

Siemens Traffic Controls Limited
Sopers Lane
Poole
Dorset
BH17 7ER

SYSTEM HANDBOOK

VEHICLE DETECTOR OUTSTATION

THIS DOCUMENT IS ELECTRONICALLY HELD AND APPROVED

PREPARED : Alan Coatsworth / Jim Ballantine
FUNCTION : Technical Specialist / Senior Technical Specialist
DATE : May 2001

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1. INTRODUCTION

1.1 Purpose

This Handbook provides information and instructions needed to install and maintain the STCL Vehicle Detector Outstation. In the interests of Health and Safety, when installing, using or servicing the equipment, the instructions in Section 1.5 should always be followed.

1.2 Part Numbers

The STCL part number of the Vehicle Detector Outstation is 667/1/26767/100

Detector cards must be specified separately. The STCL part number for an ST4M detector is 667/1/26758/000. The rack accommodates up to five detectors, providing 20 channels of detection.

1.3 Glossary

CRC	Cyclic Redundancy Check
EMC	Electro Magnetic Compatibility
IDC	Insulation Displacement Connector
IES	Integrated Expressway System
I/O	Input/Output
Loop	Inductive vehicle detector loop
MEC	Miscellaneous Equipment Cabinet
O/S	Outstation
PC	Personal Computer
PCB	Printed Circuit Board
PPC	Power PC
PSU	Power Supply Unit
RCD	Residual Current Device
STCL	Siemens Traffic Controls Limited
VDO	Vehicle Detector Outstation

1.4 Test Equipment

The following items are recommended:

General purpose Digital Multimeter

Protocol Simulator, if no Instation is available

Inductance Tester or LCR meter to measure inductance in the range 10 - 1000 μ H.

e.g.: AVO B131

Wavetek LCR55

Insulation tester

e.g.: Metrohm 16D500

Robin K 3105

Megger BM100/4

Earth Loop Impedance Tester

e.g.: LT5

Robin KMP 4120

RCD Tester - required only on installations equipped with an RCD.

e.g.: Seaward RC500

1.5 SAFETY WARNING

In the interests of Health and Safety, when installing, using or servicing this equipment the following instructions must be noted and adhered to:

- i) Only skilled and instructed personnel with relevant technical knowledge and experience, who are also familiar with the safety procedures required when dealing with modern electrical and electronic equipment are to be allowed to use and/or work on the equipment.
- ii) Such personnel must take heed of all relevant notes, cautions and warnings in this Handbook and any other document or Handbook associated with the Outstation including, but not restricted to the following:
 - a) The equipment must be correctly connected to the specified incoming power supply.
 - b) The equipment must be disconnected/isolated from any incoming power supply before removing any protective covers, or working on any part from which protective covers have been removed.
 - c) All wiring must be carried out in accordance with local statutory regulations where applicable.
 - d) Installation testing of mains wiring and earthing must be carried out in accordance with local statutory regulations.
 - e) Outstations use Sealed Lead Acid Batteries. Care must be taken in handling these to prevent a short circuit condition occurring on any of the Lead Acid Cells. The Power PC Processor PCB contains a Nickel Metal Hydride Battery that does not require special handling, as it contains no mercury, cadmium or lead.
 - f) Exercise great care when handling old batteries, which may be leaking. **BATTERIES MUST BE DISPOSED OF IN ACCORDANCE WITH THE RELEVANT STATUTORY REGULATIONS. BATTERIES MUST BE DISPOSED THROUGH AN APPROVED HAZARDOUS WASTE DISPOSAL CONTRACTOR. DO NOT PUNCTURE BATTERIES. DO NOT DISPOSE OF BATTERIES IN ANY FIRE.**

2. GENERAL DESCRIPTION

2.1 The Outstation site

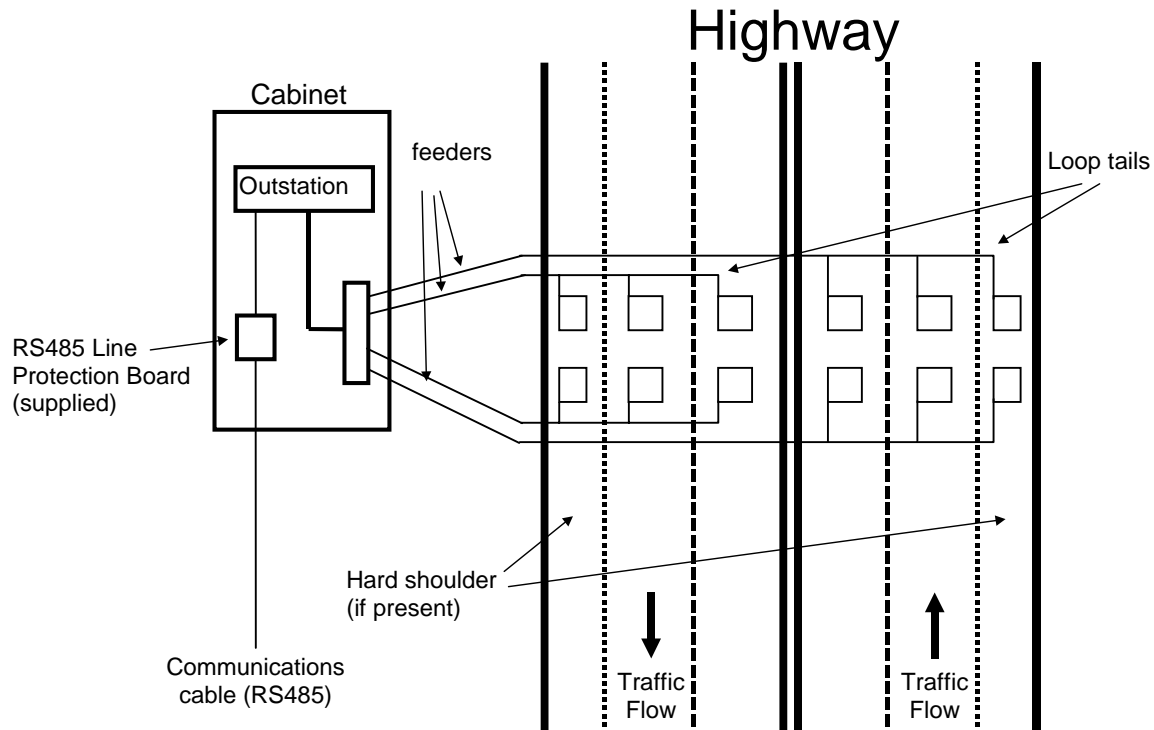


Figure 1 - Typical Outstation Site

Outstations are sited at intervals as required along the highway. Each Outstation is connected to a number of inductive loops buried in the road surface. Where the Outstation is required to monitor vehicle speed, headway or length, loops are arranged in pairs as shown in Figure 1. One pair of loops is fitted in each running lane and in the hard shoulder (if present). Where vehicle count only is required, each lane has only a single loop.

Each of the detector PCBs (maximum 5) in the Outstation is connected to up to 4 road loops, allowing up to 20 loops (10 pairs) to be controlled and monitored.

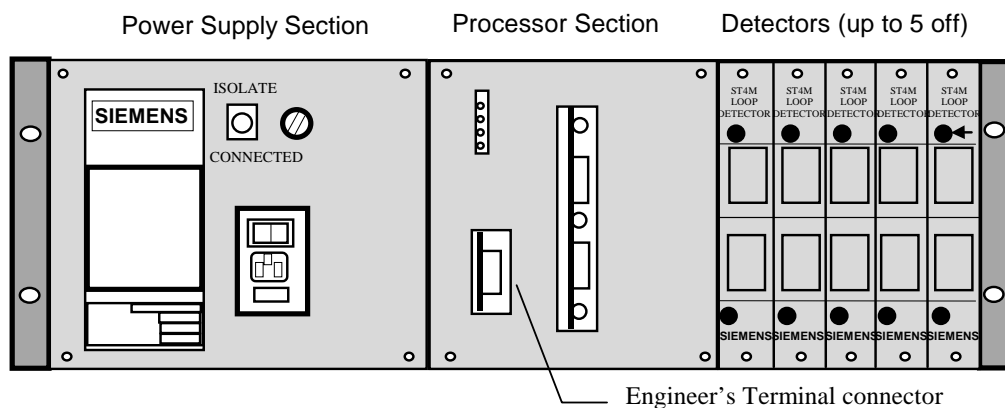


Figure 2 - Outstation

The Outstation continuously monitors vehicle data on a per-lane basis. Vehicle counts, speed, headway (distance between vehicles) and length data for individual vehicles are calculated. Time-averaged statistical data is reported to the Instation via the synchronous RS485 telecommunications connection.

The Outstation can be set to monitor the traffic data and alert the Instation when predetermined thresholds are exceeded.

A serial interface allows connection of an Engineer's Terminal, which can give identity, version and status information. Individual Vehicle Data and Alerts are also available on this link.

An additional auxiliary link is provided to operate in an output only mode to transmit individual vehicle data, Traffic data and Alerts in response to Instation configurable parameters.

Outstations are installed in roadside cabinets and may be ordered complete with suitable cabinet or installed in cabinets provided by others.

2.2 Outstation Overview

The Outstation consists of the following items as shown in the Block Diagram, Figure 3

- 1 x Power PC Processor PCB
- 1 x Comms I/O PCB
- Up to 5 x Loop detector PCBs - see section 1.2
- 1 x Detector Backplane
- 1 x Power Supply Unit
- 1 x Address Header
- 1 x Backup battery
- 1 x RS485 Line Protection Module PCB

The Line Protection Module is supplied with the Outstation but is mounted separately.

The Outstation communicates on a synchronous RS485 link.

Figure 3 shows 2 off RS485 communications links but only one is used in this application.

2.3 The RS485 link

The RS485 communications link is a single 2-wire link to the communications infrastructure. It may be used in a multi drop arrangement whereby several Outstations are connected on one 2-wire link. It is necessary to terminate the link at each end with a 140Ω resistor. Therefore the Outstation at the furthest end of the link must have a resistor added across the RS485 connection. This resistor, which is not supplied, should be rated at 1000V or more, and at least 1W to minimise the risk of damage by voltages induced by nearby lightning strikes. The protocol is synchronous serial half duplex

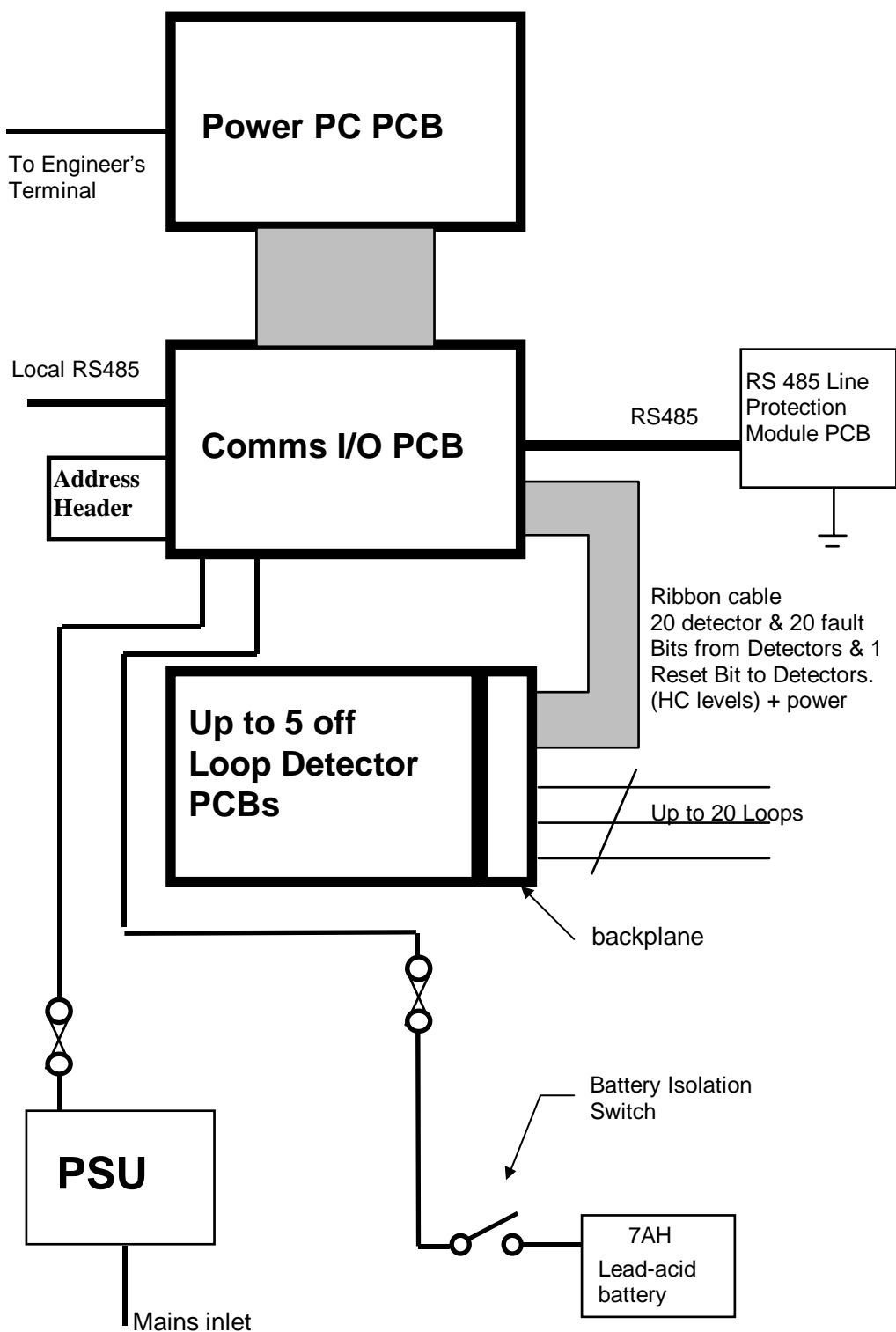


Figure 3 - Block Diagram

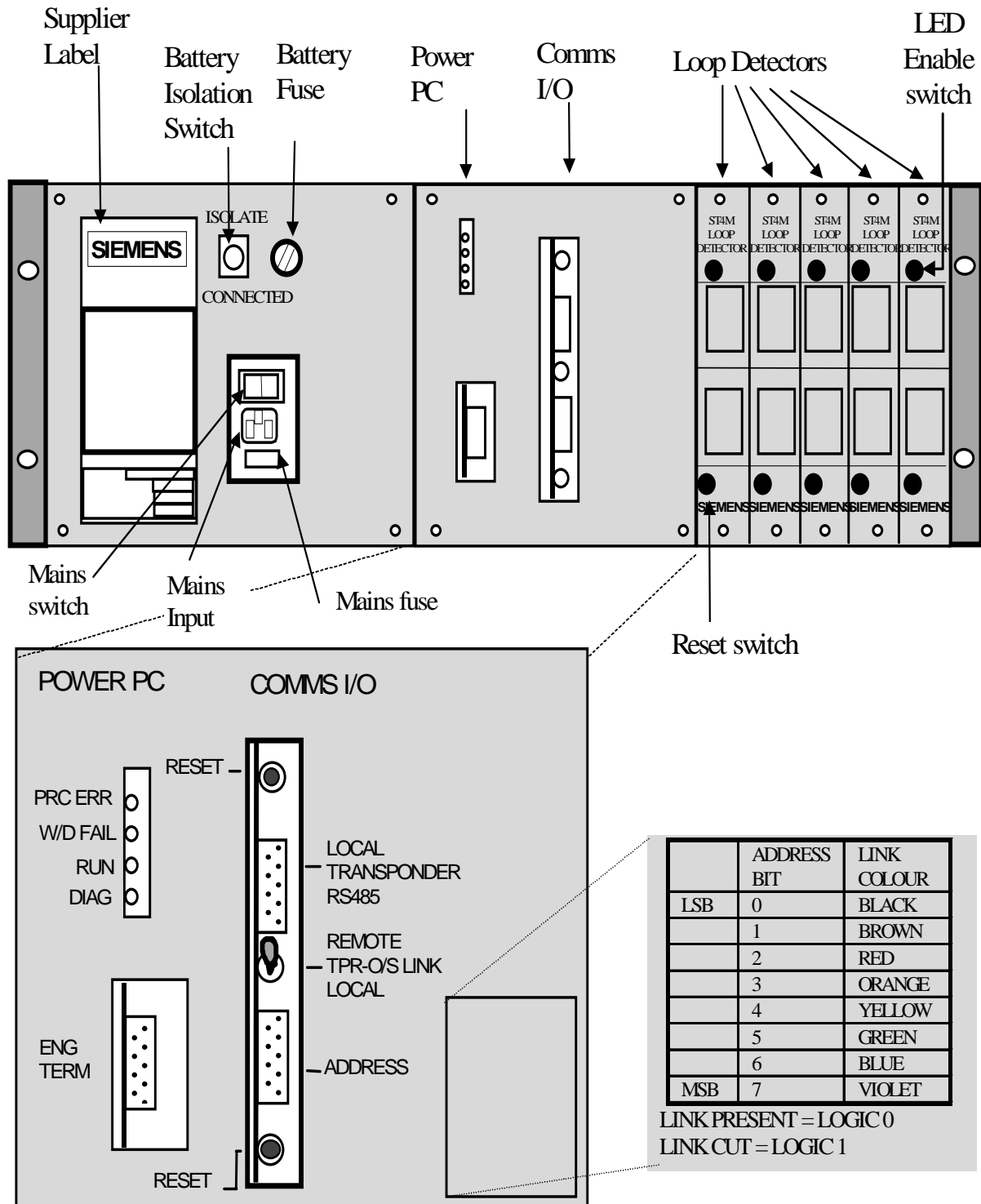


Figure 4 - Front Panels

2.4 Physical Arrangement

The Outstation is mounted in a standard 19" equipment rack of 3U height, which provides a mounting frame and mechanical protection for all the hardware other than the Line Protection module that must be mounted elsewhere in the cabinet.

