENSOR LAYOUT

Please refer to *Section 7.3: Sensor Configurations* for information on how the sensors should be located in the lane depending on the functional and sensor configuration.

12.4 SENSOR TERMINATION

The field termination panel is typically located at the bottom of the roadside cabinet and is used to connect the inductive loops and piezoelectric sensors to the XL-1000 chassis. Loop field terminals are a rugged screwed ‘push-pull’ terminal block to secure the loop feeder cable. The polarity of the loop feeder cable is not important. Piezoelectric sensors are terminated on PCB mount BNC socket connectors and the correct polarity is essential. The core of the coaxial cable must connect to the core of the BNC plug and the shield of the coaxial cable to the BNC shield. All other optional sensors and actuators use the same screw terminal fittings as the loop field terminals. If correct polarity is required, it will be marked on the field termination panel and omitted if unimportant. The panels are conformal coated for environmental protection due to their location.

All connections between the field termination panel and the chassis are multi-channel cables. Loops and piezoelectric sensors connect via flat twisted IDC ribbon cable. The server card termination panel uses a high-density DB-15 cable.

The loop connection is via a 16-way twisted pair ‘crossed over’ ribbon cable which is used to connect the IDC connector (for a set of 8 loops) on the field termination panel to the corresponding IDC connector on the bottom of the chassis backplane (designated Main X) of the chassis. The piezoelectric sensor connection uses an identical ribbon cable to connect from the IDC connector (for a set of 8 piezoelectric sensors) on the field termination panel to the corresponding IDC connector on the top of the chassis backplane (designated Auxiliary X) of the chassis.

Loop feeders are terminated in screw terminals mounted on the field termination panel and designated with its loop number. Piezoelectric sensors are terminated on the field termination panel via BNC socket connectors designated with its sensor number.

The optional contact closure inputs and outputs, battery input, temperature sensor, RS-422/RS-485 connections are terminated in screw terminals mounted on either the digital IO termination panel or server termination panel.

The field termination panel contains lightning protection circuitry to provide surge protection to the chassis during a storm. The screw terminal connectors designated as EARTH must be connected to cabinet earth for the lightning protection to work adequately.

12.4.1 FIELD TERMINATION PANEL OPTIONS

There are a number of options for the field termination panels depending on the chosen sensor configuration. The correct field terminations panels will be provided to satisfy the sensor configuration of the ordered XL-1000. The options are: 8 loop channels, 16 loop channels, 8 loop and 8 piezo channels, or 8 piezo channels.

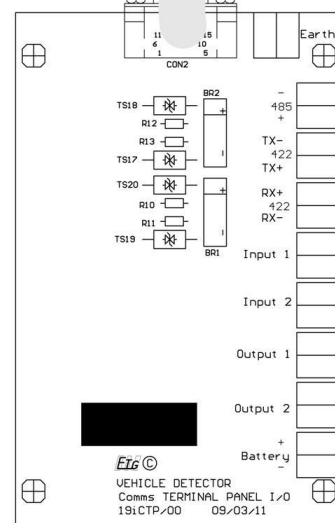
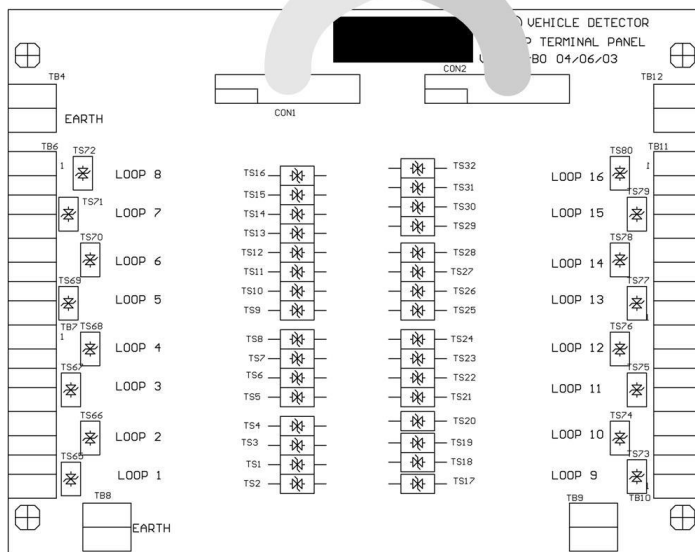
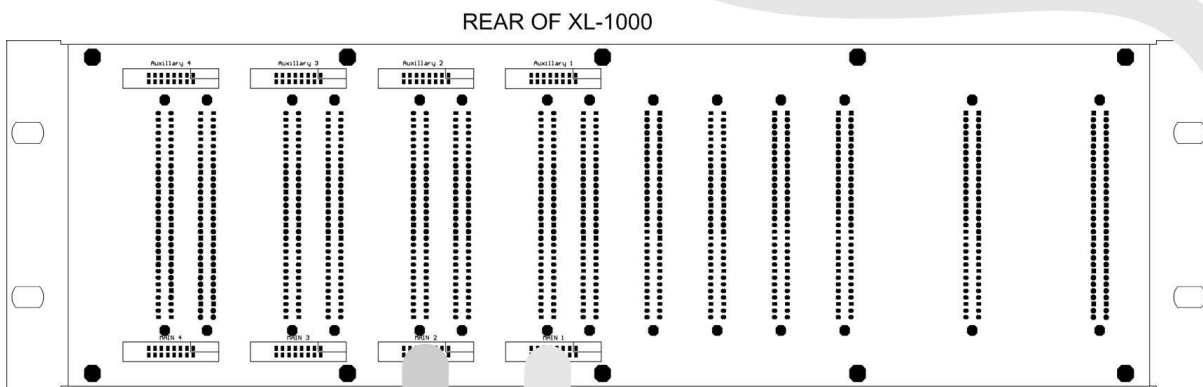
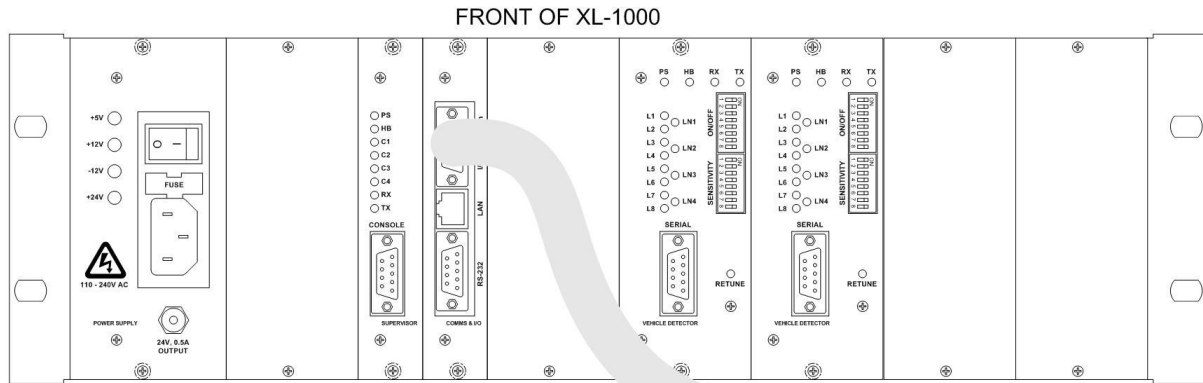
12.5 FIELD TERMINATION CONNECTION METHODOLOGY

Each field termination panel has the loop and piezo terminations labelled in sequence starting from one that corresponds to the sensor number on an individual detector. The correlation of this label to the overall sensor number is made by considering the detector that the termination panel is connected to and the number of sensors per detector. This can best be illustrated in the following two sections with the connection diagrams and tables.

