SIEMENS

Mobility, Intelligent Traffic Systems
Sopers Lane, Poole, Dorset, BH17 7ER

ST950 ICM Handbook

667/HE/45950/000

for

ST950ELV

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SAFETY INFORMATION

IT IS RECOMMENDED THAT DUE TO THE HAZARDS PRESENT WITHIN THE CONTROLLER CABINET ALL POWER TO THE CABINET IS DISCONNECTED BEFORE REMOVING OR INSTALLING ANY EQUIPMENT INTO THE CABINET. WHERE A RISK ASSESSMENT AND METHOD STATEMENT FOR THE WORKS TO BE COMPLETED AND / OR THE INSTRUCTIONS

FOR THE OEM EQUIPMENT BEING INSTALLED OR REMOVED ALLOWS, LIVE WORKING MAY BE CONSIDERED.

Safety of Maintenance Personnel

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

- Only skilled or instructed personnel with relevant technical knowledge and experience, who are also familiar with the safety procedures required when dealing with modern electrical/electronic equipment are to be allowed to use and/or work on the equipment. All work shall be performed in accordance with the Electricity at Work Regulations 1989 or the relevant local, state and government regulations.
- Such personnel must take heed of all relevant notes, cautions and warnings in this Handbook and any other Document or Handbook associated with the equipment including, but not restricted to, the following:
- The equipment must be correctly connected to the specified incoming power supply.
- The equipment must be disconnected / isolated from the incoming power supply before removing any protective covers or working on any part from which the protective covers have been removed.
- Any power tools must be regularly inspected and tested.
- Any ladders used must be inspected before use to ensure they are sound and not damaged.
- When using a ladder, before climbing it, ensure that it is erected properly and is not liable to collapse or move. If using a ladder near a carriageway, ensure that the area is properly coned and signed.
- Any personnel working on site must wear the appropriate protective clothing, e.g. reflective vests, etc.

In the event of any person working elsewhere on the junction, it is recommended that the Mains Supply to the controller be switched off and the master switch locked in the ‘off’ position.

If you are not certain that the entire system is ELV, you must switch off the Mains Supply to the controller and lock the Master Switch in the ‘off’ position.

If the controller uses an Expansion Cabinet, and in the exceptional circumstances that the expansion cabinet also needs a mains supply (to be avoided wherever possible), then the supply to the expansion cabinet must also be switched off and the master switch in the expansion cabinet locked in the off position.

To ensure and guarantee isolation the double pole master switch should be opened.

When re-commissioning signals, the following sequence is recommended to ensure that the correct signal startup sequence is followed:

- Switch OFF the controller at the main switch
- Switch ON the lamps at the Manual Panel on/off switch
- Switch ON the controller at the main switch

More specific safety information is given in the text of the handbook, where it relates to particular activities or situations.

For Hardware Fail Flash (HFF) Controllers Only (non UK only):

If the controller needs to be changed to HFF after being installed (non UK only) the following procedure must be followed:

- Ensure that the power to the controller is switched off
- Move the "Flash" switch (S3) on the CPU Card to its non-HFF position
- Ensure that the link on the HPU is in the HFF position
- Run the Controller Self-Test and confirm that it indicates that the controller hardware is set up for HFF. Note that the signals will not flash when the controller is powered because the switch on the CPU Card is in the non-HFF position
- Switch off the power to the controller
- Move the switch on the CPU Card to its HFF position
- Switch on the power to the controller and ensure that the correct traffic signals flash as the controller starts

There are various RJ45 connectors used to connect to peripheral cards within the ST950 family of controllers. Most are **not** Ethernet ports and should not be connected to other equipment, including PCs.

To isolate the equipment, the Master Switch must be in the "Off" position.

Removal of the Electricity Board Fuse or Switching the Controller switch or the Manual Panel Signals On/Off switch to "Off" does not guarantee isolation of the equipment.

Controllers require specific configuration to enable them to function correctly when installed.

The configuration process is a complex activity and should only be carried out by persons who are adequately trained, have a full understanding of the needs of the county or region were the controller is to be used and are experienced in the tasks to be undertaken.

Do not connect any device that has not been specifically designed or tested for compatibility with the ST950ELV system. If in doubt, contact Siemens Poole for further information.

ST950ELV compatible equipment such as Helios ELV traffic signals, near-side pedestrian signals and ELV LED regulatory signs are all clearly marked "ELV". If equipment is not marked "ELV" then additional care should be taken to ensure that it is suitable for use in an ELV system.

Safety of Road Users

It is important that all personnel are aware of the dangers to road users that could arise during repair and maintenance of traffic control equipment.

Ensure that the junction area is coned and signed as necessary to warn motorists and pedestrians of any dangers and to help protect the personnel working on the site.