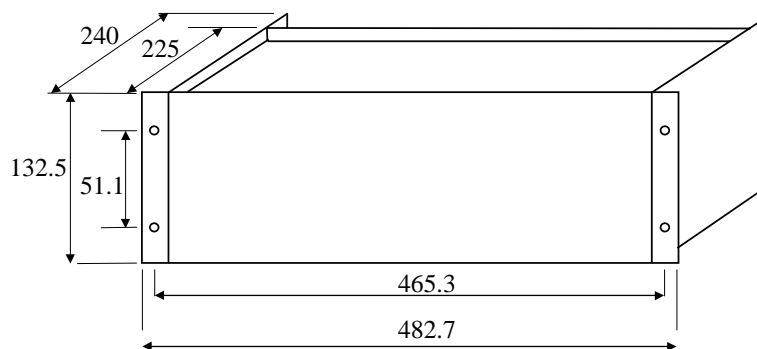


Figure 5 - Outstation dimensions

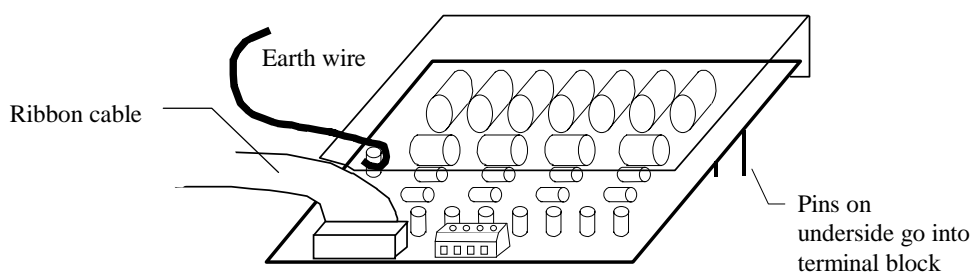


Figure 6 - Line Protection Module

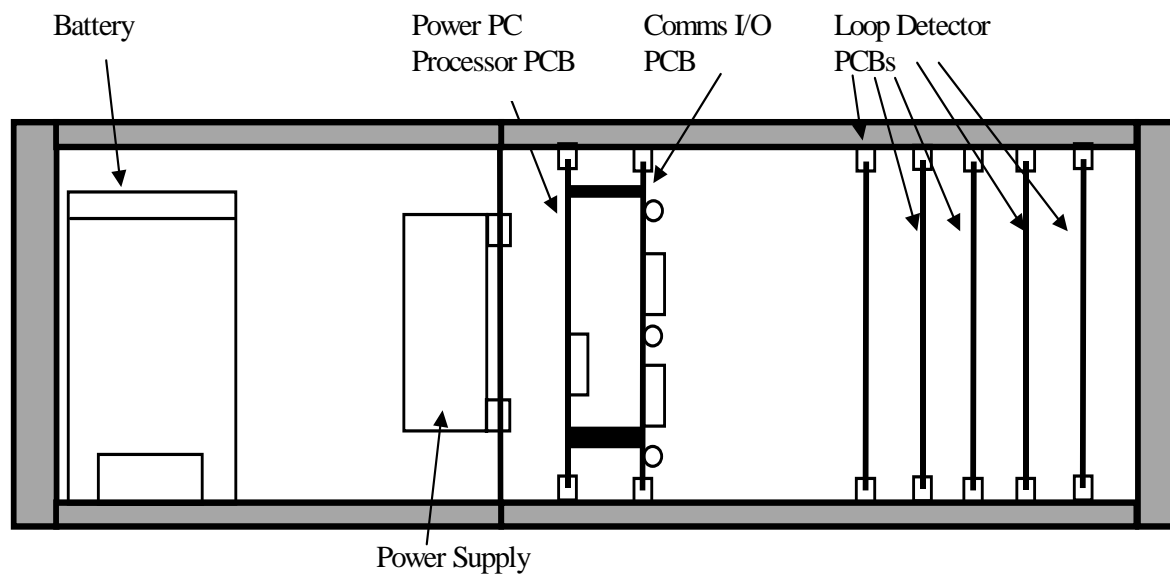


Figure 7 - Outstation front view (front panels removed)

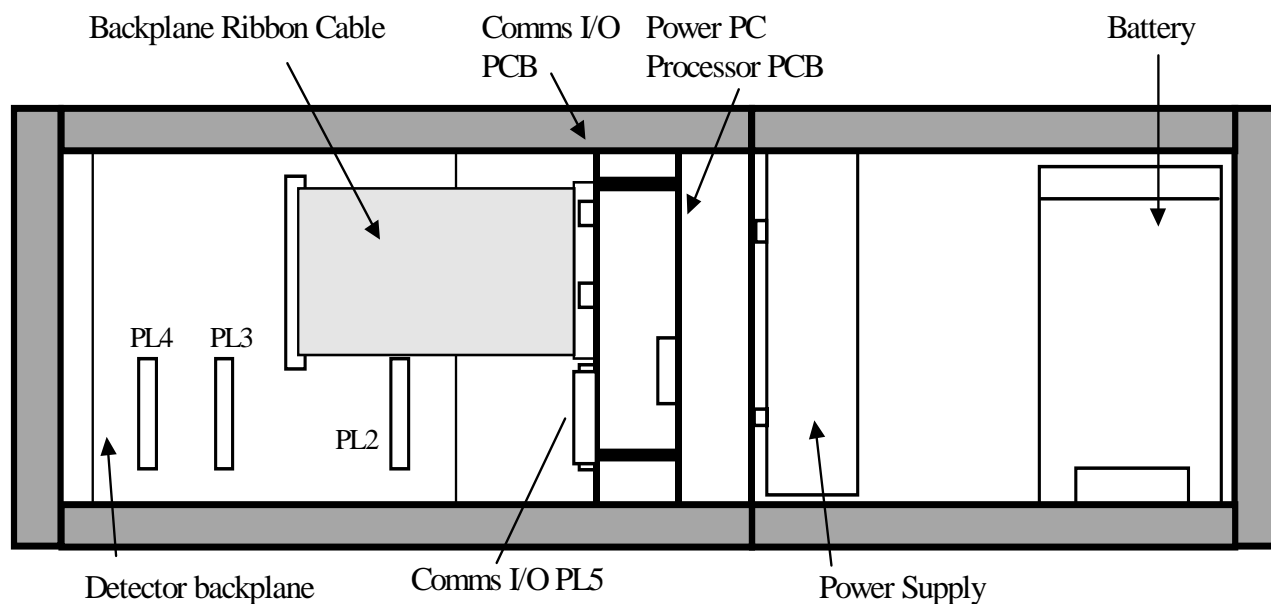


Figure 8 - Outstation rear view

2.5 Power System

The power supply is a 30W switched mode unit with a single voltage output. It provides 15V DC to power the Outstation hardware and charge the battery backup unit. See Section 8.2 for details of the power requirements.

The battery is a 12V sealed lead-acid type. It is capable of providing up to 20 hours full backup in the event of a mains failure.

The system operates normally while the battery is being recharged. The battery is fully recharged within 5 hours of mains power restoration.

2.6 Cables

The Outstation is supplied with 2 cables:

- Mains cable 3-core cable
- Detector cableform

2.7 PCBs

2.7.1 Power PC Processor PCB

The Power PC Processor PCB is based on an IBM 403GA PowerPC, which is a 32-bit processor.

The PCB has two serial ports. One is a 9-pin 'D' type socket located on the front for connection to an Engineer's Terminal. The other, an 18-pin IDC connector, is located at the back and is not used.

There are 4 LEDs located on the front which indicate the following:

LED	Function	No Fault State	Fault Indicated State
PRC ERR	Processor Error	Off	Lit Red
W/D FAIL	Watchdog Failure	Off	Lit Red
RUN	Software running	Flashing Green	Off/Steady Green
DIAG	Software status indication	Off	Lit Green

Table 1 - LEDs

See Table 7 in Section 6.3 for details of the diagnosis and possible remedy when a fault is indicated by one of the LEDs.

2.7.2 Comms I/O PCB

The Comms I/O PCB is attached to the Processor PCB. Its primary purpose is providing the RS485 communication channels and parallel input channels for interfacing to the detector PCBs. It also has circuits for charging the battery and monitoring the power supply,

At the front of the PCB (top and bottom) are two reset switches, which when pressed at the same time cause a system reset.

The Board Address Header is a 9 pin 'D' type socket above the lower reset switch. A 9 pin 'D' type plug, which has the address of the Outstation configured, is plugged into this socket. See Section 3.8.

The 9 way 'D' type plug below the upper reset switch is an additional RS485 port. When setting the Outstation to normal mode, connection may be made here instead of connecting at the Line Protection Module; see Section 5.2.

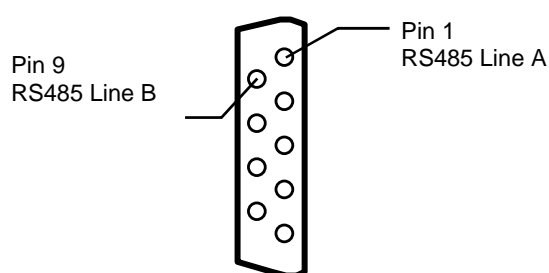


Figure 9 - Connections for Local Transponder

2.7.3 Loop Detector PCB

The Loop Detector detects the presence of vehicles over inductive loops. Each Loop Detector can support up to 4 loops.

The operating frequency and sensitivity of each of the loops is adjusted independently using on-board switches during commissioning. See Section 5.4.

2.7.4 RS485 Line Protection Module PCB

This PCB provides the Outstation with protection against voltages induced by nearby lightning strikes, and is mounted remotely within the cabinet. It has a 1 metre long lead fitted to connect to the Comms I/O PCB.

3. INSTALLATION

3.1 Cabinet Requirements

The Outstation is suitable for installation in a roadside cabinet that provides:

- Protection from rain, snow and dust etc. to IP55 or better.
- A source of electrical power with overcurrent protection (e.g. fuse).
- A suitable 19 inch rack with at least 3 'U' height. See Figure 10.
- Provision for mounting the RS485 line protection module.
- Provision for bringing the loop feeders or tails into the cabinet.
- Pre-mounted terminal blocks for loop connections.
- A connection to local earth.

The Siemens ST800 MEC (Miscellaneous Equipment Cabinet) meets these requirements and the Outstation may be ordered with this cabinet. The mains switch and fuse panel is fitted in the cabinet, as are the heaters (where applicable). In order to avoid damage in transit the outstation is shipped separately in its own packaging.

Alternatively the Outstation may be installed in any other suitable cabinet and Section 3.6 describes installation in this instance.

3.2 Additional items required for installation (not supplied)

- 4 off Terminal blocks type Klippon BK12 or equivalent (supplied with ST800 cabinet).
- Cable ties.
- Engineer's Terminal (and cable). Refer to section 8.11.
- Resistor - 140Ω 1000V 1W (only required at Outstation situated at the end of the RS485 communications line).

3.3 Recommended Tools

The following items represent the minimum requirements:

- Metric spanners covering range 5mm - 10mm.
- Engineers' Pliers.
- Side cutters.
- Small hacksaw (for cutting feeder cables).
- Utility knife.
- Pozidriv Screwdrivers sizes 1, 2 & 3.
- Plain Screwdrivers sizes 3mm & 5mm.
- Indelible pen for marking the address on the Address Header.

3.4 Installation Kit

The Outstation is supplied with an installation kit containing the following items.

1 off Mains Power Cable		
1 off Address Plug (uncoded)		
4 off 6mm Washers	}	
4 off 6mm Cage nuts		
4 off 6mm Machine screws	}	
1 off bracket for RS485 Protection board		
1 off 12 way terminal block	}	
2 off self tapping screws (10mm long)		
2 off 3mm x 25mm screws		
2 off 3mm nuts		
2 off 3mm washers		
2 off 3mm spring washers		
1 off Detector loop cableform		
1 off M5 Ring tag		

For fitting Outstation to uprights

For installation of RS485 protection board

3.5 Installation Documentation

It is assumed that details of the installation and test results will be recorded on a suitable form. The format of this form is outside the scope of this handbook. Where appropriate it will be referred to as the Installation Test Results form.

3.6 Installation of the Outstation in an ST800 MEC

3.6.1 The ST800 MEC

The ST800 MEC is a metal outercase with:

- A single door in the front
- A swinging frame with provision for mounting 3 'U' modules
- A Master Switch panel with double pole switch and fuses
- A wooden board for mounting the Electricity Supplier's Termination
- Bars in the base for securing incoming armour cables
- A panel for mounting terminal blocks
- A mounting Stool
- An optional heater for cold climates

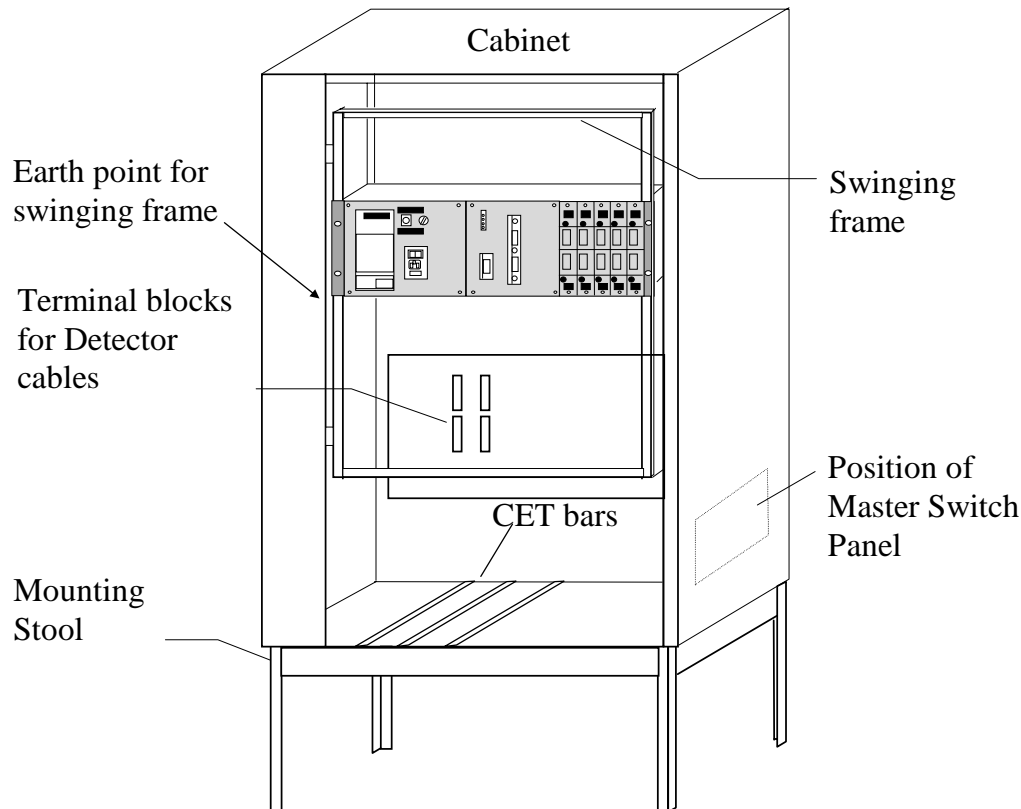


Figure 10 - The ST800 MEC

3.6.2 Installation of the ST800 MEC

The Cabinet is supplied with a Mounting Stool that is buried in the ground as part of the installation procedure.

The recommended order of installation is:

- Remove the stool from the case
- Remove the CET bars from the stool**
- Install the stool into the ground.
- Pull the cables into position
- Fit the CET bars** and terminate the armour to the CET connectors
- Test the cables
- In-fill the stool and seal the base
- Fit the cabinet
- Terminate the cables

**The CET bars may be left in position if preferred. The only reason for removing them is to prevent them obstructing the cables while the cabinet is being put onto the stool.

A hole should be dug and a flagstone at least 900mm x 600mm embedded securely at the bottom of the hole. Refer to Figure 11 for general method of installation and dimensions. Ensure that enough clearance is left around the stool to enable the fitting of the CET bars and cabinet fixings.

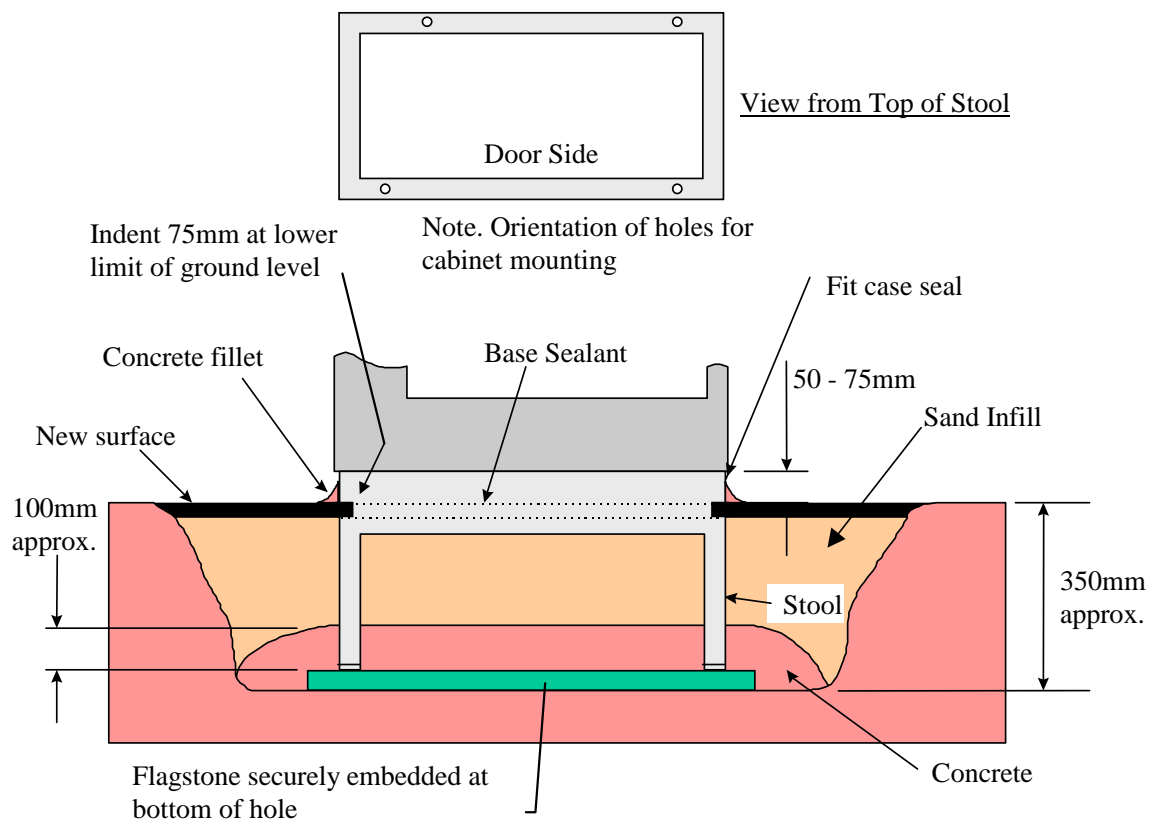


Figure 11 - Installation of Stool

If the cabinet is being installed on a slope, allowance must be made for the opening of the door adjacent to the uphill side.

The stool is placed in the centre of the flagstone with the top surface between 50 and 75 mm above the final ground level. It is essential that the stool is fitted the correct way round with the holes to the front. Adjustment may be required to ensure that the cabinet sides are vertical; this should be checked using a spirit level.

Mix up a stiff mixture of concrete (mix: 1 cement, 3 sand, 4 coarse aggregate (20mm) with no excess water) and cover the flagstone to a height approximately 100mm (4") above the bottom of the stool. The concrete must be sloped to provide a run up for the cables. Any cables already entering the pit must be held away from the wet concrete. Where there is a risk of freezing, then a suitable antifreeze additive shall be incorporated in the concrete mix to ensure proper curing.