12.5.1 EXAMPLE CONNECTION DIAGRAMS

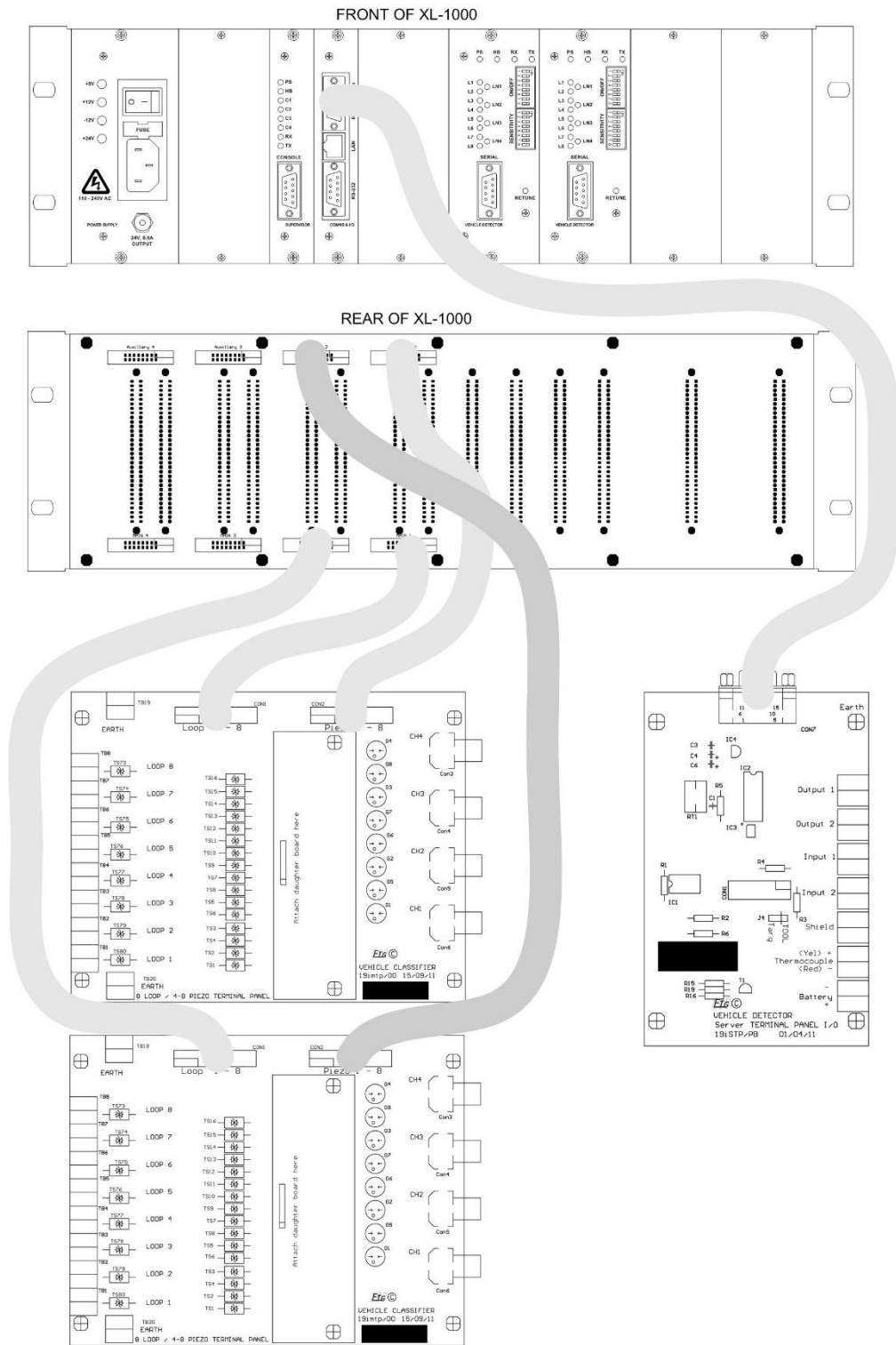
12.5.1.1 8 LANE LOOP-LOOP

An example of the sensor connections for an 8 lane Loop-Loop sensor configuration that is supplied with one 16 channel loop termination panel and a communications termination panel:



12.5.1.2 8 LANE LOOP-PIEZO-PIEZO

An example of the sensor connections for an 8 lane Loop-Piezo-Loop sensor configuration that is supplied with two 8-loop and piezo channel termination panel and a server termination panel:



12.5.2 EXAMPLE LANE CONNECTION TABLES

12.5.2.1 16 LANE LOOP-LOOP

An example of the sensor connections for a 16 lane Loop-Loop sensor configuration that is supplied with two 16-loop channel field termination panels:

<i>Detector card</i>	<i>Field Termination Panel</i>	<i>Field Termination Panel Loop Input</i>	<i>Loop</i>	<i>Location</i>	<i>Lane</i>
1	1	LOOP 1	1	Leading	1
		LOOP 2	2	Lagging	
		LOOP 3	3	Leading	2
		LOOP 4	4	Lagging	
		LOOP 5	5	Leading	3
		LOOP 6	6	Lagging	
		LOOP 7	7	Leading	4
		LOOP 8	8	Lagging	
2		LOOP 9	9	Leading	5
		LOOP 10	10	Lagging	
		LOOP 11	11	Leading	6
		LOOP 12	12	Lagging	
		LOOP 13	13	Leading	7
		LOOP 14	14	Lagging	
		LOOP 15	15	Leading	8
		LOOP 16	16	Lagging	
3	2	LOOP 1	17	Leading	9
		LOOP 2	18	Lagging	
		LOOP 3	19	Leading	10
		LOOP 4	20	Lagging	
		LOOP 5	21	Leading	11
		LOOP 6	22	Lagging	
		LOOP 7	23	Leading	12
		LOOP 8	24	Lagging	
4		LOOP 9	25	Leading	13
		LOOP 10	26	Lagging	
		LOOP 11	27	Leading	14
		LOOP 12	28	Lagging	
		LOOP 13	29	Leading	15
		LOOP 14	30	Lagging	
		LOOP 15	31	Leading	16
		LOOP 16	32	Lagging	

12.5.2.2 16 LANE LOOP-PIEZO-LOOP

An example of the sensor connections for a 16 lane Loop-Piezo-Loop sensor configuration that is supplied with four 8-loop, 8-piezo channel field termination panels:

<i>Detector card</i>	<i>Field Termination Panel</i>	<i>Field Termination Panel Loop Input</i>	<i>Loop</i>	<i>Location</i>	<i>Field Termination Panel Piezo Input</i>	<i>Piezo</i>	<i>Lane</i>
1	1	LOOP 1	1	Leading	PIEZO 1	1	1
		LOOP 2	2	Lagging			
		LOOP 3	3	Leading	PIEZO 2	2	2
		LOOP 4	4	Lagging			
		LOOP 5	5	Leading	PIEZO 3	3	3
		LOOP 6	6	Lagging			
		LOOP 7	7	Leading	PIEZO 4	4	4
		LOOP 8	8	Lagging			
2	2	LOOP 1	9	Leading	PIEZO 1	5	5
		LOOP 2	10	Lagging			
		LOOP 3	11	Leading	PIEZO 2	6	6
		LOOP 4	12	Lagging			
		LOOP 5	13	Leading	PIEZO 3	7	7
		LOOP 6	14	Lagging			
		LOOP 7	15	Leading	PIEZO 4	8	8
		LOOP 8	16	Lagging			
3	3	LOOP 1	17	Leading	PIEZO 1	9	9
		LOOP 2	18	Lagging			
		LOOP 3	19	Leading	PIEZO 2	10	10
		LOOP 4	20	Lagging			
		LOOP 5	21	Leading	PIEZO 3	11	11
		LOOP 6	22	Lagging			
		LOOP 7	23	Leading	PIEZO 4	12	12
		LOOP 8	24	Lagging			
4	4	LOOP 1	25	Leading	PIEZO 1	13	13
		LOOP 2	26	Lagging			
		LOOP 3	27	Leading	PIEZO 2	14	14
		LOOP 4	28	Lagging			
		LOOP 5	29	Leading	PIEZO 3	15	15
		LOOP 6	30	Lagging			
		LOOP 7	31	Leading	PIEZO 4	16	16
		LOOP 8	32	Lagging			