Whilst repairing signals which are in an "all-out" condition, care must be taken to ensure that no spurious signals are lit during testing which could mislead drivers or pedestrians. Particular care is required where pedestrian audible devices are installed, to ensure that no false indications are given during, for example, cable testing. Personnel should also ensure the safety of pedestrians, especially children, who may come into contact with parts of the controller or signal poles.

Safety Warning - Lithium Battery

This equipment may contain a Lithium coin cell (battery) if the optional RTC battery backup kit is installed.

Do not short circuit, recharge, puncture, take apart, incinerate, crush, immerse, force discharge, ingest or expose to temperatures above the declared operating temperature range of the product, otherwise there is a risk of fire or explosion.

Batteries should be handled and stored carefully to avoid short circuits. Do not store in disorderly fashion, or allow metal objects to be mixed with stored batteries. Keep batteries between -30°C and 35°C for prolonged storage.

The battery is a sealed unit which is not hazardous when used according to these recommendations. Do not breathe vapours or touch any internal material with bare hands should the cell become damaged in any way.

Battery disposal method should be in accordance with local, state and government regulations. In many countries, batteries should not be disposed of into ordinary household waste. They must be recycled properly to protect the environment and to cut down on the waste of precious resources.

Important ELV Considerations

To provide the most reliable operation, Siemens ELV controllers use a DC (unsmoothed) lamp supply, which in common with DC powered telecommunication equipment, is negative with respect to earth so as to avoid electrochemical corrosion effects.

To maintain all street voltages within ELV limits, equipment outside the cabinet must be supplied with voltages within the band -48V RMS with respect to earth. Voltages positive with respect to ground / earth will result in overall voltages within the system being in excess of the ELV limit as defined by BS7671.

Care should be taken to ensure that no LV (Mains Voltage) equipment is installed within the ELV street furniture as this will result in risks to personnel and risk of catastrophic failure of ELV equipment should such voltages be applied to the ELV equipment by accident.

The Siemens ELV controller has been designed and proven to meet the following requirements for Protective Extra Low Voltage (PELV) and the operation of a signal compliance monitoring system with ELV voltages:

1) The Siemens ELV system is PELV and the earth is connected all the way through, as allowed for in BS7671 414.4.1. The source is a safety isolating transformer to BS EN 61558-2-6 as allowed in 414.3 (i). Protective Isolation within the controller cabinet is achieved between the PELV circuits and those higher than band I by **ALL** conductors having insulation rated for the highest voltage 250V, as mandated for in 414.4.2 (iii), and where the parts of the circuits are not wires / conductors, then physical isolation as allowed for in 414.4.2 (v) may be used.

   Any third party ELV sources installed in this system should follow the same guidance, re-isolation and insulation and should adopt the same polarity and voltage range to avoid voltages in excess of ELV band 1 being present in the signalling / street furniture part of the system.

2) Terminations are IP2X (British standard finger proof i.e. not accessible to solid items of 12.5mm or greater).

Any third parties making alterations to such equipment / PELV installations must consider the electrical requirements for PELV and the above in what they do, and should only attempt such alterations if they are competent to do so.

The controller monitors its signal outputs for both positive and negative voltages with respect to earth for its conflict system. In order to ensure the ELV voltage band is maintained,

positive voltages with respect to earth are clamped by the controller. Should a positive voltage be applied to the signal outputs, the controller will consume current to maintain a maximum positive voltage of approximately 0.8 volts at the controller terminals.

Should a source with a large current sourcing capability be applied, catastrophic damage may result. The extent and results of such damage cannot be predicted or guaranteed.

Contents

Change History

Version	Date	Change	Author
1	October 2013	Initial Draft	C. Rabe
2	January 2014	TS007325	C. Rabe
3	May 2014	TS007424	K.R.Napper
4	Jan 2015	TS007870	H. Smyth
5	February 2016	TS008205	K.R.Napper
6	December 2018	TS009064	N. Atkinson
7	January 2020	TS008377	M. Jeerh

The electronic version of this handbook can be found on the Siemens website www.siemens.co.uk/traffic in the Handbooks section under Downloads.

1 INTRODUCTION

1.1 Purpose

The purpose of this handbook is to describe the procedures for the Installation and Commissioning of the ST950 ELV Controller and to provide guidance on routine maintenance and fault finding.

This handbook has been created in accordance with the requirements of BS EN 12675:2001 and BS 7987:2001.

Ongoing development means that some of the delivered items may differ in detail from the photographs included in this handbook.

1.2 Contact Us

If you have any comments on this handbook, or need any further information, you can contact us at trafficwebmaster.stc@siemens.com.