3.6.3 Connection to incoming power supply

There are two versions of the Master Switch panel available. The version illustrated in Figure 12 is equipped with UK-style 13A maintenance sockets and a Residual Current Device (RCD) to protect users of equipment connected to them. The alternative version has a smaller fuse box and no 13A sockets or RCD. Both versions have a wooden board for the Electricity Supplier's termination equipment.

Remove the cover from the Master Switch, route the power lead from the Outstation, along the swing frame to the Master Switch panel. Ensure that the lead does not snag as the swing frame pivots. Connect:

Brown to the outgoing side of the 6A fuse

Blue to the neutral block

Green/yellow to the earth block

Note that if maintenance sockets are fitted, the neutral and earth blocks will already have wires attached. Connect the new wires alongside.

There are 3 wires at the bottom of the panel for connecting the incoming supply. These should be connected to the Electricity Supplier's terminations as follows:

Pink to Live

Blue to Neutral

Green/Yellow to incoming Earth

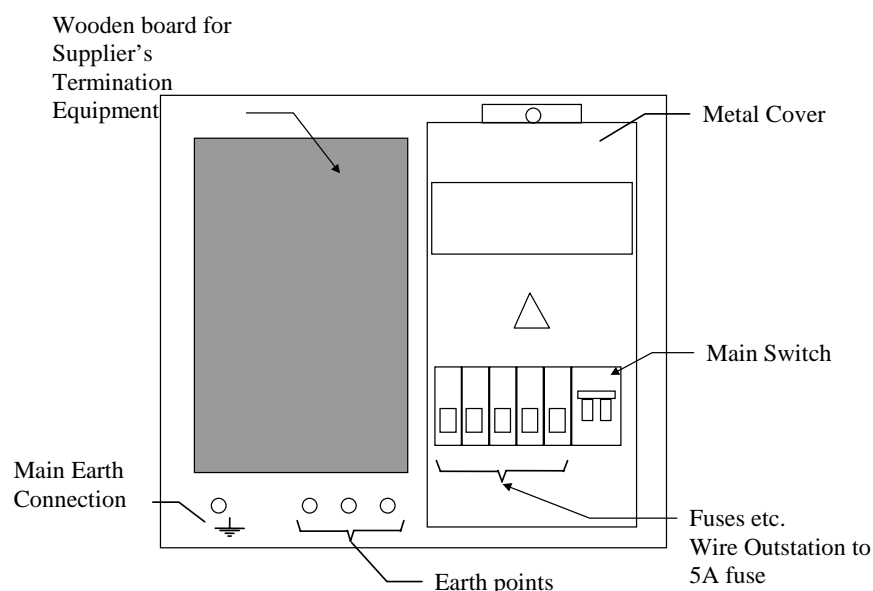


Figure 12 - Master Switch Panel

3.6.4 Earthing

The Cabinet must be Earthed for safety. The connection point for the incoming earth connection is shown in Figure 12.

3.6.5 Installation of the Loop Detector Leads

Loop detector cabling into the controller should be fed into the cabinet as close to their termination position as possible to prevent unnecessary damage being caused should the cable need to be moved once all the cables are in place. Care must be taken not to obstruct the Electricity Supply Company equipment with any cabling.

The outer sheathing must be stripped to expose the armouring, leaving not less than 25 mm of the inner sheathing above the CET bar. A further conductor length must also be allowed, sufficient to reach the terminal blocks via the proper routing.

The cable is inserted in the CET ring and the armoured wires are bent outwards and down against the ring. A hose clip is then placed over the armour wires and tightened up. The armouring must be stripped leaving a small amount (approx. 0 to 2mm) below the level of the CET ring.

Remove the inner sheathing to expose the individual leads and route the cores to the terminal blocks on the left hand side panel; see Figure 15. Ensure that the individual loop pairs are twisted together. Ensure that the wiring does not obstruct the RS485 Protection PCB or the communications wiring. Connect to the terminal blocks with reference to Figure 15 for the loop numbering. Leave sufficient spare length for re-making off the ends should this become necessary. Unused leads should be left with sufficient length to be able to connect them to any terminal should this subsequently become necessary.

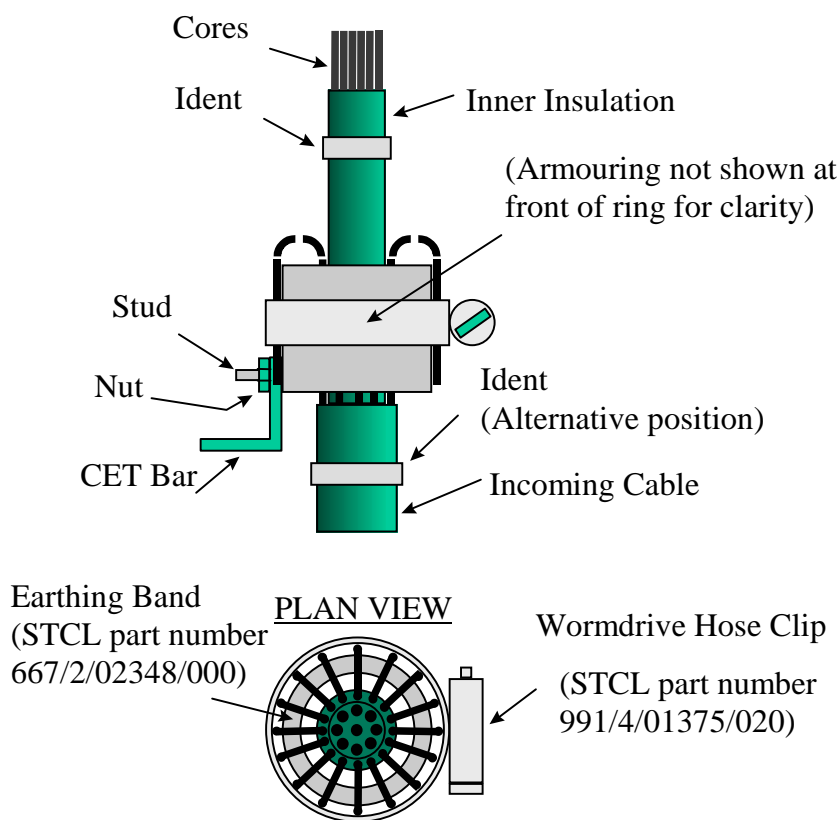


Figure 13 - Securing armoured cable to CET bar

3.6.6 Fitting the Outstation

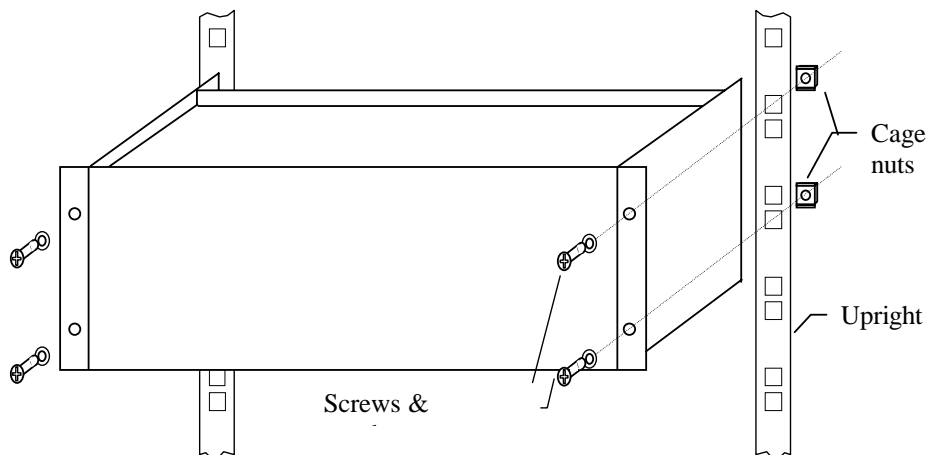


Figure 14 - Fitting O/S to swing frame

Insert the cage nuts into the required positions in the upright and mount the Outstation using four screws and washers at the front.

Route the green/yellow earth lead to the swing frame hinge. Cut to length, fit the ring tag and fit on the same screw as the existing green/yellow swing frame earth wire.

3.6.7 Installation of Detector Cableform

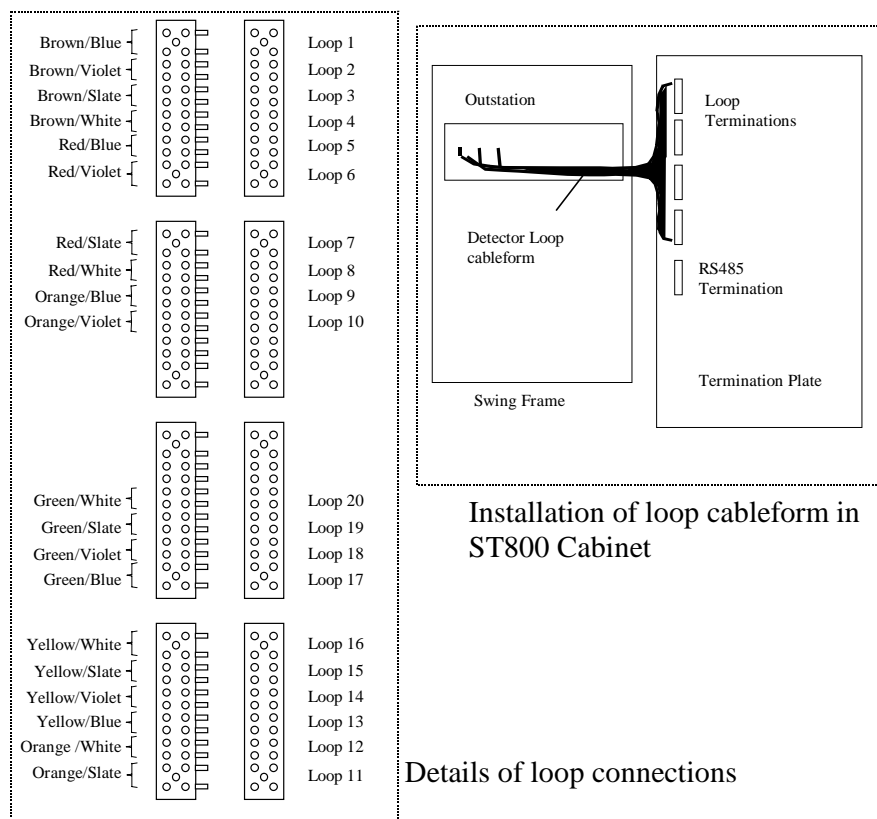


Figure 15 - Installation of Detector cableform

Route the detector loop cableform from the four the terminal blocks on the left-hand side plate of the ST800 Cabinet to the Outstation (Figure 15).

See Figure 16 for details of connection to the detector backplane.

Secure the cableform to the Outstation with cable ties as required. Ensure that the cableform does not snag as the swing frame pivots.

Note that the allocation of loop numbers to actual loops on the road is part of the configuration data downloaded from the Instation. In Table 2, loop number 1 corresponds to channel 1 of the detector PCB installed into the left-hand position as viewed from the front. Loop number 20 corresponds to channel 4 on the right hand PCB.

Loop No.	Colour of loop pair	Detector Backplane connector
1	Brown / Blue	PL2
2	Brown / Violet	
3	Brown / Slate	
4	Brown / White	
5	Red / Blue	
6	Red / Violet	
7	Red / Slate	
8	Red / White	
9	Orange / Blue	PL3
10	Orange / Violet	
11	Orange / Slate	
12	Orange / White	
13	Yellow / Blue	
14	Yellow / Violet	
15	Yellow / Slate	
16	Yellow / White	
17	Green / Blue	PL4
18	Green / Violet	
19	Green / Slate	
20	Green / White	

Table 2 - Wiring of Loop Leads

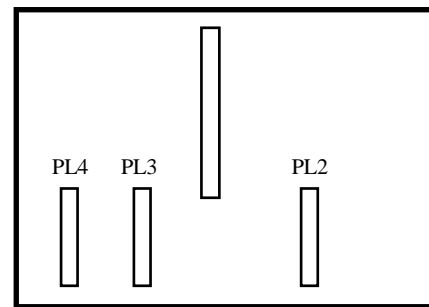


Figure 16 - Detector Backplane

3.6.8 Connection of RS485 Line Protection module

Fit the RS85 Line Protection module to the side panel of the ST800 MEC. Connect the incoming line to Port 0 A and Port 0 B in Figure 17.

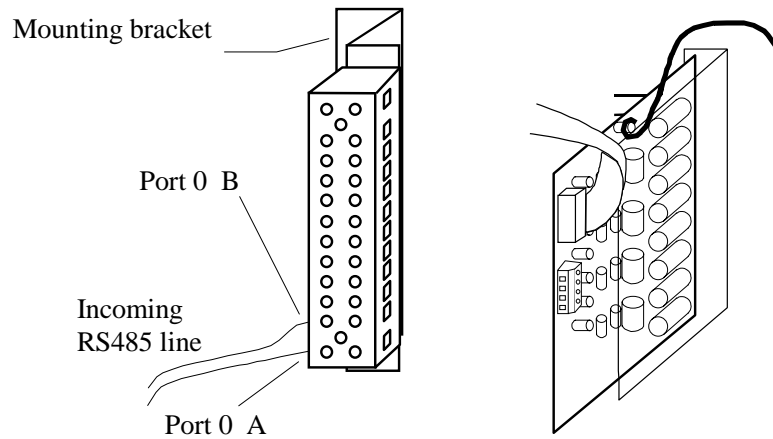


Figure 17 - Connection of RS485 Protection module

3.7 Installation in Other Cabinets

3.7.1 Outstation fitting

The Outstation is supplied fully assembled with the exception of the Address Header and the mains power cable. It is designed to be installed in a cabinet fitted with pierced uprights. See Figure 18

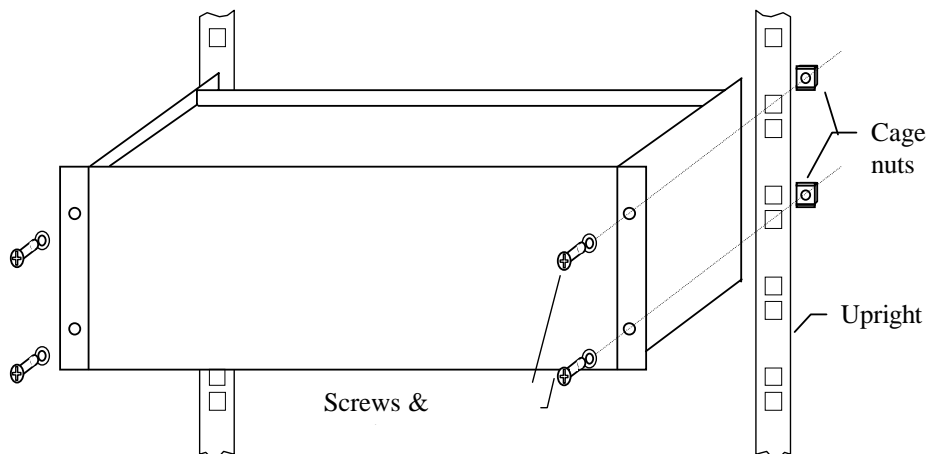
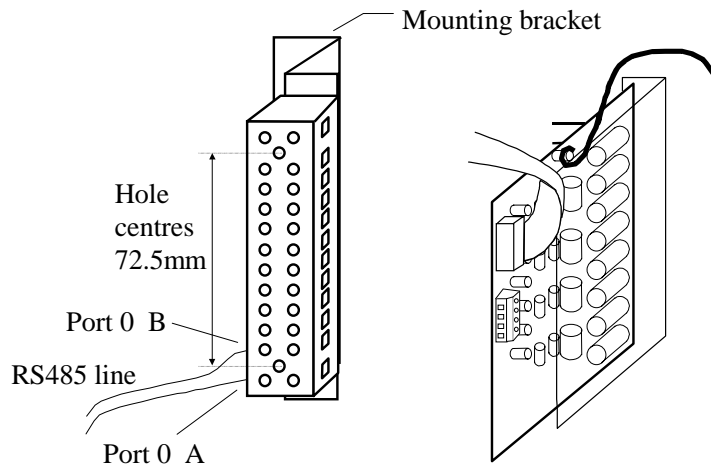


Figure 18 - Fixing onto pierced uprights

Insert the cage nuts into the required positions in the upright and mount the Outstation using four screws and washers at the front.

3.7.2 Installation of RS485 Line Protection Module

This module consists of a single PCB with an attached ribbon cable for connection to the Comm I/O PCB, and a row of pins on the rear for connection to the terminal block supplied in the installation kit.



The module is supported by the terminal block that must be mounted to allow clearance for the module. When it is desired to mount on a flat surface the bracket will be required. See Figure 19.

Two off 25mm long 3mm screws with nuts and washers are supplied to fit the terminal block to the bracket.

Figure 19 - Mounting of RS485 Line Protection Module

Check the metal fuseholders; if necessary remove the fuse, squeeze the clips together and refit the fuse. Connect the incoming RS485 line to the terminal block positions shown as 'PORT 0 A and PORT 0 B' in Figure 19. If the Outstation is at the end of the line fit the 140Ω termination resistor (see sections 2.3 and 3.2).

Route and terminate the green/yellow earth wire to an appropriate earthing point in the cabinet. Route the ribbon cable to connector PL5 on the rear of the Comms I/O PCB, see Figure 8 on page 13.

3.7.3 Installation of loop detector cableform

Figure 20 shows the loop detector cableform provided to connect the incoming loop connections to the detector backplane.

Refer to Section 3.6.7 for details of the loop connections.

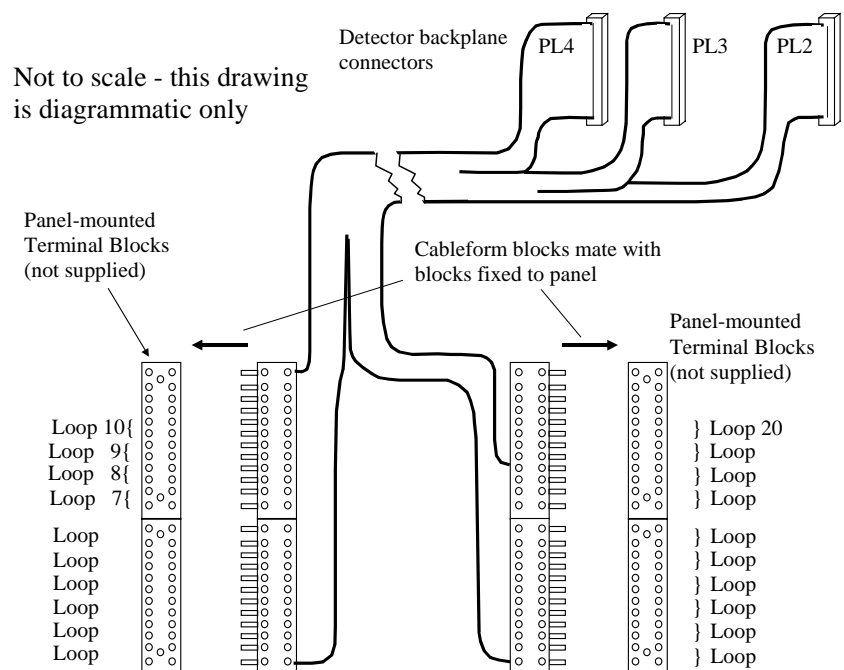


Figure 20 - Loop Detector cableform

3.7.4 Connect Mains Lead to Power Distribution Unit

Ensure the mains power to the cabinet is turned off before starting to connect the power lead.