12.5.2.3 16 LANE LOOP-PIEZO-PIEZO-LOOP

An example of the sensor connections for a 16 lane Loop-Piezo-Piezo-Loop sensor configuration that is supplied with four 8-loop, 8-piezo channel field termination panels:

<i>Detector card</i>	<i>Field Termination Panel</i>	<i>Field Termination Panel Loop Input</i>	<i>Loop</i>	<i>Location</i>	<i>Field Termination Panel Piezo Input</i>	<i>Piezo</i>	<i>Lane</i>
1	1	LOOP 1	1	Leading	PIEZO 1	1	1
		LOOP 2	2	Lagging	PIEZO 2	2	
		LOOP 3	3	Leading	PIEZO 3	3	2
		LOOP 4	4	Lagging	PIEZO 4	4	
		LOOP 5	5	Leading	PIEZO 5	5	3
		LOOP 6	6	Lagging	PIEZO 6	6	
		LOOP 7	7	Leading	PIEZO 7	7	4
		LOOP 8	8	Lagging	PIEZO 8	8	
2	2	LOOP 1	9	Leading	PIEZO 1	9	5
		LOOP 2	10	Lagging	PIEZO 2	10	
		LOOP 3	11	Leading	PIEZO 3	11	6
		LOOP 4	12	Lagging	PIEZO 4	12	
		LOOP 5	13	Leading	PIEZO 5	13	7
		LOOP 6	14	Lagging	PIEZO 6	14	
		LOOP 7	15	Leading	PIEZO 7	15	8
		LOOP 8	16	Lagging	PIEZO 8	16	
3	3	LOOP 1	17	Leading	PIEZO 1	17	9
		LOOP 2	18	Lagging	PIEZO 2	18	
		LOOP 3	19	Leading	PIEZO 3	19	10
		LOOP 4	20	Lagging	PIEZO 4	20	
		LOOP 5	21	Leading	PIEZO 5	21	11
		LOOP 6	22	Lagging	PIEZO 6	22	
		LOOP 7	23	Leading	PIEZO 7	23	12
		LOOP 8	24	Lagging	PIEZO 8	24	
4	4	LOOP 1	25	Leading	PIEZO 1	25	13
		LOOP 2	26	Lagging	PIEZO 2	26	
		LOOP 3	27	Leading	PIEZO 3	27	14
		LOOP 4	28	Lagging	PIEZO 4	28	
		LOOP 5	29	Leading	PIEZO 5	29	15
		LOOP 6	30	Lagging	PIEZO 6	30	
		LOOP 7	31	Leading	PIEZO 7	31	16
		LOOP 8	32	Lagging	PIEZO 8	32	

12.5.2.4 16 LANE PIEZO-LOOP-PIEZO

An example of the sensor connections for a 16 lane Piezo-Loop-Piezo sensor configuration that is supplied with four 8-loop, 8-piezo channel field termination panels:

<i>Detector card</i>	<i>Field Termination Panel</i>	<i>Field Termination Panel Loop Input</i>	<i>Loop</i>	<i>Location</i>	<i>Field Termination Panel Piezo Input</i>	<i>Piezo</i>	<i>Lane</i>
1	1	LOOP 1	1	Leading	PIEZO 1	1	1
				Lagging	PIEZO 2	2	
		LOOP 2	2	Leading	PIEZO 3	3	2
				Lagging	PIEZO 4	4	
		LOOP 3	3	Leading	PIEZO 5	5	3
				Lagging	PIEZO 6	6	
		LOOP 4	4	Leading	PIEZO 7	7	4
				Lagging	PIEZO 8	8	
2	2	LOOP 1	5	Leading	PIEZO 1	9	5
				Lagging	PIEZO 2	10	
		LOOP 2	6	Leading	PIEZO 3	11	6
				Lagging	PIEZO 4	12	
		LOOP 3	7	Leading	PIEZO 5	13	7
				Lagging	PIEZO 6	14	
		LOOP 4	8	Leading	PIEZO 7	15	8
				Lagging	PIEZO 8	16	
3	3	LOOP 1	9	Leading	PIEZO 1	17	9
				Lagging	PIEZO 2	18	
		LOOP 2	10	Leading	PIEZO 3	19	10
				Lagging	PIEZO 4	20	
		LOOP 3	11	Leading	PIEZO 5	21	11
				Lagging	PIEZO 6	22	
		LOOP 4	12	Leading	PIEZO 7	23	12
				Lagging	PIEZO 8	24	
4	4	LOOP 1	13	Leading	PIEZO 1	25	13
				Lagging	PIEZO 2	26	
		LOOP 2	14	Leading	PIEZO 3	27	14
				Lagging	PIEZO 4	28	
		LOOP 3	15	Leading	PIEZO 5	29	15
				Lagging	PIEZO 6	30	
		LOOP 4	16	Leading	PIEZO 7	31	16
				Lagging	PIEZO 8	32	

12.5.3 SITE ORIENTATION

Detector sites should be consistently configured across multiple installations such that lane 1 is always on the same side of the road. This makes interpreting results and field work much easier. It is recommended that a site drawing is stored in the cabinet that shows the location of all sensors and the adopted number system.

As described in *Section 7.1.3: Crosstalk* the best prevention for inter-card cross talk is careful placement of the loops. Accordingly, it is usually a good idea to separate directions of travel onto separate detector cards if they will not fit onto one card. Some examples of common site configurations with a sensor configuration of two loops per lane are detailed below.

4 lane site:

- Card 1, loops 1-4 monitor inbound direction
- Card 1, loops 5-8 monitor outbound direction.

6 lane site:

- Card 1, loops 1-6 monitor inbound direction
- Card 2, loops 1-6 monitor outbound direction.

In this case loops 7-8 of both cards are unused. This provides better cross talk prevention than using all 8 loops of card 1 and only loops 1-4 of card 2.

6 lane site with ramps:

- Card 1, loops 1-6 monitor inbound direction
- Card 1, loops 7-8 monitor inbound ramp
- Card 2, loops 1-6 monitor outbound direction
- Card 2, loops 7-8 monitor outbound ramp.

8 lane site:

- Card 1, loops 1-8 monitor inbound direction
- Card 2, loops 1-8 monitor outbound direction.

8 lane site with ramps:

- Card 1, loops 1-8 monitor inbound direction
- Card 2, loops 1-8 monitor outbound direction
- Card 3, loops 1-4 monitor inbound ramp
- Card 3, loops 5-8 monitor outbound ramp.

12.6 CHASSIS CONFIGURATION

The chassis must be configured with the correct settings for the specific installation site. Settings are stored in non-volatile memory and remain after power off. They do not need to be reloaded unless the specifics of the site change.

While there are several methods for updating the configuration settings this procedure will only deal with using the console port of the supervisor. This is the recommended method for performing the initial configuration.