Route the mains lead to the power distribution and connect in accordance with the following colour code:

Brown	Line (230v)
Blue	Neutral
Green/Yellow	Earth

The Power lead must be protected by a fuse or other overcurrent protection device rated at no greater than 5A.

3.8 Address Header

This sets the address of the unit in binary.

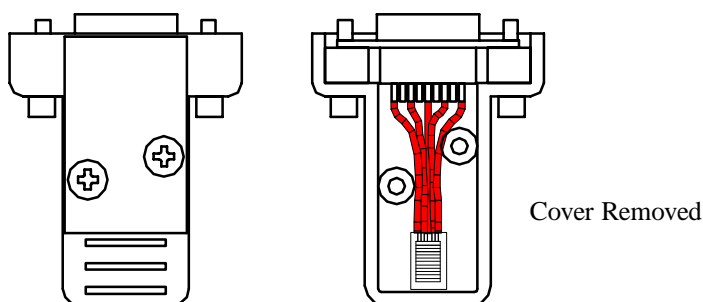


Figure 21 - Address Header

3.8.1 Programming the Address Header

Dismantle the unit by removing the two front cover screws, and cut the links where appropriate. Table 3 below gives details of the link values.

	Address Bit	Link Colour
LSB	0	Black
	1	Brown
	2	Red
	3	Orange
	4	Yellow
	5	Green
	6	Blue
MSB	7	Violet

Link Present = Logic 0
Link Cut = Logic 1

Table 3 - Address Link Values

For example to set Addresses:

Binary	Hex	Octal	Cut links
00000101	5	5	Black and Red
01010101	55	125	Black, Red, Yellow and Blue
01000010	42	102	Brown and Blue
10010111	97	223	Black, Brown, Red, Yellow and Violet

Write the address on the white label in indelible pen.

3.8.2 Fitting the Address Header

Reassemble and fit the address header into the front connector of the Comms I/O PCB (See Figure 4 on page 11). Screw it securely to the PCB.

3.9 Safety Testing

Safety testing may only be performed by suitably qualified persons - see section 1.5.

The installation testing must conform to all statutory requirements and the following tests do not absolve the installer from any such requirements. The tests described in Sections 3.9.1 to 3.9.3 refer to installation in an STCL Cabinet such as an ST800 MEC. Where the Outstation is installed in a different cabinet, parts of the procedure may need to be modified accordingly. Care must be taken to avoid damage to any other equipment installed in the same cabinet.

3.9.1 Insulation Testing

This test will be performed BEFORE the cabinet is connected to the incoming mains supply.

If the mains is connected to any additional equipment that is not capable of withstanding the 500V insulation test without damage, such connection must be removed.

Set all switches and circuit breakers other than the Master Switch to the ON position. Using the insulation tester set to the 500V range connect the test leads; one to both the live and neutral supply tails, and the other to the main cabinet earth point. Test the insulation resistance and record the result in the appropriate box on the Installation Test Results form (see section 3.5).

The minimum acceptable value for these tests is 1M Ω .

The installation can now be connected to the mains supply and powered up ready for the commissioning tests to be completed.

3.9.2 Polarity Test

The object of this test is to check that the cabinet is connected to Line and Neutral in the correct sense. It is applicable only to supply arrangements consisting of a phase conductor and a return conductor that is electrically connected to earth.

Operate the controller Master switch to the 'ON' position and check that the polarity of the phase conductor at the Outstation supply fuse is in the correct sense. I.e. The voltage measured from Line to Earth is approximately 230V AC and the voltage measured from Neutral to Earth is less than 10V AC.

3.9.3 Earth Loop Impedance Tests

3.9.3.1 General Information

Earth Loop Impedance tests apply to supply arrangements consisting of a phase conductor and a return conductor which is at earth potential. The tests as described cannot be carried out on systems that employ earth-free or centre tapped (2 phase) supply systems.

Earth Loop Impedance tests are carried out at any points in the system where mains and exposed metal work are present. The fault path within the installation comprises of the live conductors, installed equipment such as the Outstation and the Continuity Protective Conductor (CPC). The fault path external to the installation (Z_e) contains the Electricity Suppliers transformer windings, the live conductor and CPC of the Electricity Suppliers distribution network, or the earth electrode.

The Earth Loop Impedance test results are required to ensure that in the event of an earth fault (or a short circuit fault) the protection devices e.g. fuses afforded to the appropriate circuit will disconnect that circuit within a specified time limit. A maximum Earth Loop Impedance of 10.9Ω will ensure disconnection within 5 seconds when the circuit is protected with the BS1361 fuse used to protect the Outstation. The recommended disconnection times are 0.4 seconds for pluggable equipment and 5 seconds for permanently wired equipment.

The Earth Loop Impedance test measures the earth loop impedance by connecting live to earth via a low resistance, causing a simulated fault current of approx. 25A to flow for a period of approximately 10 - 20mS around the loop. If the impedance is higher than this, it is recommended that the supply be wired via a 300mA RCD. A suitable kit of parts is available from STCL as part number 667/1/27117/000.

SAFETY NOTE. It is vital to ensure that NO person is in contact with the cabinet during the Earth Loop Impedance test.

3.9.3.2 Fuse Replacement

Following any earth loop impedance tests all fuses (with the exception of the Electricity Suppliers fuse) which have been placed under stress are to be changed.

A fuse with a current rating of less than 10A is considered to have been placed under stress.

3.9.3.3 Measuring Earth Loop impedances

Follow the instructions provided with the Tester e.g. LT5, to measure the earth loop impedance between the supply side of the 5A fuse and:

1. The main Cabinet earthing point - see Figure 10 on page 18.
2. The head of one of the screws securing the Outstation to the pierced upright.

If measurement 1 exceeds 10Ω do not proceed with further testing and report the supply as out of specification to the Organisation responsible for the Electricity supply and earth.

If the value of Earth Loop Impedance exceeds 10Ω and the Electricity Suppliers cannot improve the characteristics of the supply, then a permissible solution is to fit a 300mA RCD to protect the whole installation. The earth loop impedance must not then exceed 100Ω .

3.9.3.4 Prospective Short Circuit Current

Follow the instructions provided with the Tester e.g. LT5, to measure the prospective short circuit current at the origin.

If this value exceeds 16000A refer to the Electricity Supplier.

3.9.4 RCD Testing

Note: This section applies when the Outstation is installed in an STCL-supplied Cabinet that is equipped with an RCD-protected maintenance socket.

Using a Seaward RC500 or similar, connect the RCD tester into the maintenance socket. Set the test trip current to 30mA, press test button: The maximum allowable trip time is 0.2 seconds.

Reset the RCD. Set the trip current to 150mA and re-test: The maximum allowable trip time is 0.04 seconds.

If either test fails replace the RCD.

4. LOOPS AND FEEDERS

4.1 Loop Size and Position

The Outstation is designed to monitor vehicles travelling in lanes on high-speed roads. There are two detector loops in each lane. Each of the loops is connected to a vehicle detector PCB in the Outstation. (Each detector PCB can be connected to 4 loops).

The loops are constructed by burying wires in the road surface and connecting them back to the Outstation via feeder cables. For the Outstation to perform correctly, the loops must be the correct size and in the correct position. Figure 22 shows the size and spacing for a suitable pair of loops to go into a traffic lane.

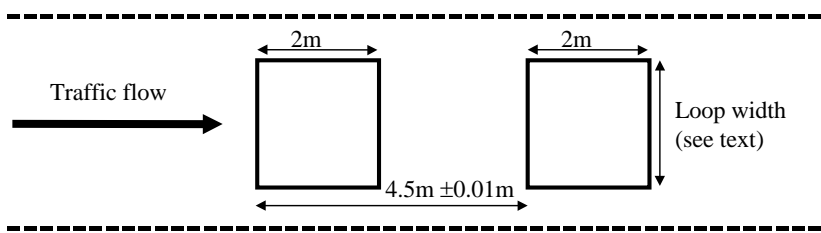


Figure 22 - Loop size and spacing

The width of the loops depends on the width of the carriageway. The following general rules apply to the running lanes:

- Distance from hard shoulder (where provided) to nearside edge of loop = 0.6m
- Distance from lane boundary to nearside edge of loop = 0.9m
- Distance from central reservation to far edge of loop = 0.6m

For loops in the hard shoulder:

- Distance from the edge of the road to the nearside edge of the loop = 0.8m
- Distance from the far side of the loop to the edge of the inside running lane = 1.2m

Figure 23 illustrates the loop layout for a three lane plus hard shoulder installation.

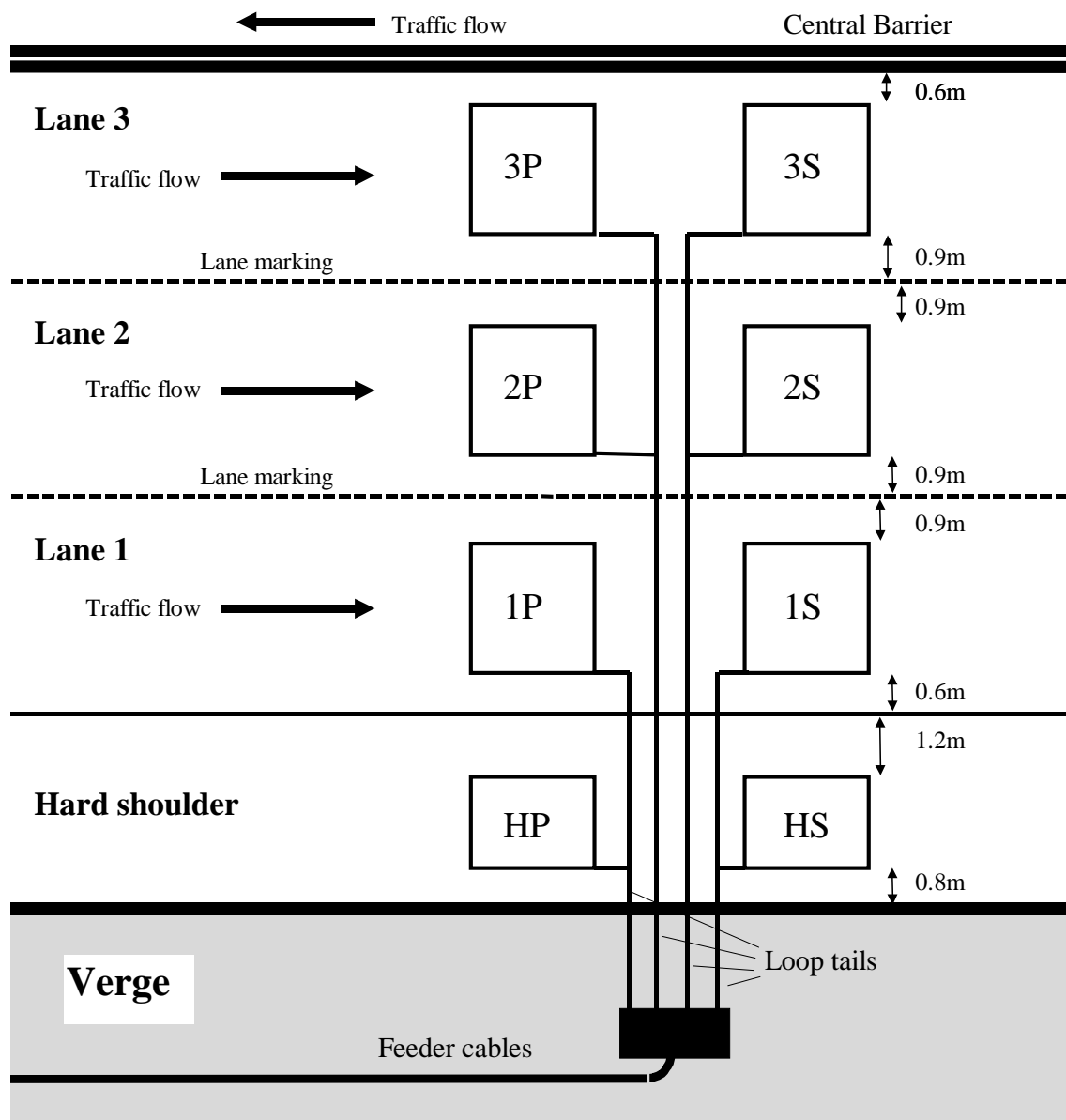


Figure 23 - Typical loop layout for 3 lanes and hard shoulder

The loop conductors may be run back directly to the cabinet or jointed onto feeder cable at the roadside depending on the distance from the loops to the cabinet. If feeder cable is not used, each pair of loop tails must be twisted together over the entire length from the roadside back to the cabinet. See Section 4.8

Figure 23 shows the loop tails from 2 loops sharing a single slot. It is allowable to share a slot between 4 loops where the depth of road surface is sufficient.

Where the Outstation is on the opposite side of the road it is recommended that armoured feeder cables are used to cross the carriageway.

Figure 23 shows loops designated 1P, 1S etc. The first character designates the lane (H = Hard shoulder) and the second character designates 'Primary' or 'Secondary' where the primary is the first loop to be crossed by the traffic.

4.2 Road Surface

4.2.1 Reinforced Concrete

Inductive loops will not function correctly if laid too close to the steel reinforcing mesh commonly used in the construction of concrete wearing surfaces. There should be at least 50mm vertical spacing between the top of the mesh to the bottom of the slot loop. Reinforcing has no effect on feeder cable or loop tails.

4.2.2 Expansion Joint

Where a concrete road surface has expansion joints it is recommended that either the loops and feeders are planned to avoid them or provisions are made to prevent the expansion from damaging the wires. In any case the loops should be laid in an area free of joints.

Where it is necessary for loop tails to cross joints it is recommended that a wider slot, filled with a flexible encapsulant is used. The cables are laid loosely in the wide slot to allow movement. Refer to Figure 24. Use a mastic compound to form temporary dams in the feeder channels to hold the sealant in place while it sets.

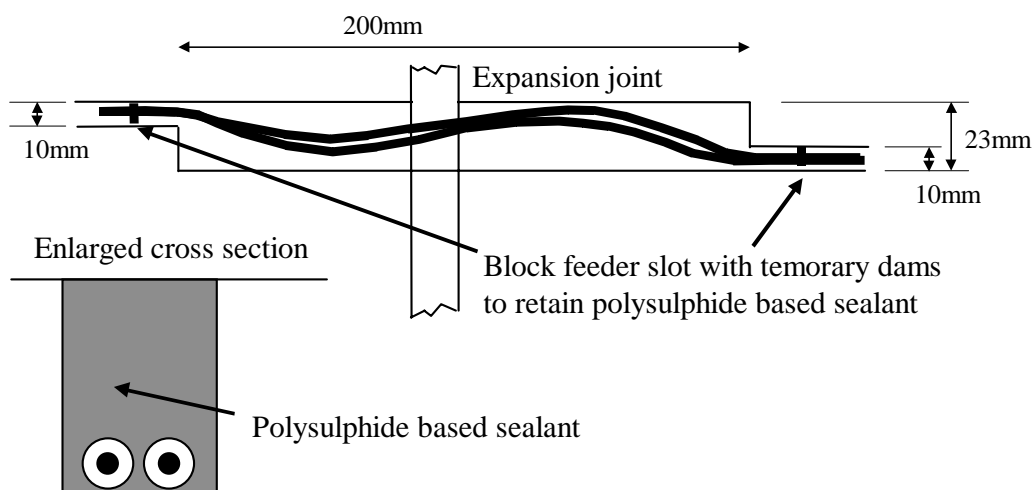


Figure 24 - Wire crossing expansion joint

4.2.3 Buried Metal Objects

Although inductive loops will provide vehicle detection in the presence of compact items such as girders, the speed measuring accuracy may be affected. It is therefore recommended that loops be sited at least 1 metre from such items.

4.2.4 Surface Objects

Slot cutting closer than 1 metre from items such as manhole covers may weaken the road surface and reduce its life. It is therefore recommended that loops and tails be sited at least 1 metre from such items.

4.2.5 Flexible Road Surfaces

It is important that slot cutting does not weaken the road surface significantly. There must be sufficient depth of road to accommodate the slot. If the saw breaks through into the hardcore bed, work must stop. Either the slots must be re-planned to allow the use of shallower slots or the depth of road surface must be improved.

Most inductive loops are installed using loop cable with an overall diameter of 6mm, see Section 4.8.2. This type of cable has good abrasion resistance and flexibility that eases installation. However providing care is taken to avoid damage to the insulation, the use of cable with thinner insulation is acceptable and may be preferable to weakening the road surface.

4.2.6 Flexible Road Surfaces Containing Ferrous Materials

If the road surface incorporates blast furnace slag in its makeup, the performance of the loop will be severely impaired. STCL will not take responsibility for the performance of loop detectors connected to loops installed in such surfaces.

4.3 Installation of Loops and Feeders

It is recommended that slot cutting, loop laying and connection to the cabinet be performed as a single operation. The action of backfilling the loop slots precludes rectification of any mistakes. It is important therefore to adopt a sequence that allows testing prior to backfilling. The feeder cables may be installed in advance provided that the ends are sealed to prevent the ingress of water. It is recommended that the expected loop test parameters are calculated in advance to allow immediate evaluation of test results. Refer to section 4.10.

4.4 Slot Cutting

Loops are laid in slots cut into the road surface with a motorised slot cutting machine. It is recommended that a machine fitted with a water cooled diamond tipped blade is employed. The width of the slot should exceed the diameter of the cable by at least 2mm. Inside corners of loops should be relieved to minimise risk of damage to the cable insulation when bending the cable around a sharp corner.

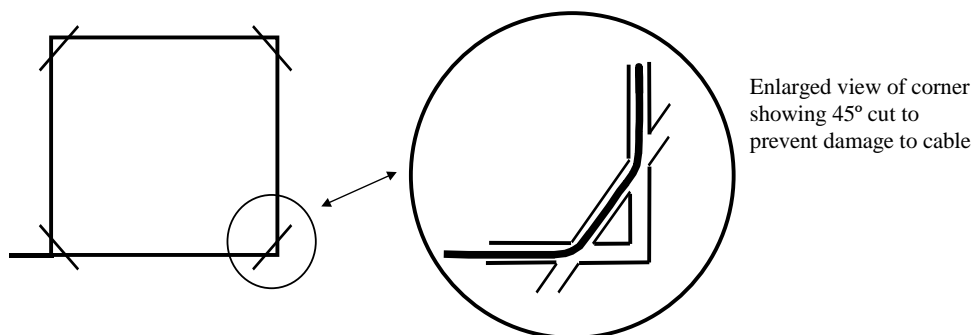


Figure 25 - Relieving the corners

This may be implemented by an additional slot at 45° or by using a cold chisel to relieve the inside of the corner.