The following configuration steps will describe all the possible settings and configuration steps. Not all these settings will be available in all functional configurations and can be skipped if not present in the unit being configured.

12.6.1 STEP 1 – PRE-CONFIGURATION VERIFICATION

This step is part of the verification of the operation of the unit but is required to be performed before configuration to ensure that configuration can proceed.

1. Check that all the LEDs on the power supply card are lit to verify the unit is correctly powered.
2. Check that the PS LED on the supervisor is lit and that the HB LED is flashing to indicate the supervisor is operating.
3. Check the supervisor has a C1/C2/C3/C4 LED lit for each successive detector card installed to verify the supervisor is communicating with the detector cards.
4. Check the PS LED for each detector card is lit and that the HB LED is flashing to verify the detector card is operating.

12.6.2 STEP 2 – REAL-TIME CLOCK

The real-time clock is used for time stamping all generated data. It should be set to the current date and time.

Console commands: Main Menu → Real time clock

12.6.3 STEP 3 – SYSTEM

These settings configure the general operation of the unit and need to be set before a more detailed configuration is performed.

- Site name is an eight-character alphanumeric identifier for the unit and should be unique. It is important that this is unique if using any of the data storage options because the generated data will include the site name so it can be identified by computer programs that process the data
- Description is an optional 64 ASCII character extended identifier
- Number of cards is a count of the number of detector cards that are present in the chassis
- The server communications card should be enabled if present
- The units specify the units of measurement and is likely metric
- Address should be 1 unless the chassis is part of a multi-drop communications network
- The host protocol should match what is being used and doesn't matter if no real-time data interface is being used
- The host medium only needs to be set if a real-time interface is being used on the server card
- The host baud rate needs to match the interfacing host system if a serial real-time data interface is being used (otherwise, not important)
- If a sensor layout with piezos is used the piezo detector type should be complex
- The sensor configuration should match the installed sensor layout.

Console commands: Main Menu → Settings and data → Station settings → Edit

12.6.4 STEP 4 – LOOP SETTINGS

Loop configuration involves three settings.

- Turn off any unused loops by setting the loop state off
- The loop sensitivity can be left at the default value of 10 unless there are crosstalk problems
- The loop length should match the length of the loop in the direction of travel.

Console commands: Main Menu → Settings and data → Loop settings → Edit

12.6.5 STEP 5 – PIEZO SETTINGS

This step can be skipped if no piezo sensors are present. This step assumes that the piezo detector type is set to complex.

- Turn off any unused piezos by settings the piezo state off
- The minimum and maximum threshold values can be left at their default values 6 and 4 respectively unless there are sensitivity problems.

Console commands: Main Menu → Settings and data → Piezo settings → Edit

12.6.6 STEP 6 – LANE SETTINGS

- Lane direction should be set to forward unless operating in a tidal flow situation
- Lane pairing should be paired for normal vehicle detection
- Loop spacing is only applicable if there are two loops per lane according to the sensor configuration and should match the leading edge to leading edge distance of the two loops
- Piezo spacing is only applicable if there are two or more piezos per lane according to the sensor configuration and should match the distance between piezos.

Console commands: Main Menu → Settings and data → Lane settings → Edit

12.6.7 STEP 7 – CLASSIFICATION SETTINGS

The loop classification settings should be configured to match the desired scheme. The scheme can be reset to a default scheme, or a custom scheme can be used which will require all classes to be modified. The same applies for the axle classification scheme.

Console commands: Main Menu → Settings and data → Loop class settings → Edit

Console commands: Main Menu → Settings and data → Axle class settings → Edit

12.6.8 STEP 8 – OUTPUT TRIGGER SETTINGS

This step can be skipped if the I/O outputs are not used.

- Set the output active state to match the desired value to interface with the external equipment
- The pulse duration can be left as default unless a different value is specifically required
- For each output, set the desired minimum and maximum lane settings to only trigger on vehicles in those lanes
- Set the trigger type for the desired vehicle parameter that should trigger the output
- Set the desired class, speed, and length trigger values for the desired trigger type. The parameters that do not match the trigger type do not matter.

Console commands: Main menu → Settings and data → Output settings → Edit

12.6.9 STEP 9 – LOGGER SETTINGS

This step can be skipped if no logger card is present.

- Half rack logging should be enabled if the chassis is a half width rack, and the logger card should be located in the second detector slot
- The number of files per day should be set to 1 unless it is desired to split the data files into 2 so that they can be processed more easily.

Console commands: Main menu → Settings and data → Logger settings → Edit

12.6.10 STEP 10 – SERVER SETTINGS

This step can be skipped if the server card is not present.

- The IP Address, IP Netmask, and IP Gateway should match the network that the server card is attached to
- The External IP should match the IP Address unless a Network Address Translation (NAT) device is used on the network (e.g., a router)
- The access port needs to match the port value used in the ETC Site Monitor PC program and can be left at the default 10 unless the connected network requires a different port range
- The FTP control and data ports can be left at default values unless the connected network requires different port ranges
- The FTP username and password can be left as default unless different values are desired
- Network Time Protocol (NTP) only needs to be configured if using a NTP server to synchronise the time
- The time zone should match the current location
- Daylight savings should be enabled if the current time zone supports it. Please see *Section 9.2*:
- *Daylight Savings* for details on how to configure the start and end times.

Console commands: Main menu → Settings and data → Server settings → Edit

12.6.11 STEP 11 – FILE SETTINGS

This step can be skipped if the server card is not present.

- Folders should be enabled unless an automatic downloader utility is used that requires all files to be placed in the root directory
- File headers should be enabled
- The file format should match the desired setting
- Verbose should be off
- Data compression should be enabled if reduced bandwidth is critical
- Keep uncompressed should be set to no
- The vehicle file period can be set to any value that suits the user
- The status logging period can be set to any value that suits the user.

Console commands: Main menu → Settings and data → File settings → Edit

12.6.12 STEP 12 – SETUP COMPLETE

Setup is now complete. The configured settings can be verified by navigating to each settings menu and observing the displayed data.

12.7 VERIFICATION

Once the XL-1000 has been installed and setup, the installation should be verified. The following steps test the vehicle detection, vehicle measurement, and the data interface. This will use the console interface, please refer to *Section 13*:

Console Interface for details on how to connect to the console.

12.7.1 TEST 1 – LOOP DETECTION

This test checks that the inductive loops are operating correctly. If there are no inductive loops in the sensor configuration this can be skipped.

1. Connect to the console.
2. Check that each loop LED on the detector module front panel is lit when a vehicle passes over the corresponding loop and is off when no vehicle is present. If the LED is continuously flashing, it indicates a faulty loop. The mapping of the LEDs to the loop numbers is described in *Section 6.12.1: Front Panel Interface*.
3. Use the console interface to check the status of the faulty loops. Navigate to the loop settings menu (Main menu → Settings and data → Loop settings). An example screen is shown in the listing below. If there are any faults with the loops, rectify before continuing.

```

+- -
| ETG Vehicle Detector - Build: 11.09.14, Rev: 1822          09:40:18 -
10/11/11
+- -
| Loop settings:                                           ok
+-----+-----+-----+-----+
| No.|State|Op| Len| Freq|Sen|
|  1:|  On | G|2000|48622| 10|
|  2:|  On | G|2000|48020| 10|
| !3:|  On | S|2000|    0| 10|
|  4:|  On | G|2000|49597| 10|
|  5:|  On | G|2000|47953| 10|
|  6:|  On | G|2000|48543| 10|
| !7:|  On | O|2000|    0| 10|
|  8:|  On | G|2000|47353| 10|
+-----+-----+-----+-----+

> Press (B) for menu, (E) to edit, (Q) to quit
    
```

The example shows that loop 3 has a short circuit condition and that loop 7 has an open circuit condition. These loops should be tested with a loop tester that is available from Excel Technology Co to prove that the loop is faulty and not the detector. Alternatively, the loop input on the field termination panel can be swapped with a known good loop to observe if the problem follows the loop. If the same loop channel continues to exhibit a problem the loop is not faulty, and the problem exists somewhere between the field termination panel and the detector module.

12.7.2 TEST 2 – PIEZO DETECTION

This test checks that the piezoelectric sensors are operating correctly. If there are no piezoelectric sensors in the sensor configuration, this test can be skipped. It is not possible to completely test the operation of the piezos in this test. Further testing will be conducted in the following tests. Observe that each piezo LED on the detector module front panel flashes once for each axle that passes over the sensor. If the piezo LED never flashes, it indicates that there may be a problem with the piezo sensor. Connect an oscilloscope to the piezo channel to observe its output. Poor signal levels may indicate a problem with the sensor installation.

12.7.3 TEST 3 – SENSOR ORIENTATION

This test checks that the leading and lagging sensors are connected to the correct channels. Observe the sequence of the Lx LEDs as vehicles pass over the sensors. Providing that the lane direction is set

to forward, the odd numbered LED of each pair should be lit first followed by the even numbered LED. For example, a vehicle travelling in the correct direction of lane 1 activates L1 first followed by L2. If this sequence is reversed the sensor inputs to the field termination panel should be switched.

12.7.4 TEST 4 – VEHICLE MEASUREMENT

This test checks that vehicles are being measured correctly. This test should only be performed in free-flowing traffic because measurements are not accurate in highly congested (stop-start) traffic.

1. Connect to the console interface as before.
2. Select the vehicle transactions mode from the console interface (Main menu → Vehicle transactions).
3. A line of data will be displayed for each vehicle that is measured. Verify that for each lane a vehicle transaction is displayed when a vehicle passes over the sensors of that lane.
4. For each vehicle transaction, verify that the speed measurement is close to the actual speed of the vehicle. An estimate based on observation and the posted speed limit may be adequate. If the speed measurement is significantly different, the loop spacing for the lane may be incorrect.
5. Verify the measured length is close to the actual length of the vehicle. An estimation based on typical lengths of known vehicles should be sufficient. Estimation is most reliable with family sedans which are normally 4.5m to 5.2m long. If the measured length is significantly different and the speed is correct, the loop length may be incorrect.
6. If using a sensor configuration with piezos, check that the measured number of axles matches the vehicle. If the axle count is incorrect, it may indicate a faulty piezo installation.

Check that the speed error is low for free-flowing vehicles. For example, a vehicle travelling at 100km/h at a constant speed should have an error value of around 2 or less. If the error is high, the loops may not have the same length, or they are not very sensitive. It can also be high if a vehicle is changing lanes over the sensors.

13 ERROR ANALYSIS

The detector uses multiple speed and length measurements for each vehicle, to increase the probability of more accurate results. Combined with the high scan rate, the detector gives consistently low error results. However, the loop spacing, and loop length parameters also influence the accuracy of the speed and length calculations. The error analysis in the following sections investigates the impact of each factor when using a sensor configuration with two loops and less than two piezoelectric sensors. It is calculated using metric units.

13.1 SPEED

13.1.1 SCAN RATE

The speed of a vehicle is calculated using the time taken to travel from the leading loop to the lagging loop and the loop spacing, using the following formula:

$$\text{speed } (s) = \frac{\text{Loop spacing } (d)}{\text{Time between loops } (t)}$$

The XL-1000 detector uses four time measurements (two time periods) to calculate time between loops:

- Activation of loop 1 (t_{i1}) to activation of loop 2 (t_{i2})
- Clearing of loop 1 (t_{o1}) to clearing of loop 2 (t_{o2})

These measurements are then averaged to find the time between loops, therefore:

$$t = \frac{(t_{i2} - t_{i1}) + (t_{o2} - t_{o1})}{2}$$

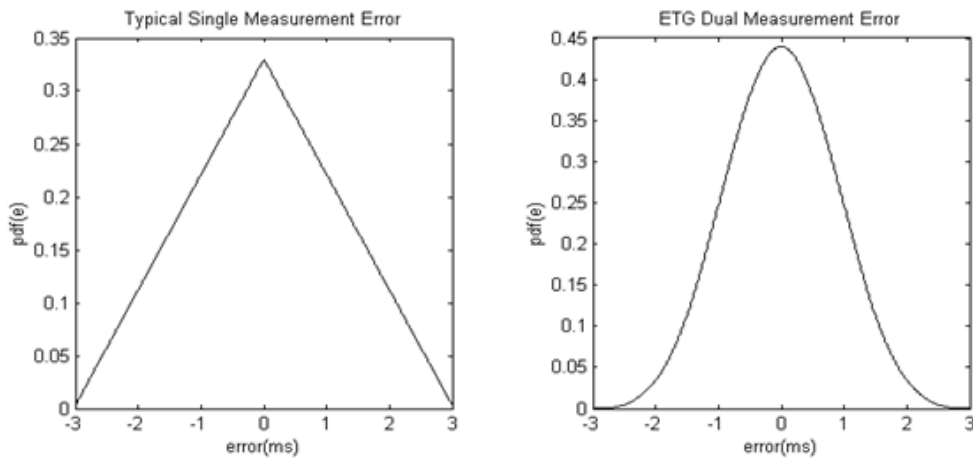
Assuming a worst-case scenario, the scan rate for the loops is ~2.5ms. The detector measures time with 1ms precision. Therefore, there is an error in each time measurement of 0 to 3 milliseconds. This error can be modelled as a uniform random variable e , where e is an element of [0, 3], therefore:

$$t = \frac{[(t_{i2} - e_{i2}) - (t_{i1} - e_{i1})] + [(t_{o2} - e_{o2}) - (t_{o1} - e_{o1})]}{2}$$

$$t = \frac{(t_{i2} - t_{i1}) + (e_{i1} - e_{i2}) + (t_{o2} - t_{o1}) + (e_{o1} - e_{o2})}{2}$$

$$t = \frac{(t_{i2} - t_{i1}) + (t_{o2} - t_{o1})}{2} + E \quad \text{Where } E = \frac{e_{i1} - e_{i2} + e_{o1} - e_{o2}}{2}$$

The following figure shows the probability density function (PDF) for E when the typical one set of measurements is used (left graph) compared to the PDF for E when the two-measurement method is used. It can be seen that the two-measurement method gives a higher probability of an accurate result.