All slots must be washed clear of silt and debris and dried before laying the loop cable. It is recommended that a motorised high volume blower be used to dry the slots.

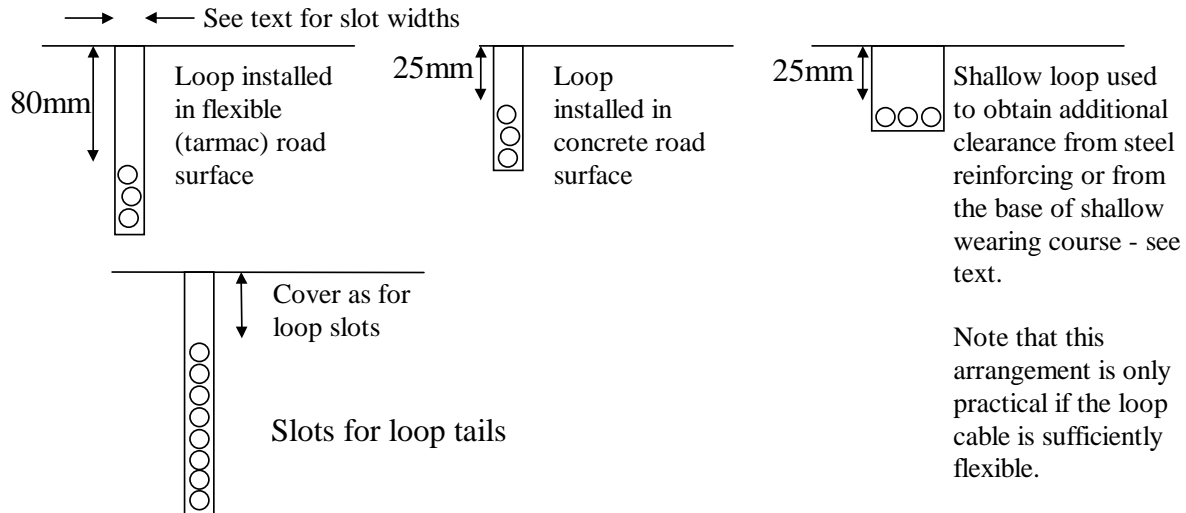


Figure 26 - Slot dimensions

4.5 Laying the Loop

Each loop is laid using a single length of suitable stranded wire, pushed into the bottom of the slot using a blunt instrument. All loops must consist of 3 turns.

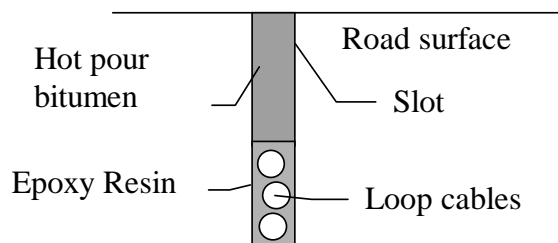


Figure 27 - Cross section of loop

The loop cables should lie in the bottom of the slot. No part of the cable should be allowed to rise towards the surface, to avoid the risk of damage as the hot pour compound wears.

Refer to Appendix A for suppliers of materials.

4.6 Loop Tails

The loop tails are laid across the carriageway in a slot of sufficient depth to give the same depth of cover as for the loop. To minimise crosstalk the tails should be arranged as per Figure 28

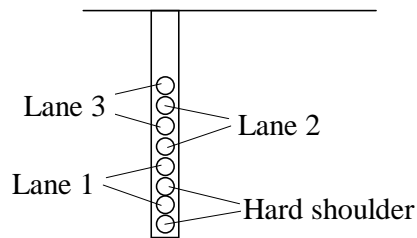


Figure 28 - Loop tails

4.7 Backfilling the loops

It is recommended that the loops be tested before backfilling

The recommended backfilling system consists of epoxy resin to cover the cables, followed by hot pour bitumen to the surface. The epoxy resin ensures that the cable is surrounded. If hot pour is used without epoxy there is a danger of a void beneath the upper cable which could allow movement of the lower layers. This is particularly likely if pouring onto a cold, damp road surface. See Appendix A for materials.

4.8 Feeder Cables

Where the loops are close to the cabinet it is practical to run the loop tails directly back to the cabinet. In this case each pair must be twisted separately with at least 10 twists per metre to minimise noise pickup and crosstalk between tails from different loops.

For longer runs the use of feeder cable is recommended. Up to 300 metres of feeder may be used. Sharing a multipair feeder between different detector PCBs is not recommended.

4.8.1 Specification of Feeder Cable

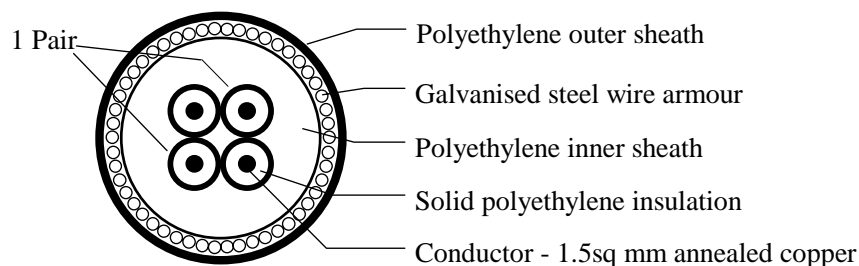


Figure 29 - 2 pair armoured cable cross section

Figure 29 shows the cross section of a suitable 2-pair armoured cable. It may be necessary to substitute different insulation materials to suit local conditions particularly in respect of pest and vermin damage. The outer sheath must be free from pinholes and suitable for direct burial in the ground.

Minor differences in dimensions will not affect performance in this application. It is acceptable to use cable with fewer or greater numbers of pairs. However it is not recommended to share a feeder cable between 2 or more detector PCBs. Cable with more than 4 conductors must be

'paired' - that is it must consist of pairs of twisted wires made up into a cable. Multicore cable, consisting of parallel conductors is not suitable.

It is not an electrical requirement to have steel wire armouring. Steel wire armouring is recommended where the cable is to be buried directly in the ground. Non-armoured cable is suitable where cable is installed in ducts. It is recommended that non-armoured cable should have an electrical screen. This is particularly important for installation in areas with a high risk of lightning.

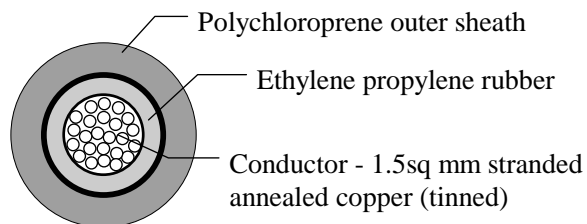
Typical electrical specifications:

Conductor DC resistance	12.1 Ω /km
Capacitance	90pF per metre
Inductance	0.9uH per metre
Insulation resistance	100M Ω minimum for a 1km length

4.8.2 Specification of Loop Cable

Figure 30 illustrates the cross section of a typical loop cable. The essential requirements are for a cable which has at least 1.5 square mm cross sectional area of copper, which has good resistance to abrasion and which will withstand the temperature of the hot pour bitumen during installation. It must be noted that cables which do not easily lay flat will cause difficulties during installation.

Figure 30 - Loop cable cross section



4.8.3 Jointing of Feeder Cable to Loop Tails

The preferred arrangement is to joint cables in a roadside chamber using a proprietary jointing kit. Joints should be sealed within a re-enterable jointing enclosure. All loop cables should be labelled.

An acceptable alternative is the use of a resin sealed jointing system.

4.9 Terminating Loop Feeders in Cabinets

Details of termination of loop tails and feeders into a cabinet is outside the scope of this handbook as it is dependant on the cabinet used. However the following principles should be observed:

- The base of the cabinet must be sealed to prevent ingress of moisture causing condensation. See Appendix A for suppliers of suitable materials.
- Armoured cable should be mechanically supported close to the entry point. The armour should be electrically connected to earth. Appendix A lists a supplier of suitable cable accessories.
- The feeder/tail conductors should be connected to the terminal blocks. Figure 31 shows a typical installation, showing the feeder connected with strain relief. Figure 13 on page 21 shows armoured cable clamping in an ST800 MEC.

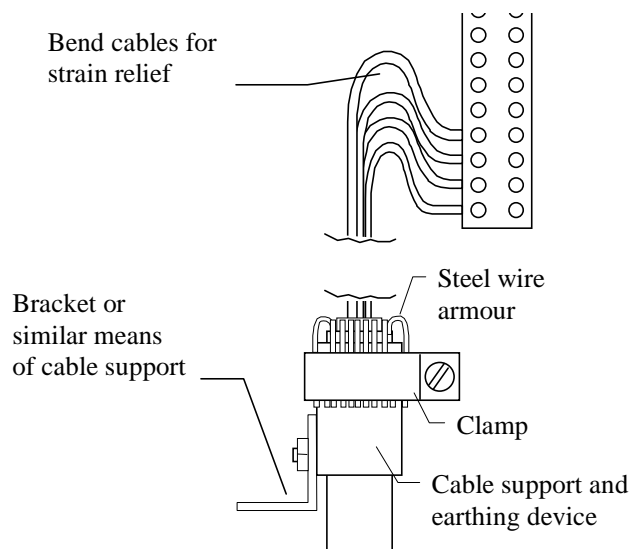


Figure 31 - Termination of feeder cables

Allocation of loops to detectors is system dependant. The Outstation is downloaded with the loop configuration. The allocation of loops must be made available to the Installer.

4.10 Testing

It is strongly recommended that loops be tested before backfilling as rectification on installed loops is expensive.

Identical size loops will have the same inductance within 10%. A mismatch of 30% would indicate that one of the loops has the wrong number of turns. Test results should be recorded for future reference.

4.10.1 Inductance

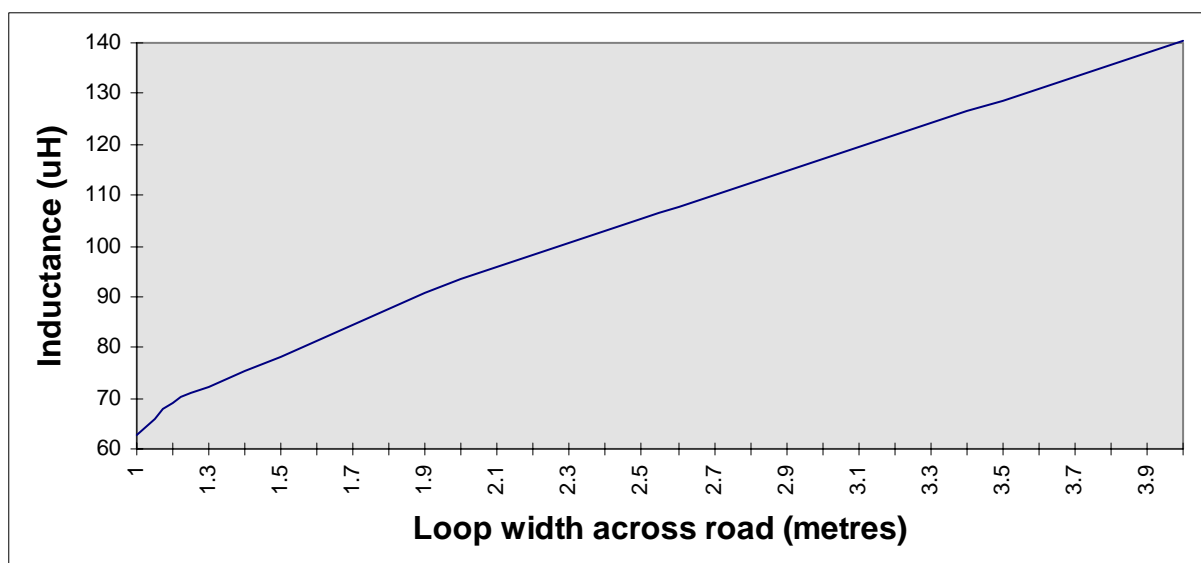


Figure 32 - Inductance of 3 turn loop (no loop tails)

The inductance of 3 turn road loops of length 2 metres is shown in Figure 32. The values given in Figure 32 are approximate and will vary with different loop cable and road surfaces. However any deviation from these values by more than 20% should be investigated. The inductance of the loop tails and feeder cables must be taken into account. Where the loop cable is of 1.5 sq. mm conductor area and overall diameter 6mm, the inductance of the tails in μH is given by:

$$\text{Tail length (metres)} \times 0.64$$

The inductance per metre of the feeder cable will be obtainable from the manufacturer. A typical value in μH for the cable illustrated in Figure 29 is given by:

$$0.8 \times \text{length (metres)}$$

4.10.2 Series Resistance

The anticipated total series resistance of copper conductors of 1.5 sq. mm, in ohms (at 20°C) is given by the total length of copper in metres multiplied by 0.012. To calculate the total length of conductor, each conductor in the feeder and loop tail and each turn of the loop must be considered separately.

For example in the case of a 3 turn loop of dimensions 2m x 3m with 10m of loop tail and 100m of feeder the total resistance should be:

$$\begin{aligned} & (3 \times \text{loop perimeter} + 2 \times \text{tail} + 2 \times \text{feeder}) \times 0.012 \\ = & (30 + 20 + 200) \times 0.012 \\ = & 3\Omega \end{aligned}$$

Allowance must be made for the accuracy of the meter and the resistance of the meter leads and connections.

4.10.3 Insulation Resistance

N.B. This test must only be carried out by a person trained in the use of the high voltage test equipment used - refer to section 1.5.

This test should be carried out at the cabinet, on the incoming feeder or loop tail cables before connection is made to the detector backplane.

Connect the two conductors of the loop under test together and test between this point and earth. The insulation resistance at 500V should be at least 100 MΩ.

5. COMMISSIONING

The configuration for the Outstation is held in the Instation and is downloaded into the Outstation. Commissioning cannot take place until this has taken place.

If the Instation is unavailable, then a suitable simulator will be required to load a default configuration into the Outstation. The simulator must provide an RS485 connection.

The simulator is connected by wiring either to the LOCAL TRANSPONDER RS485 D-type on the front of the Comms I/O module or to the line protection module (with the line disconnected). If the LOCAL TRANSPONDER RS485 connection is used then set the TPR-O/S link switch on the comms I/O PCB to 'LOCAL'.

If the Outstation is connected to a functioning Instation then proceed as in section 5.1. If a simulator is available then proceed as in section 5.2.

5.1 Setup when connected to the Instation

- Ensure that the switch and link settings on the unit are set to their default values, as defined in section 6.5.1.
- Turn the power on at the main switch.
- Make sure that the Battery Isolation Switch is set to 'CONNECTED'.
- Check the Power PC LEDs. (The RUN LED should be flashing green; the others should be off. Refer to Figure 4 on page 11).
- Connect an Engineer's Terminal. (Section 8.11 defines the hardware and software requirements for the Engineer's Terminal. Section 7 describes the use of the Engineer's Terminal).
- Check that the baud rates are as described in Section 7.6.1 (factory defaults).
- Check the Extended Status Data dialog box. The details should be as seen in Figure 37 on page 55 except the entry against Config Data CRC, which is not relevant here. "Transponder Link" should show OK, to indicate that the Outstation is communicating with the Instation. "Loop Status" should show 0.
- If "Battery" shows low, commissioning may continue. It may be necessary to wait at least one hour for the battery to become sufficiently charged to clear this fault.

5.2 Setup using an Instation Simulator

- Connect the RS485 link from the Instation simulator to the Outstation.
- Turn the power on at the main switch.
- Make sure that the Battery Isolation Switch is set to CONNECTED.
- Refer to the operating instructions in the Simulator Handbook to initialise the Outstation
- Check the Power PC LEDs. (The RUN LED should be flashing green; the others should be off. Refer to Figure 4, page 11).

- Connect an Engineer's Terminal. (Section 8.11 defines the hardware and software requirements for the Engineer's Terminal. Section 7 describes the use of the Engineer's Terminal).
- Check that the baud rates are as described in Section 7.6.1 (factory defaults).
- Check the Extended Status Data dialog box. The details should be as seen in Figure 37 page 55 except the entry against Config Data CRC, which is not relevant here.
- If "Battery" shows low, commissioning may continue. It may be necessary to wait at least one hour for the battery to become sufficiently charged to clear this fault.

5.3 Configure the Loop Presence times

The 4 front panel switches marked 'P' adjust the presence time. This is the maximum time for which a loop channel is reported as 'occupied'. If a vehicle is over a loop for longer than this time, the detector retunes and the detect state reverts to 'unoccupied'. This time is selectable as 4 minutes or 35 minutes. Unless otherwise instructed for system purposes, the 'P' switches should be set to 'on' (35 minutes).

5.4 Configure the Loop Sensitivities

Where only a single loop is installed per lane proceed as follows:

- Note that the RESET button on the detector PCB must be pressed if the switch settings are changed. Changes in the settings will not take effect until the PCB is reset.
- When the traffic flow is dense it may be necessary to switch off all but the channel to be tested by using the sensitivity switches on the detector PCBs (See Table 4). In this case record each setting as it is established in order that it may be restored following the completion of the settings.
- Set the channel under test to 0.50% (ON OFF OFF in Table 4) and observe the 'DETECT' LED and the traffic crossing the loop. Check that all vehicles are detected. If the detector is missing some vehicles or if it is giving more than one detection on long vehicles then increase the sensitivity to 0.2%. (remember to use the reset switch). Observe the traffic and the 'DETECT' LED again. If detection is still unreliable then increase the sensitivity by one step. Repeat until reliable detection is achieved.
- Enable the logging vehicle data message as described in section 7.5.1. Go to the Logging Report Dialog Box Figure 44. Check that a vehicle crossing a loop causes a vehicle data message to appear on the screen of the Engineer's terminal.
- Repeat until all channels are set.
- Once all detectors are set and enabled, check each channel for spurious loop events or cross-channel interference i.e. any detection of a vehicle not in the same lane as the loop. If spurious loop events occur, select a different detector operating frequency (see Table 5). Alternatively, reduce the sensitivity of the loop detector channel concerned then check that the channel is still giving reliable detection of vehicles.

Where loops are installed in pairs for speed, headway and length evaluation, proceed as follows:

- When the traffic flow is dense it may be necessary to switch off all but the pair of channels to be tested by using the sensitivity switches on the detector PCBs (See Table 4). If the channels are switched off during testing, they must be re-enabled to the correct sensitivity when steps 1 & 2 below are completed.
- The RESET button on the detector PCB must be pressed if the switch settings are changed. Changes in the settings will not take effect until the PCB is reset.

S1	S2	S4	Sensitivity (% Δ L/L)
ON	ON	ON	Channel Off
OFF	ON	ON	0.02
ON	OFF	ON	0.04
OFF	OFF	ON	0.08
ON	ON	OFF	0.20
OFF	ON	OFF	0.50
ON	OFF	OFF	0.50
OFF	OFF	OFF	1.00

Table 4 - Detector Sensitivity Settings

SW 5 – 8, Pos 1	SW 5 – 8, Pos 2	Frequency
OFF	OFF	Highest
ON	ON	Lowest
OFF	OFF	Highest
ON	ON	Lowest

Table 5 - Detector Operating Frequency Settings

- **Step 1:** Enable the logging vehicle data message as described in section 7.5.1. Go to the Logging Report Dialog Box Figure 44. Check that a vehicle crossing a pair of loops in a lane causes the detect LEDs of the corresponding loop detector channels to flash and a vehicle data message appears on the screen of the Engineer's terminal.

Record the result.

- **Step 2:** While monitoring the flow of vehicles in a lane, look for the passage of a vehicle with a known length. Compare the length of this vehicle with the vehicle record. If the vehicle record length is too short, the sensitivity of the pair of loop detector channels should be increased. Conversely, if the length is too great, the sensitivity should be reduced.

The sensitivity of both loops should be adjusted together.

Repeat this procedure until the Outstation consistently gives the correct length for a known set of vehicles and record the sensitivity.

Repeat steps 1 and 2 for each pair of detector channels.

- **Step 3:** **Once all detectors are set and enabled, check each channel for spurious loop events or cross-channel interference i.e. any detection of a vehicle not in the same lane as the loop. If spurious loop events occur, select a different detector operating frequency (see Table 5). Alternatively, reduce the sensitivity of the loop detector**

channel concerned then repeat step 2 for the channel. Record any changes to the sensitivity against step 3.

5.5 Final Checks

- If the Outstation is working correctly, no faults will appear in the Fault Report.
- Check the Outstation address is correct for the location.
- If a simulator was connected to the RS485 line then remove the Simulator connection and restore the connection to the RS485 communication line.
- Make sure the TPR-O/S link switch is set to REMOTE.

6. MAINTENANCE

Before undertaking any maintenance of the equipment, read the Safety Instructions in Section 1.5.

When maintenance and refitting is carried out on other equipment within the cabinet, it may be necessary to move the VDO equipment, in particular the RS485 Line Protection Module. Follow the instructions given for individual items of equipment in Section 6.5.

For a diagram of the Outstation internal layout see Figure 10, and for the front panels see Figure 4.

In addition to standard equipment such as tools for dismantling and wiring, an Engineer's Terminal is required - see Section 8.11. This may be in the form of the Engineer's Terminal software running on the same PC as the IES Simulator specified in Section 5.2.

6.1 Replaceable Parts

The following parts are replaceable. Follow the instructions given in the remainder of this section for replacing individual parts.

Item	Description	STCL Part Number
1	Outstation Power PC Processor PCB	667/1/26601/000
2	Comms I/O PCB	667/1/26747/000
3	Loop Detector PCB	667/1/26758/000
4	RS485 Line Protection Module PCB	667/1/20982/000
5	Power Supply Unit	605/4/97048/000
6	Address Header	667/1/26774/000
7	Programmed PROM – export version (PB324)	667/1/12324/000
or	Programmed PROM – Original version (PB751)	667/1/12751/000
8	Battery Backup fuse (3.15A)	518/4/90285/007
9	Line Protection Module fuse (1A)	518/4/90284/005
10	Mains fuse (1A anti surge)	518/4/90284/004
11	Power PC Processor PCB Battery	418/4/39820/000
12	Power Supply Battery, 12V, 7A hours	418/4/42314/023
13	Engineer's Terminal Software	667/1/26752/000

Table 6 - Part Numbers of replaceable parts

6.2 Routine Maintenance

There is no routine maintenance required on the Vehicle Detector Outstation.

It is recommended that safety items forming part of the installation be tested. This applies to RCDs (where fitted) and to the insulation tests (sections 3.9.1 and 3.9.4).

6.3 Fault Finding

Listed below are the main faults which might be reported by Outstations

Note that if the Outstation is reset without mains power present it will not restart. Therefore do not operate the reset button if no mains is available. (See Section 6.4).

Symptom	Diagnosis	Remedy
The PRC ERR LED on the Power PC PCB is lit	Processor error.	Replace the PPC PCB.
	Software exception error.	Replace the PPC PCB.
The W/D FAIL LED on the Power PC PCB is lit	The watchdog has failed.	a. Reset the Outstation. b. Check the watchdog link is shorted (LK5 on PPC PCB).
	Hardware fault.	a. Reset the Outstation. b. If the fault persists, replace the PPC.
The RUN LED on the Power PC PCB is not flashing	Software is not running.	a. Reset the Outstation. b. If the fault persists, replace the PPC.
	Hardware fault.	a. Reset the Outstation. b. If the fault persists, replace the PPC.
The DIAG LED on the Power PC PCB is lit	There is a fault reported in the Fault Log.	Refer to the Fault Report for further information. See Section 7.4.1.
A Battery Low fault is reported at the Instation or in the Fault Report. (To access the Fault Report via the Engineer's Terminal see Section 7.)	The battery is not being charged. (Disconnect the battery terminals and check the output of the charging circuit - should be greater than 13V)	Replace the Comms I/O module. If the battery voltage does not start to rise with the new Comms I/O then change the battery.

Symptom	Diagnosis	Remedy
	The battery is faulty.	Replace the battery. To check that the charging circuit is working, check that the voltage on the battery leads with the battery disconnected is at least 13V
A Mains Fail fault is reported at the Instation or in the Fault Report. (To access the Fault Report via the Engineer's Terminal see Section 7.)	The Mains is disconnected.	Check that the mains is connected.
	The Mains has failed.	a. Check the mains fuse. b. Check the mains supply. DO NOT reset the Outstation. See Section 6.4.
	The PSU has failed.	The PSU output should be $14.3V \pm 1V$. If not, replace the PSU.
	The Comms I/O has failed.	Replace the Comms I/O module.
A Battery Charger fault is reported at the Instation or in the Fault Report. (To access the Fault Report via the Engineer's Terminal see Section 7.)	The battery is not being charged. (Disconnect the battery terminals and check the output of the charging circuit - should be greater than 13V)	Replace the Comms I/O module. If the battery voltage does not start to rise with the new Comms I/O then change the battery.
	The Comms I/O has failed.	Replace the Comms I/O module.
	The battery is faulty.	Replace the battery. To check that the charging circuit is working, check that the voltage on the battery leads with the battery disconnected is at least 13V
A Loop Detector fault is reported at the Instation or in the Fault Report. (To access the Fault Report via the Engineer's Terminal see Section 7.)	A road loop is disconnected.	a. Reconnect the road loop. b. Reset the detector.
	A road loop is shorted	a. Remove the short. b. Reset the detector.
	A fault in the Loop Detector PCB.	Replace the Loop Detector PCB.
Instation reports Outstation unobtainable	The link has failed.	a. Check the link connections. b. Check the site configuration.
	The address is configured incorrectly	Reconfigure the address header
Any other fault report or message.		Reset the Outstation (DO NOT reset if the mains has failed. See Section 6.4).

Table 7 - Fault Finding

6.4 Reset

Note: **Do Not** carry out a manual reset during a mains fail, as the equipment will shut down. It can only be restarted with mains present.

To carry out a reset of the Outstation, locate the two buttons marked “Reset” on the front of the Comms I/O PCB (as shown on Figure 4, page 11) and press them both at the same time. The system then restarts.

Note: The Loop Detectors also have reset buttons, which are required for resetting latched loop faults and for changing loop sensitivity and presence times.

6.5 Fitting and Replacement Procedures

Please note that PCB switches are factory set. Check with Table 6 that the PCB is the correct one. Check with Section 6.5.1 that the default settings are correct before fitting the replacement. Part numbers for all the replaceable parts are given in section 6.1.

6.5.1 Default Settings

The following table shows the default settings for the various items of equipment.

It is important to ensure that the equipment uses the settings detailed below when first installed. Some individual settings may require adjustment during commissioning.

		Default Setting	Meaning/remarks
Power PC Processor PCB	Item 1 in Table 6		
Battery switch		On	Battery Connected
Watchdog Disable LK5		Shorted	Watchdog Enabled
All other links		Open	Not Used
Comms I/O PCB	Item 2 in Table 6		
PCB Add	S6,1	On	One PCB in rack
	2	Off	(Would be on if 2 PCBs in rack, all others off)
	3	Off	(Would be on if 3 PCBs in rack, all others off)
	4	Off	
RS 485 Line Voltage Biasing	S2	Off (up)	Biasing Disabled
	S4	Off (up)	Biasing Disabled
	S5	Off (up)	Biasing Disabled
	S8	Off (down)	Biasing Disabled
Loop Detector PCBs	Item 3 in Table 6		
Front panel switches		**All off	Adjusted during commissioning
Card 1 Frequency selection switches	SW5 - 8	Pos 1 - Off Pos 2 - Off	Highest frequency
Card 2 Frequency selection switches	SW5 - 8	Pos 1 - On Pos 2 - On	Lowest frequency
Card 3 Frequency selection switches	SW5 - 8	Pos 1 - Off Pos 2 - Off	Highest frequency
Card 4 Frequency selection switches	SW5 - 8	Pos 1 - On Pos 2 - On	Lowest frequency
Card 5 Frequency selection switches	SW5 - 8	Pos 1 - Off Pos 2 - Off	Highest frequency
Link Data Rates (Set via Engineer's Terminal; See Section 7.6.1)			
Outstation Auxiliary Link - OAL		4800	Baud speed
Engineering Terminal Link - ETR		9600	Baud speed
Transponder/Instation Link - Upstream		4800	Baud speed
Downstream 1		Any	Not used
Downstream 2		Any	Not used

Table 8 - Switch Default Settings

** 'P' Switches select the presence time and should be set to 'on' (= 35 minutes) during

installation. Refer to Section 5.3.

N.B. Switch numbers are identified by the markings on the PCB. The 'ON' position is marked on the switch body.

6.5.2 Power PC Processor PCB

1. This PCB contains a nickel metal hydride rechargeable battery. Note the Safety Warning in Section 1.5.
2. Switch off at the main power switch. See Figure 4, page 11.
3. Set the Battery Isolation Switch to 'ISOLATED'.
4. Undo the four screws holding the front panel and remove it.
5. Disconnect the 4 way Molex connector on the Comms I/O PCB. The PCB positions are identified on Figure 7, page 12.
6. Disconnect the 10 way IDC connector on the rear of the Comms I/O PCB.
7. Pull out the Power PC Processor PCB (PPC) and Comms I/O modules.
8. Disconnect the 50 way IDC on the Comms I/O PCB.
9. Disconnect the PPC from the Comms I/O PCB by undoing the four spacer screws.
10. Pull the PPC and Comms I/O units apart.
11. Replace the PPC Board. Before fitting the new PCB check that the default settings correspond with those in Section 6.5.1. Also make sure that the PROM part number is the same as that listed in Section 6.1 item 7.
12. Reverse the above procedures to reassemble and reconnect the PCBs.

6.5.2.1 Power PC Processor PCB Battery

1. To replace the battery follow items 1 - 10 from Section 6.5.2 above.
2. Desolder the battery (labelled BAT1) from the PCB.
3. Replace the battery and solder securely to the PCB.
4. Fix a new date label on the battery.
5. Reassemble and reconnect the PCBs.

6.5.3 Comms I/O PCB

1. Switch off at the main power switch. See Figure 4, page 11.
2. Set the Battery Isolation Switch to 'ISOLATED'.
3. Undo the four screws holding the front panel and remove it.
4. Disconnect the 4 way DC power cable connector on the Comms I/O PCB. The PCB positions are identified on Figure 7 page 12.
5. Disconnect the 10 way IDC connector on the rear of the Comms I/O PCB.
6. Pull out the Power PC Processor PCB (PPC) and Comms I/O modules.
7. Disconnect the 50 way IDC on the Comms I/O PCB.
8. Disconnect the PPC from the Comms I/O PCB by undoing the four spacer screws.
9. Pull the PPC and Comms I/O units apart.
10. Replace the Comms I/O Board. Before fitting the new PCB check that the default settings correspond with those in Section 6.5.1.
11. Reverse the above procedures to reassemble and reconnect the PCBs.

6.5.4 Loop Detector PCB

1. Disconnect the mains.
2. Set the Battery Isolation Switch to 'ISOLATED' (see Figure 4 on page 11).
3. Undo the two screws on the front panel holding the Detector PCB and remove it.
4. Set all the switches on the new PCB to the same positions as the old PCB.
5. Fit the new Detector PCB and screw to the equipment rack.
6. Restore main power and set the Battery Isolation Switch to 'CONNECTED'.

6.5.5 Power Supply Unit

1. Disconnect the mains.
2. Set the Battery Isolation Switch to 'ISOLATED' (see Figure 4 on page 11).
3. Remove the left-hand front panel (with the Supplier label).
4. Disconnect the DC output and mains input plugs.
5. Remove the earth lead from the screw on top of the PSU PCB.
6. Remove the screws holding the PSU.
7. Remove the PSU.
8. Fit the new PSU and replace the screws.
9. Reconnect the mains earth lead to the screw on top of the PSU PCB.
10. Re-connect the input and output plugs.
11. Re-fit the front panel.
12. Restore main power and set the Battery Isolation Switch to 'CONNECTED'.

6.5.6 Power Supply Battery

1. Disconnect the mains and isolate the battery by setting the Battery Isolation Switch on the front panel to 'ISOLATED' (see Figure 4 on page 11).
2. Remove the left-hand front panel (with the Supplier label).
3. Slide out the battery and disconnect the battery terminals.
4. Replace the battery.
5. Re-connect the terminals to the replacement battery.
6. Replace the front panel.
7. Set the Battery Isolation Switch on the front panel to 'CONNECTED'.
8. Re-connect the mains.
9. Handle and dispose of the old battery safely in accordance with the Safety Warning in Section 1.5.

6.5.7 RS485 Line Protection Module PCB

This module protects the equipment against induced voltage transients and excessive line voltages/currents. The fuses will blow if excessive currents are coupled into the lines. It is unlikely that the module will require replacement, but it may need to be moved within the cabinet when rewiring is carried out or new equipment is fitted.

Proceed as follows:

1. Remove the ribbon cable from the Comms I/O card
2. Unscrew the module from its bracket and remove.
3. Fit the new module.
4. Refit the cabling.

6.5.8 Fuses

The STCL Part numbers are listed in section 6.1.

Location	Fuse	Rating	Fuse size
Front panel	Battery backup fuse	3.15A	20 x 5 mm
Front panel	Mains fuse	250V 500mA Slow blow	20 x 5 mm
RS485 Line Protection Module	Line Protection module fuse	250V 1A Anti-surge (T)	20 x 5 mm

Table 9 - Fuse Ratings

6.5.8.1 Battery Fuse

Isolate the battery using the Battery Isolation Switch. Remove the fuse from the battery front panel and replace with one of the same rating.

Re-connect the battery at the Battery Isolation Switch.

6.5.8.2 Mains Fuse

Isolate the mains using the Mains Switch.

Remove and replace the fuse in the mains socket. See Figure 4 on page 11.

Re-connect the mains at the Mains Switch.

6.5.8.3 Line Protection Module Fuse

Remove the plastic cover from the Line Protection Module. Replace fuses FS1 to FS8 as required.

Replace the cover.

7. USE OF THE STCL ENGINEER'S TERMINAL

7.1 General

Note: The following section applies *only* to the use of an STCL Engineer's Terminal.

The term MIDAS refers to the UK project that the software was originally developed for.

This section assumes that the user is familiar with Windows® software and terminology.

Connect the Engineer's Terminal to the socket shown on Figure 4.

Start the Engineer's Terminal program. Figure 33 shows the initial screen displayed on entry to the Engineer's Terminal.

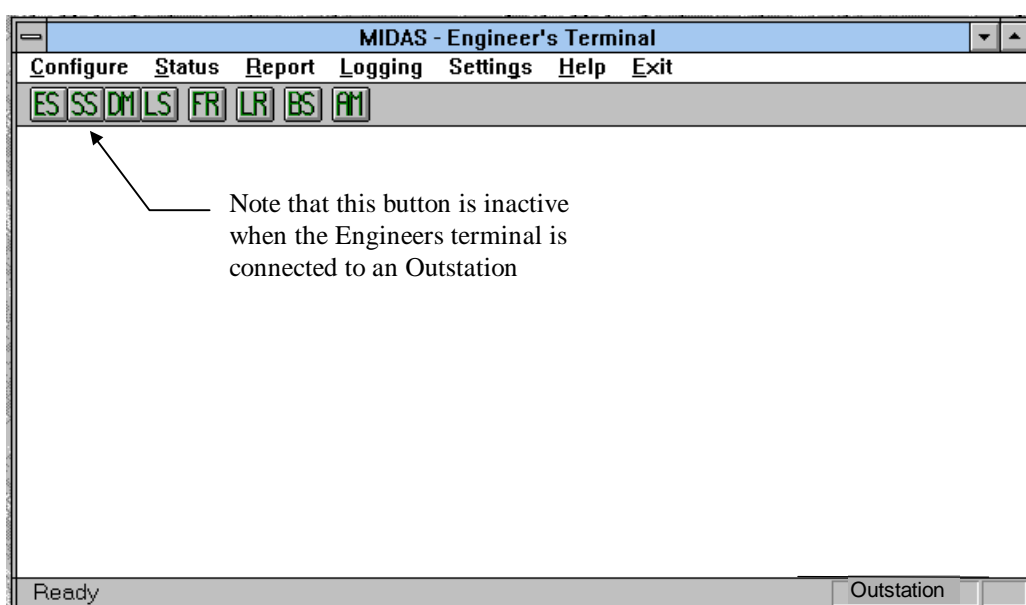


Figure 33 - Initial Screen

Notes:

The menus and buttons displayed on the initial screen above show options that relate to a Transponder as well as an Outstation. Not all options are available when the Engineer's Terminal is connected to an Outstation, and any attempt to select them displays a message indicating that the selection is not valid. Only the options available from an Outstation are described in this section.

Until the Outstation has been set to normal mode, by having data downloaded to it from the Instation, only the Baud Speed and About ... options are available

On the Main Menu Window, under the menu bar, there are buttons that give easy access to the options listed below (see Figure 33):

- ES - Extended Status
- DM - Device Modification
- LS - Loop Status
- FR - Fault Report

- LR - Logging Report
- BS - Baud Speed
- AM - About ...

These options are described in detail later in this section.

There is a status bar at the bottom of the window. On the left hand side there is a summary of what each menu option can do. On the right hand side there are two small windows; the larger one displays the name of the device the Engineer's Terminal is connected to (i.e. Outstation), and the smaller window shows the address of the device. Until the Engineer's Terminal has been configured as described in Section 7.2 these windows are blank. For example, Figure 33 shows the screen before the Terminal has been configured; Figure 40 shows the screen after configuration.

7.2 Configure

This menu confirms the connection of the Engineer's Terminal to the host, and these options should be selected before using any of the remaining menu options.