Since $Measured\ speed\ (s') = \frac{Loop\ spacing\ (d)}{Measured\ time\ (t')}$

And $t' = Actual\ time\ (t) + E$

Then $s' = \frac{d}{t'+E}$

Thus, the percentage error in speed (e_s) is:

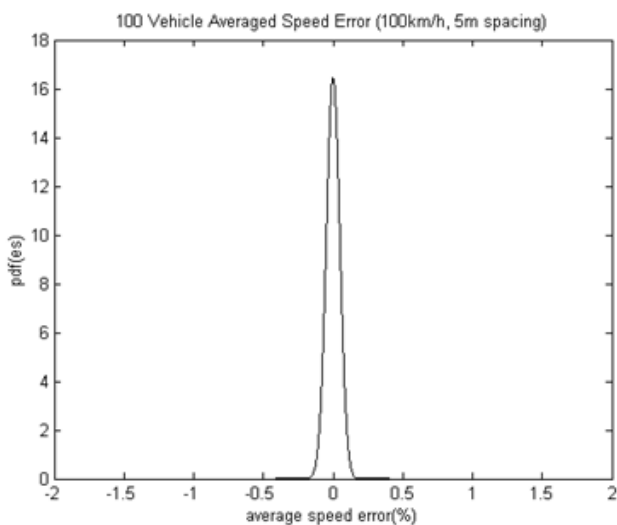
$$e_s = \left[1 - \frac{s'}{s} \right] \times 100\%$$

$$e_s = \left[1 - \left(\frac{d/(t'+E)}{d/t} \right) \right] \times 100\%$$

$$e_s = \left[1 - \left(\frac{t}{t'+E} \right) \right] \times 100\%$$

A car travelling at 100km/h takes 180ms to travel 5m. If the loops are spaced 5m apart, then the maximum speed error due to scan rate will be 1.67%. However, the probability of this error is low, and we can therefore assume that most readings will be within 1% of the actual speed.

Averaging the speed measurements decreases the error probability. The following figure shows the average speed error PDF for 100 cars travelling at 100km/h measured over a 5m spaced loop pair.



13.1.2 LOOP SPACING

The speed error due to loop spacing is proportional to the error in the loop spacing.

$$\text{Measured speed } (s') = \frac{\text{Loop spacing } (d) \pm \text{Loop spacing error } (e_d)}{\text{Time between loops } (t)}$$

Therefore, percentage speed error (e_s) is:

$$e_s = \left[1 - \frac{s'}{s} \right] \times 100\%$$

$$e_s = \left[1 - \left(\frac{(d \pm e_d)/t}{d/t} \right) \right] \times 100\%$$

$$e_s = \left[1 - \left(\frac{d \pm e_d}{d} \right) \right] \times 100\%$$

$$e_s = \left[\pm \frac{e_d}{d} \right] \times 100\%$$

Thus a $\pm 10\text{cm}$ loop spacing error on a loop pair of proper length 5m will result in a speed error of $\pm 2\%$. To avoid this error care should be taken to make sure the loop spacing is correct. This error does not diminish with averaging.

13.2 LENGTH

13.2.1 SCAN RATE

The length of a vehicle is calculated using the speed of the vehicle, the loop length, and the average occupied time of both loops:

$$\text{Length } (l) = [\text{Speed } (s) \times \text{Occupied time } (t)] - \text{Loop length } (dl)$$

The detector uses four time measurements (two time periods) to calculate the loop occupancy:

- Activation of loop 1 (t_{i1}) to clearing of loop 1 (t_{o1})
- Activation of loop 2 (t_{i2}) to clearing of loop 2 (t_{o2}).

These measurements are then averaged to find the average occupancy, therefore:

$$t = \frac{(t_{o1} - t_{i1}) + (t_{o2} - t_{i2})}{2}$$

As in the previous section we can express the total error of this measurement as the summation of four uniform random variables, E, where $E = \frac{e_{o1} - e_{i1} + e_{o2} - e_{i2}}{2}$. The PDF for E is therefore the same as shown previously.

To calculate the overall length error PDF is complicated as it is related to the speed error and is beyond the scope of this manual. A worst-case analysis will give a rough idea of the error, however.

Assume a 5m long vehicle travelling at 100km/h (27.78m/s) drives over 2m loops spaced 5m apart. From the previous section we know the speed error is ± 1.67 km/h (0.46m/s) and simple maths tells us that the time over each loop should be $(2m + 5m) / 27.78m/s = 0.252s$. Therefore:

$$\text{Length } (l) = [\text{Speed } (s) \times \text{Occupied time } (t)] - \text{Loop length } (dl)$$

$$l = (27.27ms^{-1} \pm 0.46ms^{-1}) \times (0.252s \pm 0.003s) - 2m$$

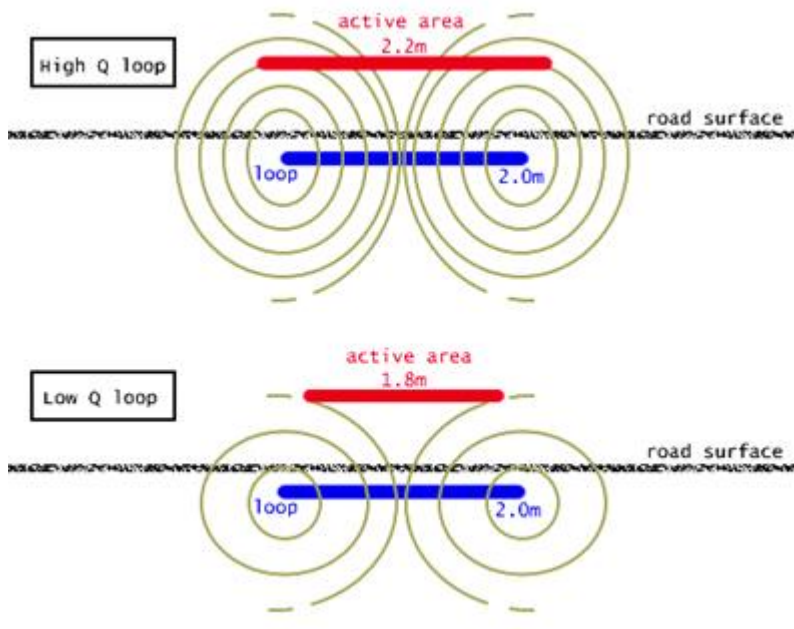
$$l = 7.00m \pm 0.12m \pm 0.08m - 2m$$

$$l = 5m \pm 0.2m$$

Thus, the length error is $\pm 0.2m$.

13.2.2 LOOP LENGTH

Loop length is the length of the active area of the loop in the direction of travel. The active area is the size of the loop electromagnetic field in which a vehicle will change the inductance of the loop above the detection threshold. The size of the active area is determined by the sensitivity of the loop (Q), the depth of the loop, and the sensitivity of the detector.



For loops installed according to the specifications given in *Section 7: Error! Reference source not found.*, the active area of the loop should be close to the physical loop size. For existing loops with low Q, the active area may be diminished.

The error in the loop length directly affects the error in the vehicle length. For example, if there is an error in the loop length of -0.4m then vehicles will be reported as being 0.4m shorter than they actually are. This error can be minimised by following these steps:

1. Set the detectors to the most sensitive setting possible without crosstalk (crosstalk can only occur between cards).
2. Using the vehicle transaction mode in the console, observe the lengths of 5 or more Holden or Ford sedans. These cars have a typical length of 4.9m.
3. Average the results and subtract 4.9m.
4. The result is the amount by which the loop length value should be modified.

For example: 5 vehicles are measured at 4.1m, 4.3m, 4.0m, 4.0m 4.1m. The average is 4.1m. Subtracting 4.9 gives -0.8m. Therefore, the loop length should be decreased by 0.8m.

14 FIRMWARE UPGRADE

14.1 HARDWARE CONFIGURATION

Reprogramming of the XL-1000 firmware is performed via the CONSOLE connector for the supervisor card, the SERIAL connector for the detector card, and the RS-232 connector for the server card.

For the reprogramming you will need:

- A straight through DB-9 female-to-female serial cable
- Computer with a serial COM port running Windows HyperTerminal, or similar terminal emulator with YMODEM upload capabilities
- Firmware relevant to the card that is being upgraded.

14.2 REPROGRAMMING USING WINDOWS HYPERTERMINAL

The following directions are for reprogramming using Microsoft Windows HyperTerminal on Windows XP.

14.2.1 SETUP AND RUNNING HYPERTERMINAL

The first step is to connect the computer to the XL-1000.

1. Connect the serial cable from the COM port of the computer to the serial port of the card to be reprogrammed.
2. Start windows and point to Start > Programs > Accessories > Communications.
3. Click the HyperTerminal icon to start the program.
4. The Connection Description screen will now be displayed, enter a name for the connection, for example 'XL-1000'. Click OK.
5. The Connect To screen will now be displayed, choose the correct COM port from the drop-down box, and click OK.
6. The COM Properties screen will now be displayed. Set the bits per second to 115200, data bits to 8, parity to none, stop bits to 1, and importantly flow control to none. Click OK.
7. HyperTerminal should now be connected. Rather than perform this setup process every time, save the connection by clicking File > Save As and choosing an easy to remember location. Next time you want to connect to the XL-1000, open the saved connection description instead and the HyperTerminal will start with all the old settings.

14.2.2 REPROGRAMMING SUPERVISOR OR DETECTOR

The second step is to reprogram the firmware.

1. Cycle the power on the XL-1000. The figure below shows an example of a complete transcript of the reprogramming sequence. After cycling the power, the first line of this will be displayed.
2. Press the <Shift>+<P> keys within two seconds of the first line appearing to enter the boot loader.

```
Booting.....
Done

+-----+
----+
|           Boot loader - Build: 10.11.24, Rev: 1453
|
+-----+
----+
|
| Press 'P' to enter boot loader
|
+ >
```

3. The listing below shows a menu to allow a selection for which section of the communications card to upgrade. Select <f> to upgrade the firmware.

```
+-----+
----+
| Upgrade menu
|
+-----+
----+
|
| (B) - Boot loader
| (F) - Upgrade Firmware
| (Q) - Quit without upgrading
|
|
|
+-----+
----+
|
+ >
```

4. The lines in the following listing will be displayed asking you to confirm entry to the boot loader. Press <y> to confirm entry.

```
WARNING: This will erase the flash memory
Do you wish to continue? (y/n)
Erasing Sector: 7...Done
Erasing Sector: 8...Done
Erasing Sector: 9...Done
Erasing Sector: 10...Done
Erasing Sector: 11...Done
Erasing Sector: 12...Done
Erasing Sector: 13...Done
Start YMODEM program transfer

C
```

5. After the rest of the transcript has been displayed (with slight variances between the different sections) the <C> character will be displayed every 3 seconds. Within HyperTerminal select the Send File option under the Transfer menu.
6. Ensure the protocol is set to Ymodem.
7. Browse to the relevant file provided to you by Excel Technology Co and Click Send. The firmware file will be named “sup_xl-1000_YYMMDD.bin” for the supervisor and the firmware file will be named “det_xl-1000_YYMMDD.bin” for the detector where YY is the year, MM is the month, and DD is the day.

14.2.3 REPROGRAMMING SERVER CARD

The server card follows a slightly different procedure to the supervisor and detector cards. There are two possible sections of the server card that can be reprogrammed, the hardware and the firmware. Both sections follow the same procedure but require different files.

NOTE: Ensure the serial jumpers on the Server Card PCB are set to CON and not MOD. The jumpers are located behind the RS232 DB9 connector on the PCB.

1. Cycle the power on the XL-1000. The figure below shows an example of a complete transcript of the reprogramming sequence. After cycling the power, the first two lines of this will be displayed.
2. Press the <Shift>+<P> keys within two seconds of the first line appearing to enter the boot loader.

```
Booting....
Done

+-----+
----+
|           Boot loader - Build: 10.11.24, Rev: 1453
|
+-----+
----+
|
| Press 'P' to enter boot loader
|
+ >
```

- The listing below shows a menu to allow a selection for which section of the server card to upgrade. Select <h> to upgrade the hardware or <f> to upgrade the firmware. The procedure is the same for both sections but will require different files.

```

+-----+
----+
| Upgrade menu
|
+-----+
----+
|
|
| (B) - Boot loader
|
| (H) - Upgrade Hardware
| (F) - Upgrade Firmware
|
| (Q) - Quit without upgrading
|
|
|
+-----+
----+
|
+ >
    
```

- The lines in the following listing will be displayed asking you to confirm entry to the boot loader. Press <y> to confirm entry.

```

WARNING: This will erase the flash memory
Do you wish to continue? (y/n)
Erasing Sector: 7...Done
Erasing Sector: 8...Done
Erasing Sector: 9...Done
Erasing Sector: 10...Done
Erasing Sector: 11...Done
Erasing Sector: 12...Done
Erasing Sector: 13...Done
Start YMODEM program transfer

C
    
```

- After the rest of the transcript has been displayed (with slight variances between the different sections) the <C> character will be displayed every 3 seconds. Within HyperTerminal select the Send File option under the Transfer menu.
- Ensure the protocol is set to Ymodem.

Browse to the relevant file provided to you by Excel Technology Co and Click Send. The two different files for the two sections will be named to reflect the section they are intended for. The hardware file will be named “srv_xl-1000_hard_YYMMDD.bin” and the firmware file will be named “srv_xl-1000_firm_YYMMDD.bin” where YY is the year, MM is the month, and DD is the day.

15 COMPATIBILITY GUIDE

The table below summarises the compatibility between different firmware release sets for the XL-1000 system and the Site Monitor software. Using a version of Site Monitor that is not compatible with the firmware of a particular XL-1000 unit will result in unexpected operation and program crashes.

Note: a release set is a collection of the latest tested firmware at a particular point in time. To determine the release set for a particular unit, the user will need to obtain the firmware revisions of the different modules in the chassis. The firmware revisions for the communications (server) and detector cards can be obtained by connecting to the RS-232 port at the correct baud rate (specified in the XL-1000 installation and usage manual) and pressing 'h'. The firmware revision of the supervisor card can be obtained by connecting to the RS-232 port at the correct baud rate (specified in the XL-1000 installation and usage manual) and entering the menu, where the firmware version will be displayed at the top of the screen.

Please contact Excel Technology Co should the combination of firmware versions for a particular XL-1000 unit not match those below.

Number	Release Set				Site Monitor
	Supervisor	Detector	Comms Hardware	Comms Firmware	
11.08.26	11.08.26	11.06.06	10.10.21	11.08.26	v2.14
13.03.01	13.03.01	11.09.27	12.03.27	13.01.29	v2.17
13.06.03	13.06.03	13.05.30	13.03.07	13.05.17	v2.18
16.01.07	16.01.07	16.01.07	13.03.07	15.10.21	v2.3.6
16.06.03	16.06.03	16.02.26	13.03.07	16.06.03	v2.3.7
17.06.22	17.06.22	16.02.26	13.03.07	17.06.22	v2.3.9
19.03.21	19.01.14	19.01.15	13.03.07	19.03.21	v2.3.10
20.07.20	20.07.20	20.04.03	13.03.07	20.07.20	v2.3.12
21.04.28	21.04.28	20.07.20	13.03.07	21.02.11	v2.3.12
22.11.17	22.11.17	22.11.16	13.03.07	22.11.17	v2.5.2
22.11.18	22.11.17	22.11.16	13.03.07	22.11.18	v2.5.2
22.11.21	22.11.17	22.11.18	13.03.07	22.11.18	v2.5.2
23.02.01	23.02.01	23.01.30	13.03.07	23.02.01	v2.5.3