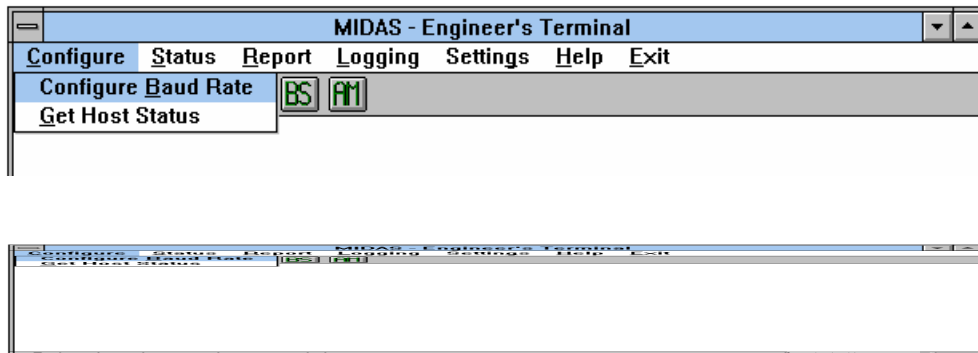


Figure 34 - Configure Menu Options

7.2.1 Configure Baud Rate

Choose from 9600, 4800 or 2400 baud speed for the Engineer's Terminal to communicate with the Outstation. Click on the <OK> button to confirm the entry and close the window. <Cancel> closes the window without making any change to the entry.

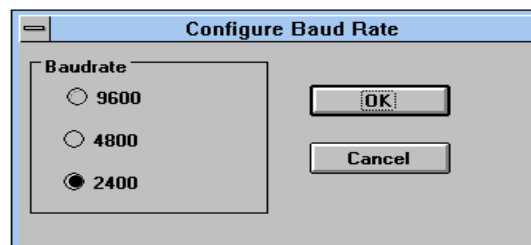


Figure 35 - Configure Baud Rate Dialog Box

7.2.2 Get Host Status

Selecting this option identifies the name and address of the device to which the Engineer's Terminal is connected. The information is then displayed in the status bar at the bottom of the window.

7.3 Status

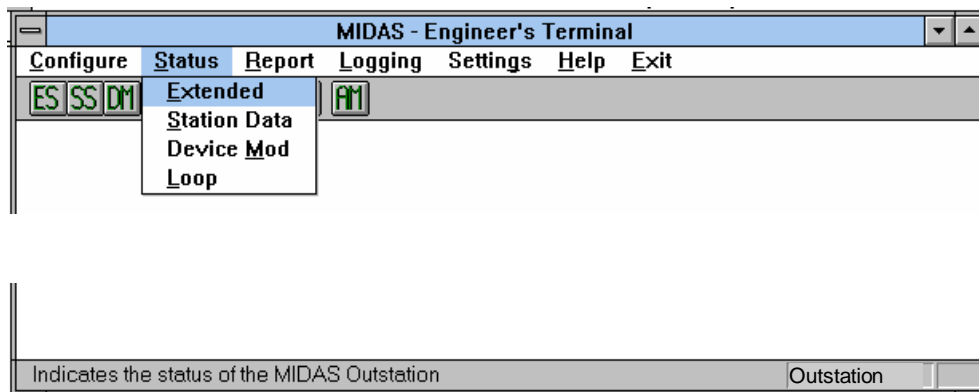


Figure 36 - Status Menu Options

7.3.1 Extended Status

This facility displays a view-only dialog box with the data taken from the Extended Status Reply message. Click on the <OK> button to close the window.

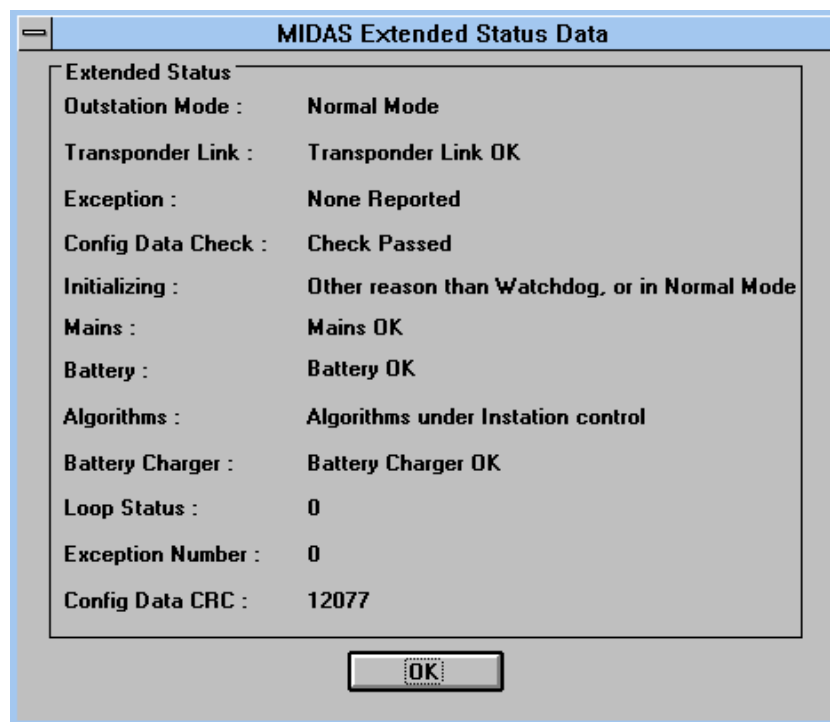
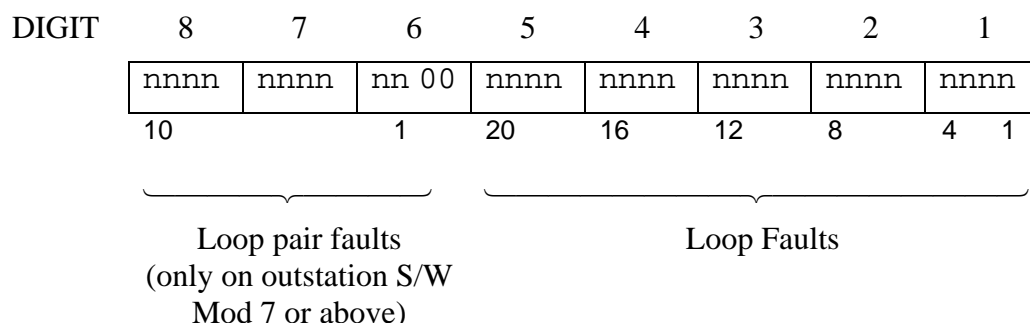


Figure 37 - Extended Status Data Dialog Box

Dialog Box Field	Possible Data	Explanation
Outstation Mode	Initialisation, Normal <i>or</i> Reserved mode	Current mode of Outstation
Transponder Link	Re-established <i>or</i> OK	Transitory indication – do not use
Exception	Exception reported <i>or</i> None reported	Fault/exception number reported, or not
Config Data Check	Failed/not done, <i>or</i> Check Passed	Status of configuration data check
Initialising	Watchdog reset, <i>or</i> Other reason than Watchdog, or in Normal Mode	Reason for initialisation
Mains	Failed <i>or</i> OK	Mains Status
Battery	Low <i>or</i> OK	Battery Status
Algorithms	Disabled by Outstation <i>or</i> Under Instation control	Status of algorithms
Battery Charger	Fault <i>or</i> OK	Battery Charger Status
Loop Status	0 – FFCFFFFFF (see Note 1)	Faulty loop / faulty loop pair
Exception Number	Matching exception code to loop	Fault/exception number. Reason for restart.
Config Data CRC	0 – FFFF	CRC

Table 10 - Extended Status Data Details

Note 1: For Engineering Terminal software issues greater than 4, the 8 digit HEX value has bits set to indicate loop faults as follows:



n = 1 indicates fault present
n = 0 indicates no fault.

For example, 0080000C indicates loop pair faults on loop pair 2, comprising loops 3 and 4.

Note: A loop pair fault is always mirrored by a pair of loop faults. A loop fault does not imply a loop pair fault. Loop pairs are allocated in site and lane order.

A loop pair is indicated faulty when there have been more than a configured number of vehicles detected (typically 10) on one of the loops in the lane, without any detections on the other loop. If the detector has a 'hard' fault, (e.g. open circuit loop), then the loop pair check is inhibited.

7.3.2 Device Modification

This facility displays a view-only dialog box with the data obtained from the Device Modification Reply message. Click on the <OK> button to close the window.

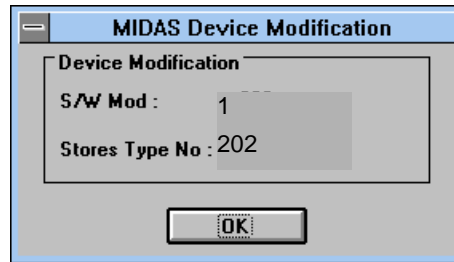


Figure 38 - Device Modification Dialog Box

Dialog Box Field	Possible Data	Explanation
S/W Mod	Number	Modification Number
Stores Type No	202 = Outstation original PROM PB751 0 = Export outstation PROM PB324	Store Type Code

Table 11 - Device Modification Details

7.3.3 Loop Status

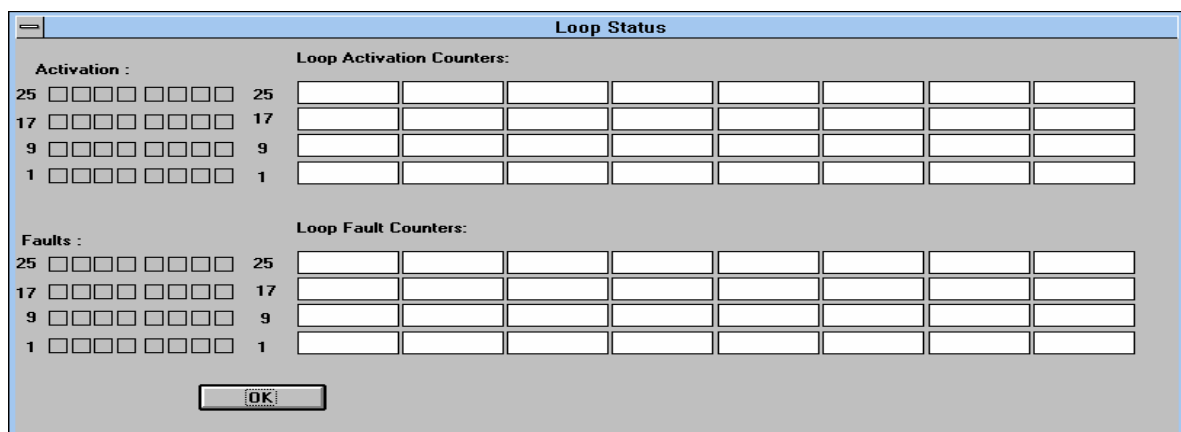


Figure 39 - Loop Status Dialog Box

This facility displays a view-only dialog box with the data obtained from the Loop Status message. Note that this box displays a 'snapshot' of the loop status - it will not update. The top

half of the screen displays loop activation data; when a loop is activated a cross appears in the relevant Activation box.

The lower half of the screen displays fault data; when a loop fault is detected a cross appears in the relevant Faults box.

If the outstation is configured to perform loop pair fault monitoring, the detection of the loop pair fault condition causes both of the loops in a lane to be indicated as faulty on this screen.

Click on the <OK> button to close the window.

7.4 Report

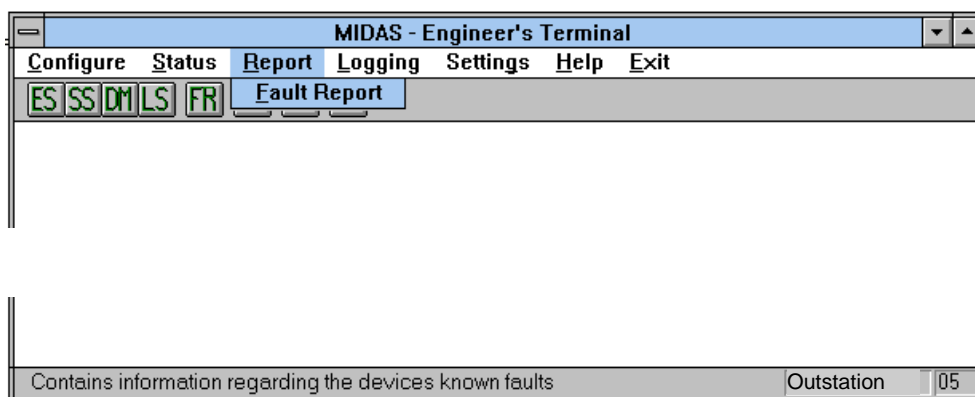


Figure 40 - Report Menu Option

7.4.1 Fault Report

This facility displays a view-only dialog box with the data obtained from the Fault Report message. Click on the <OK> button to close the window. Click on the <Save> button to save the contents of the window to a text file. You are prompted to enter a name and destination for the text file.

Access the text file and print the fault report (if required) using a text editor or word processor.

The faults and fault clearances are retained in the log in battery supported store. When the log has filled up completely, new fault entries overwrite the oldest ones. The outstation has no record of date, so the log only contains times of day.

Note: Software Mod 7 (see Device Modification command, section 7.3.2) does not put an entry in the fault log for loops which were already faulty prior to entering normal mode. Use the loop status command to check the current fault status of loops.

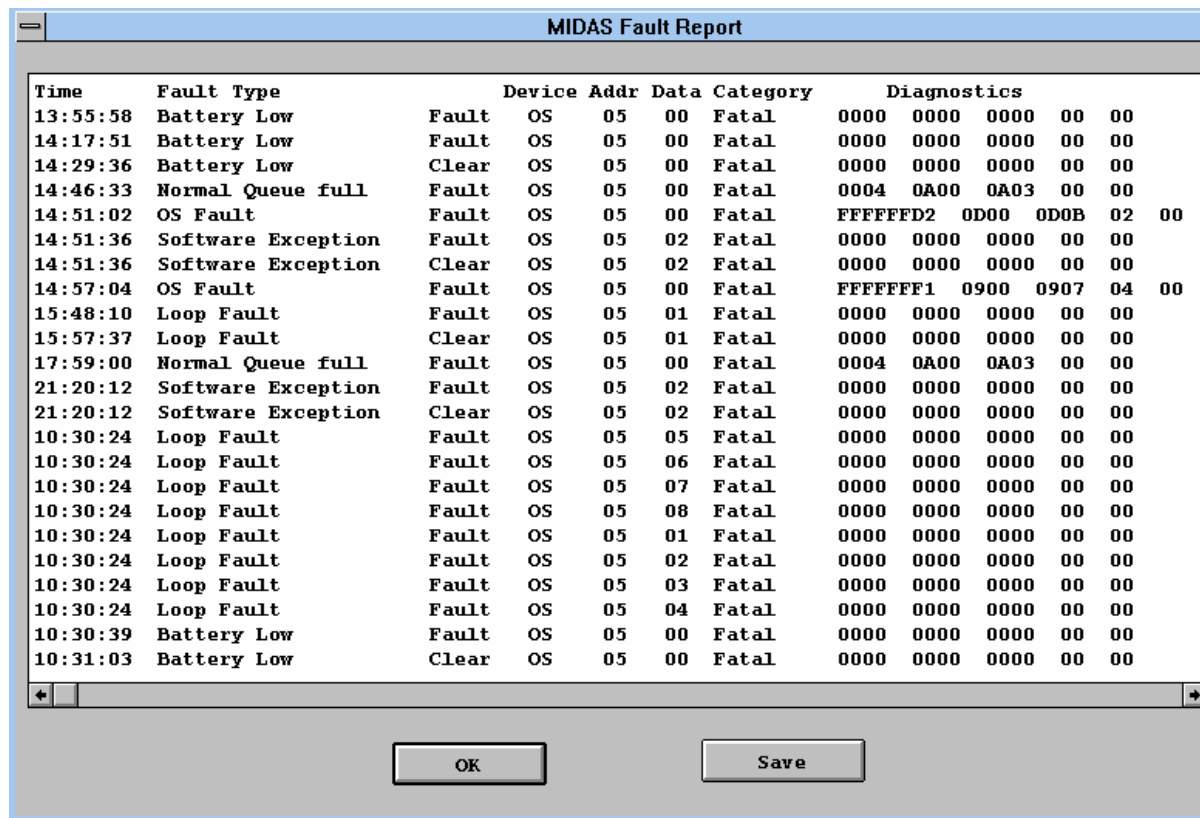


Figure 41 - Fault Report Dialog Box

Dialog Box Field	Possible Data	Explanation
Time	0-23 for hours, 0-59 for minutes, 0-59 for seconds	Time that the fault or clearance of fault occurred
Fault Type	Text	Name of the fault. See Section 6.3 for diagnosis and remedy for faults
Fault Status	Clear <i>or</i> Fault	Fault cleared or fault reported
Device	Outstation (O/S)	The device reporting the fault
Addr	Number	Address of the Outstation
Data	Number	Dependent on fault type - For detectors this shows the loop number. For engineering use only
Category	Fatal, Error <i>or</i> Warning	Category of fault
Diagnostics	Number	Dependent on fault type – for engineering use only

Table 12 - Fault Report Details

7.5 Logging

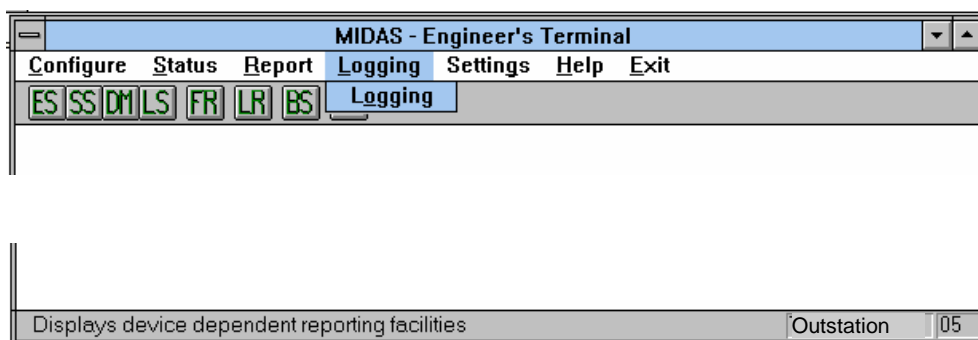


Figure 42 - Logging Menu Option

7.5.1 Logging

This facility first displays a dialog box as shown in Figure 43. The data to be displayed can be enabled or disabled, by clicking on the required check box(es). When a change is made in the window and the <OK> button is pressed a dialog box appears, "Are you sure you want to Enable/Disable these functions?"

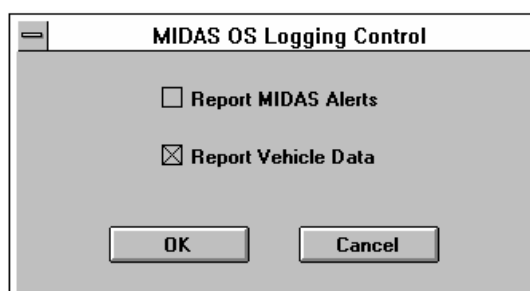


Figure 43 - Logging Control Dialog Box

The <Cancel> button closes the dialog box without saving any changes and re-displays the main screen (See Figure 33). The <OK> button closes the window and then a further window prompts for a file name and destination for the logging data. Make entries where appropriate on the screen and press <OK>. The <Cancel> button allows the data to be displayed without saving it to disk.