16 DOCUMENT CONTROL

<i>Version</i>	<i>Date</i>	<i>Change</i>	<i>Author</i>
1.0	01/11/2011	Document created	AK
1.0a	17/11/2011	-	AH
1.0b	01/10/2015	-	AH
1.0c	-	-	-
1.0d	01/10/2015	Updated ETG to ETC	AH
2.0	10/10/2022	Added: EULA, Compatibility Guide, Document Control, XL-1000-P section, South Africa Classification details, Appendix D; Removed: XL-1000-B, misc. redundant sections, superseded product references; Updated: Formatting, Disclaimer, requirements, Power Consumption Table, Parts Schedule, Firmware-specific updates, misc. typographical corrections.	DJC
2.1	19/02/2024	Updated compatibility guide for Site Monitor v2.5.2 and v2.5.3	DJC
2.2	01/04/2024	Removed EULA from guide	DJC

APPENDIX A: AUSTRROADS AXLE CLASSIFICATION

AUSTRROADS Vehicle Classification System

Level 1		Level 2		Level 3		AUSTROADS Classification	
Length (indicative) Type	Axes and Groups	Vehicle Type	Typical Description	Class	Parameters	Light Vehicles	Typical Configuration
Short up to 5.5m	1 or 2	Short	Sedan, Wagon, 4WD, Utility, Light Van, Bicycle, Motorcycle, etc	1	$d(1) \leq 3.2m$ and axles = 2		
	3, 4 or 5	Short - Towing	Trailer, Caravan, Boat, etc	2	groups = 3 $d(1) \geq 2.1m$, $d(1) \leq 3.2m$, $d(2) \geq 2.1m$ and axles = 3, 4 or 5		
Medium 5.5m to 14.5m	2	Two Axle Truck or Bus		3	$d(1) > 3.2m$ and axles = 2		
	3	Three Axle Truck or Bus		4	axles = 3 and groups = 2		
	> 3	Four Axle Truck		5	axles > 3 and groups = 2		
	3	Three Axle Articulated	Three axle articulated vehicle, or Rigid vehicle and trailer	6	$d(1) > 3.2m$, axles = 3 and groups = 3		
	4	Four Axle Articulated	Four axle articulated vehicle, or Rigid vehicle and trailer	7	$d(2) < 2.1m$ or $d(1) < 2.1m$ or $d(1) > 3.2m$ axles = 4 and groups > 2		
Long 11.5m to 19.0m	5	Five Axle Articulated	Five axle articulated vehicle, or Rigid vehicle and trailer	8	$d(2) < 2.1m$ or $d(1) < 2.1m$ or $d(1) > 3.2m$ axles = 5 and groups > 2		
	> 6	Six Axle Articulated	Six axle articulated vehicle, or Rigid vehicle and trailer	9	axles = 6 and groups > 2 or axles > 6 and groups = 3		
	> 6	B Double	B Double, or Heavy truck and trailer	10	groups = 4 and axles > 6		
Medium Combination 17.5m to 36.5m	> 6	Double Road Train	Double road train, or Medium articulated vehicle and one dog trailer (M.A.D.)	11	groups = 5 or 6 and axles > 6		
	> 6	Triple Road Train	Triple road train, or Heavy truck and three trailers	12	groups > 6 and axles > 6		

Group: Axle group, where adjacent axles are less than 2.1m apart
 Groups: Number of axle groups
 Axles: Number of axles (maximum axle spacing of 10.0m)

d(1): Distance between first and second axle

d(2): Distance between second and third axle

APPENDIX B: PRO-FORMA SITE TEST SCHEDULE

Pro forma Commissioning Schedule provides a permanent record of site characteristics when installed. This is a useful reference for future maintenance.

The following schedule is offered as a guide. An electronic copy is available in Microsoft Word by contacting Excel Technology Co.

Front of Page

Site Description:	Site Number:
	Chassis Serial Number:

In-pavement Schedule

Number of Lanes:

Loop #	Lane	Pair	Resistance	Inductance	Loop 'Q'	Insulation	Initial	Date
1						Pass/Fail		
2						Pass/Fail		
3						Pass/Fail		
4						Pass/Fail		
5						Pass/Fail		
6						Pass/Fail		
7						Pass/Fail		
8						Pass/Fail		
9						Pass/Fail		
10						Pass/Fail		
11						Pass/Fail		
12						Pass/Fail		
13						Pass/Fail		
14						Pass/Fail		
15						Pass/Fail		
16						Pass/Fail		

Piezo #	Capacitance Reading	Actuation	Validation	Initial	Date
1		Pass/Fail			
2		Pass/Fail			
3		Pass/Fail			
4		Pass/Fail			
5		Pass/Fail			
6		Pass/Fail			
7		Pass/Fail			
8		Pass/Fail			

Back of Page

Comments: _____

Signature: _____ Date: ___ / ___ / _____

Test Schedule Notes:

- Lane # - The lane where the loop is located
- Pair - The loop number of corresponding paired loop
- Resistance - Typically $<3\Omega$
- Inductance - Typically $> 180 \mu\text{H}$ & $<300 \mu\text{H}$
- Loop 'Q' - Typically 20 - 30
- Insulation - Cross out applicable result PASS <> FAIL
- Initial - Record of test personnel
- Date - Date test complete
- Capacitance Reading - Typically microfarads
- Actuation Validation - Led indication
- Signature - Site Authorised Testing Officer

APPENDIX C: PARTS SCHEDULE

The following page contains the complete parts schedule that lists all orderable parts for the XL-1000 system.

XL-1000 series Multi-Function Chassis

- /I – Function: Vehicle Incident Detection + length/metal mass classification
- /C – Function: Vehicle Classification (length/axle position)
- /P – Function: Vehicle Presence Detection
- /W – Function: Vehicle Weigh in Motion

Part #	Description	
Software options		
XL-1001	ETC Site Monitor PC Software	
Chassis		
XL-1010	19 inch, 3U height chassis	
XL-1012	Half-19 inch, 3U height chassis	
Power supply		
XL-1020	240Vac power supply	
XL-1022	240Vac basic UPS power supply with external battery (not included)	
XL-1023	240Vac monitored UPS power supply with external battery (not included)	
XL-1024	12Vdc power supply (9-18Vdc input)	
XL-1026	24Vdc power supply (18-36Vdc input)	
XL-1028	48Vdc Power supply (36-72Vdc input)	
Supervisor card		
XL-1030	Supervisor card (19isup/AA)	
Communications card		
XL-1040	Communications card (19icom/OC) with RS-232, RS-422/RS-485, or Ethernet	
XL-1042	Server Comms card (19ircc/OD)	
Detector card		
XL-1050	4 lane (8 loop / 8 piezo) detector card (19icpu/AB + 19idet/AA)	
XL-1052	2 lane (4 loop / 4 piezo) detector card (19icpu/AB + 19idet/AA) product key restricted to 2 lanes	
Field termination panel		
XL-1070	Field termination panel – Server card I/O (19istp/00)	
XL-1072	Field termination panel – Communications card I/O (19ictp/00)	
XL-1073	Field termination panel – 16-way digital I/O (19iotp/00)	
XL-1074	Field termination panel (19imtp/00) – 8 loop channels 4 piezo channels	
XL-1076	Field termination panel (19iptp/00) – 8 loops channels 8 piezo channels	
XL-1077	Field termination panel (vdclif/BC) – 16 loop channels	
Cables		
XL-1080	Field termination panel to chassis connection cable	
XL-1082	DB-9 PIN – SKT straight through serial cable	
XL-1083	Ethernet cross-over cable	
XL-1084	DB-15 PIN – PIN Straight through cable (I/O)	
XL-1085	240Vac IEC power cable	
XL-1086	ELV DC power cable	
XL-1088	UPS external battery cable	
XL-1089	Temperature Probe Cable	

APPENDIX D: LOOP TERMINAL PANEL DIMENSIONS