The Logging dialog box (Figure 44) then appears where messages are displayed as they are sent and received. This information may not be changed.

The <Pause> button in the Logging box stops the scrolling of messages in the window.

The <OK> button in the Logging box closes the dialog box.

The <Resume> button in the Logging box starts the scrolling of messages in the window again.

In the dialog box shown below, the first message is an Alert and all the others are vehicle data messages.

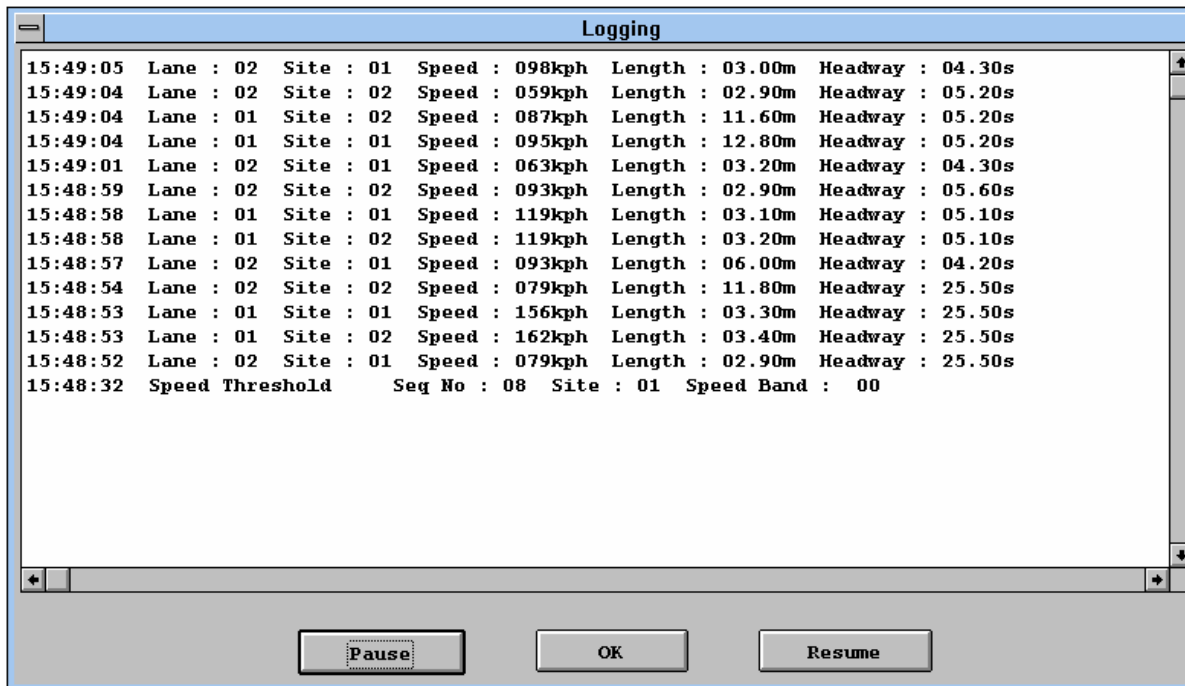


Figure 44 - Logging Report Dialog Box

Alert messages are presented in the following form:

Dialog Box Field	Possible Data	Explanation
Time	0-23 for hours, 0-59 for minutes, 0-59 for seconds	Time of the occurrence
Message Data	Text	Dependent on Type of Message
Sequence Number	Number	Alert sequence number
Site Number	Number	Dependent on Type of Message
Alert Data	0 - 255	Lane in Alert

Table 13 - Alert Logging Report Details

Vehicle Data messages are presented in the following form:

Dialog Box Field	Possible Data	Explanation
Time	0-23 for hours, 0-59 for minutes, 0-59 for seconds	Time of the occurrence
Lane Number	Number	The number of the lane within the site monitored by the loop
Site Number	Number	The number of the site containing the loop
Speed	Number	Vehicle speed in Km per hour
Length	Number	Vehicle length in 0.1m increments
Headway	Number	Vehicle headway in 0.1m increments

Table 14 - Vehicle Data Logging Report Details

7.6 Settings

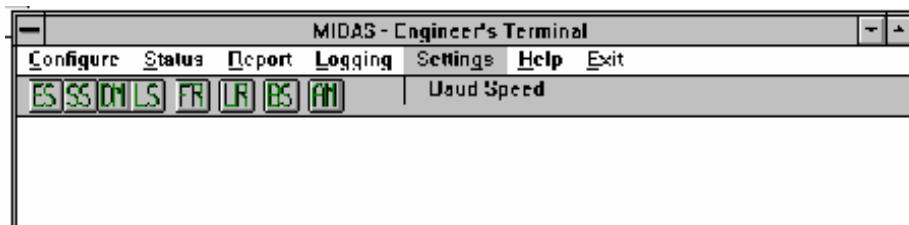


Figure 45 - Settings Menu Option

7.6.1 Baud Speed

This facility displays a dialog box with the data obtained from the Baud Rate Reply message. The data can be changed, by clicking on the required radio buttons. Click on the <OK> button to close the window, recording any changes made to the baud rates of individual links. Click on the <Cancel> button to close the window, without saving any changes.

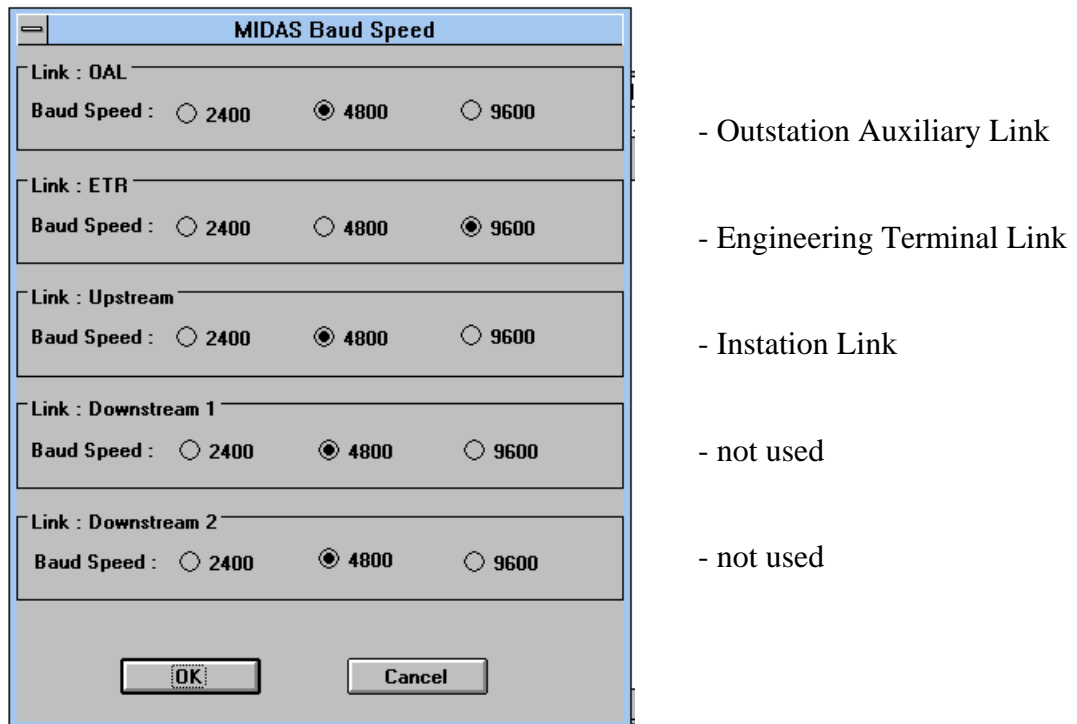


Figure 46 - Baud Speed Dialog Box

7.7 Help

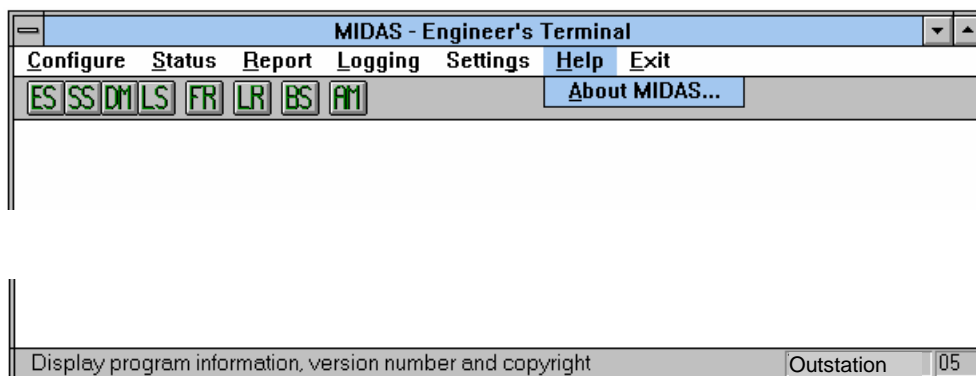


Figure 47 - Help Menu Option

7.7.1 About...

This facility displays a view-only dialog box with the data obtained from the “About” message. Click on the <OK> button to close the window.

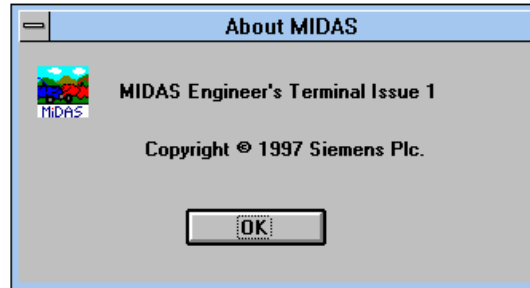


Figure 48 - About ... Dialog Box

7.8 Exit

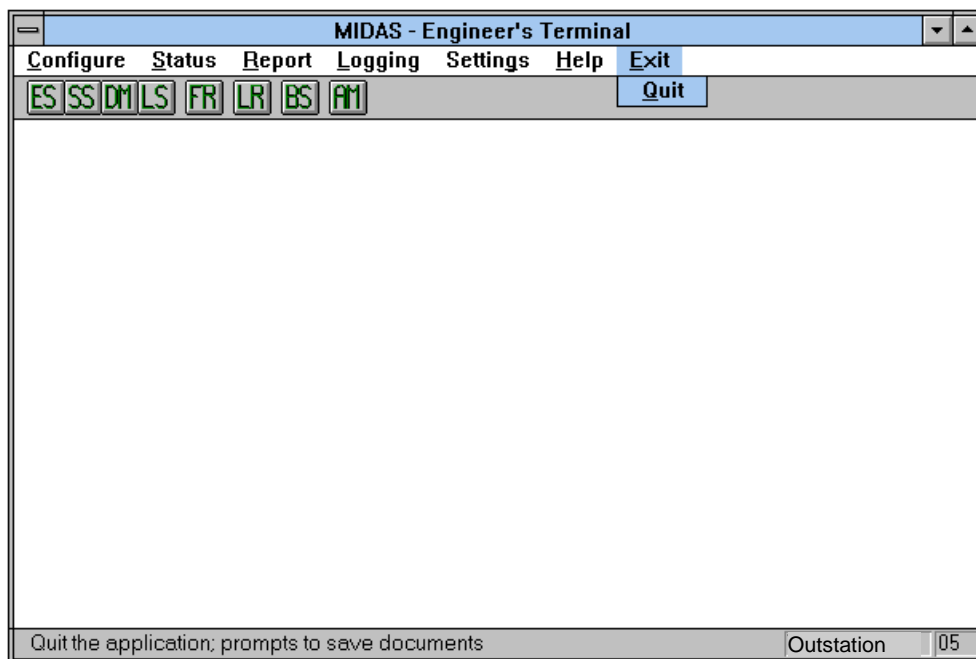


Figure 49 - Exit Menu Option

7.8.1 Quit

This facility exits the application.

8. TECHNICAL SPECIFICATION

8.1 Physical Characteristics

		Unpackaged - unit only	Packaged with installation kit
Size	height	130 mm	225 mm
	width	480 mm	580 mm
	depth	240 mm	465 mm
Approx. Weight	without battery	3.0 Kg	7.2 Kg
	with battery	5.8 Kg	10.0 Kg

8.2 Power Requirements

	Mains Input
Voltage	85 - 260V AC
Frequency	47 - 440Hz
Rated current	150mA

8.3 Features

‘CE’ Certified.

An Outstation can sample up to 20 loops when fully populated with 5 detector PCBs.

It reports averages for speed, occupancy, headway and flow over a configurable interval.

It provides alarms when there is a configurable change in average speed or flow at a site.

It provides alarms when there is a high occupancy condition in a lane.

8.4 Safety

Meets Electrical Safety requirement BS EN 60950.

Meets Telecommunications Safety requirement EN 41003.

8.5 EMC

Vehicle Detector Outstations meet emission and susceptibility requirements of UK Highways Agency specification TRG 1068, with the exception of the Detector Loop operating frequency, which complies with MPT 1337.

8.6 Environmental Information

Operating temperature from -15°C to 65°C.

Humidity +95% (non-condensing).

8.7 Data Rates

Standard rates 2400, 4800, 9600.

Other rates programmable up to 38,400.

8.8 Battery Backup

Lead acid battery support - 20 hour operation.

SRAM memory support - 1 year.

8.9 Lightning Protection

Meets the requirements of CCITT K20.

8.10 Processor

32 bit Embedded Power PC.

Up to 512KByte PROM, 1Mbyte SRAM (Battery backed).

4 Synchronous/Asynchronous Isolated RS485 ports.

2 Synchronous/Asynchronous RS232 ports.

1 Asynchronous RS232 port.

Joint Test Action Group (JTAG) Interface.

Real Time Clock.

8.11 Engineer's Terminal

The hardware needed to run the Engineer's Terminal software is a standard (IBM compatible) portable PC with a suitable lead to connect to the 9 pin 'D' type socket located on the front of the Power PC Processor PCB.

The PC must have the following features as minimum requirements:

- Processor of the 80386 family e.g. '386, '486, Pentium.
- 4 Mb of RAM.
- Hard disk drive with minimum capacity 40Mb ("C" drive).
- 1 x integral floppy disk drive (3.5", 1.44Mb) or access to one.
- 1 x RS232C 9 way serial port with cable connections defined in Figure 50 below.
- 1 x standard 25 pin parallel printer port.
- Operating system MS-DOS® (version 3.3 minimum) or Microsoft® Windows® 95.
- Microsoft® Windows® version 3.1 or greater.
- Standard size display screen (80 column x 25 lines) CGA compatible, colour or monochrome.
- Power supply from mains (with adapter) and batteries (rechargeable).
- Full QWERTY keyboard.

In addition, a mouse or trackerball would be a desirable option.

Note that where a PC-based IES Simulator is available it may be possible to use the serial port on this to implement the Engineer's Terminal function. However the Engineer's Terminal interface in the Outstation requires that the Outstation is communicating with an Instation or suitable simulator. Therefore if a single PC is used for both functions, it must be have suitable multitasking capability. The User must ensure that the PC is suitable.

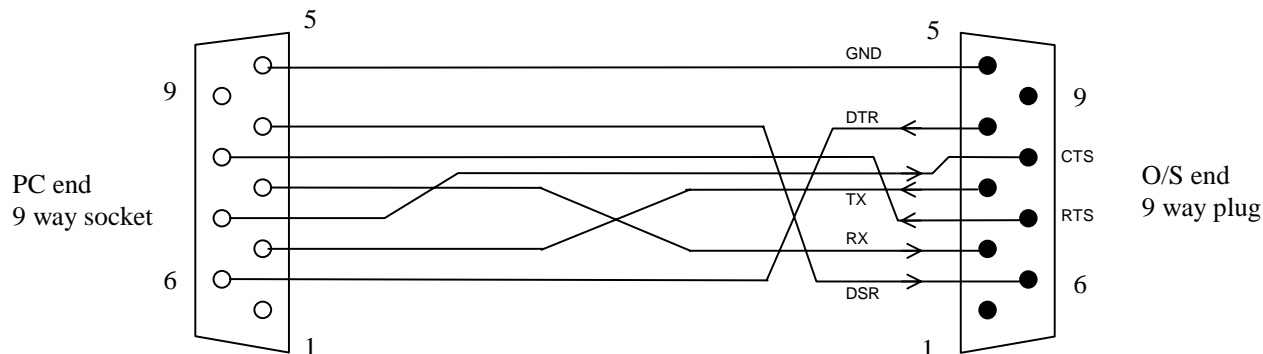


Figure 50 - Cable for Engineer's Terminal

The part number of the software for the Engineer's Terminal is 667/1/26752/000.

8.12 Loop Detector PCBs

Number of loops - 20 (maximum).

Meets the requirements of United Kingdom Highways Agency specification TR0100A.

The Loop Detector is a scanning 4-channel detector with a single Eurocard outline. It meets the requirements of United Kingdom Radio Regulation MPT 1337.

The front panel has the following features:

- Three sensitivity switches per channel.
- One presence time switch per channel.
- Reset button.
- Lamp button.
- Fault and Detect LEDs.

Power supply and current	either A: 5V DC at 60mA current
	12V DC at 20mA current
	or B: 24V DC at 80mA current
Environmental	-15°C to 65°C up to 95% humidity
Size	160mm x 100mm x 25mm
Inductance Tuning Range	50µH to 300µH (plus feeder inductance)
Feeder Length	0 - 200 metres
Operating Frequency	20kHz to 110kHz
Vehicle Speed Range	0 to 195 km/h using loops 2m in direction of travel

APPENDIX A - MATERIALS

Materials for loop backfilling

Epoxy resin type PX212ZE is available from:

Robnorganic Systems Ltd.

Hunt Rise

South Marston Park

Swindon

Wiltshire

SN3 4TE

Tel: (44) 1793 823741

Fax: (44) 1793 827033

Hot pour bitumen compounds type R85 and R95 are available from:

Colas Construction Ltd.

Gabriels Wharf

Water Lane

Exeter, Devon

EX2 8BZ

Tel: (44) 1392 207 201

Note that the two digits following the 'R' indicate the softening temperature of the compound in degrees Celsius. The R95 is recommended in hotter climates.

Materials for cabinet base sealing

Global Resins Telephone (44) 1225 812 201

Cable termination accessories

Charles Endirect Telephone (44) 1935 815 001

APPENDIX B - TECHNICAL DRAWINGS

This Appendix contains the following drawings:

667/GA/26767/000	Outstation
667/GA/26775/ETC	Detector Loop Cable Assembly
667/GA/26771/ETC	Comms I/O PCB Kit
667/GA/26601/ETC	Power Processor PCB Assembly
667/GA/20982/ETC	RS485 Line Protection Module Assembly
667/GA/26761/000	Backplane PCB Assembly
667/GA/26759/ETC	Outstation Detector PCB

The drawings in this Appendix are not included in the page numbering of this document.

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