1.3 Reference Documents

1.3.1 Controller (Essential)

Publisher	Reference Number	Document Title
ITS	667/SU/46000/000	Use of ST950 Firmware and Hardware Configurations
ITS	667/HB/46000/000	ST950 Family General Handbook
ITS	667/HH/46000/000	ST950 Family Handset Handbook
ITS	667/HU/46000/000	ST950 User Interface Handbook
ITS	667/DA/46000/002	ST950ELV UK Power Circuit Diagram
ITS	667/GA/32900/ETC	ELV Top Level General Assembly

1.3.2 Cabling (Essential)

Publisher	Reference Number	Document Title
ITS	667/HE/20664/000	Installation and Commissioning Handbook - Installation Testing (General)
ITS	667/HE/20663/000	Loop Detector and Cable Terminations – Installation and Commissioning

1.3.3 Ancillary Equipment

Publisher	Reference Number	Document Title
ITS	667/HE/20662/000	Installation & Commissioning – Signals & Poles

ITS	667/HE/20665/000	Installation and Commissioning Handbook 5 - Above Ground Detectors
ITS	667/HB/32600/000	Gemini2 Traffic Outstation Handbook
ITS	667/HB/27663/000	ST4R/ST4S Loop Detector Handbook
ITS	667/HB/45200/000	SLD4 Loop Detector Handbook
ITS	667/HB/30000/000	Helios General Handbook

1.3.4 Intersection Design

Publisher	Reference Number	Document Title
ITS	667/DS/20664/048	Traffic Signal Junction Cable Design & Certification for ELV Systems
ITS	667/HE/31699/000	Loop Inductance and Turns Calculation Spreadsheet
ITS	667/DJ/27000/000	Controller Forms User's Handbook
ITS	667/DZ/45950/000	ST950ELV Family Tree
ITS	667/DZ/46950/000	ST950 Family Tree
ITS	667/HB/20168/000	IC4 Configurator Handbook

1.4 Pre-Requisites

Before reading this handbook, you should be familiar with the ST950 General Handbook 667/HB/46000/000.

Anyone undertaking installation, commissioning and first line maintenance on the ST950 family of controllers will also need the ST950 User Interface Handbook (667/HU/46000/000) which provides details of how to connect to the controller and the different user interfaces which are available. If the handset interface is chosen to be used then the ST950 Handset Commands Handbook (667/HH/46000/000) will also be required.

1.4.1 Qualifications

Only skilled or instructed personnel with relevant technical knowledge and experience, who are also familiar with the safety procedures required when dealing with modern electrical/electronic equipment, are to be allowed to use and/or work on the equipment. All work shall be performed in accordance with the Electricity at Work Regulations 1989 or the relevant local, state and government regulations.

Any personnel working on the ST950 family of controllers should have completed the following training courses:

- HA Sector Scheme Sector 8 Modules 5XX
- M609 – Junction Traffic Controller Maintenance for ST950 / ST950ELV

Training requirements for non UK users may be different.

1.4.2 Required Tools

In addition to a standard Engineer's tool kit, the following tools are required when carrying out any work on the ST950 family of controllers.

User Interface

One of the following is required depending on the user interface chosen to be used during the installation.

Description	Part Number
Compatible browser + USB cable (A to B)	
Compatible terminal emulator + USB cable (A to B)	
Netbook kit + USB cable (A to B)	667/1/32380/000
Serial handset Techterm + RS232 cable	667/4/13296/001
Old Oyster handset + RS232 cable	667/4/13296/000
Larger Screened Oyster handset + RS232 cable	667/4/13296/002

Cabinet Access

One or more of the following will be required to gain access to the controller cabinet.

Description	Part Number
T-bar key	667/2/20234/000
S-18 key – Main Cabinet *	4/MC 289
Manual Panel key Type 900	667/4/13651/000

* - In some areas customers specified keys may be used

1.4.3 Spares

See the appendix for a full list of spares that are necessary when carrying out a site visit to the controller, whether for installation, commissioning or maintenance.

1.5 Definitions

Item	Definition
Bit	Binary digit (i.e. `0' or `1')
Byte	Eight bit data array (i.e. bits 0-7, and 8-15 are bytes)
Configuration data (aka Customer Data) and site specification	Data supplied by the customer as to how the controller is to function. It is recommended that the Controller Forms Handbook be used as the blank form for this.

EM	Controller identification number (ElectroMatic).
CIC	Configuration Identity Code (equivalent to EM above)
GVP	Generic Versatile Platform - used by ST950 and other Siemens products to provide general services such as comms, user interface, etc.
STS (Site to Scale)	A scale drawing of the intersection including controller position, detector loop positions and specification, cable routing and poles with signal head arrangements.
Word	Two-byte data array (i.e. bits 0-15 constitutes a data word)
Works Specification	Document produced by Siemens, which details the hardware required for the controller and includes Site Data, usually in the form of a printout of the data entered on the configurator.

1.6 Abbreviations

Abbreviation	Meaning
AC	Alternating Current
CLF	Cableless Linking Facility
CLU	Cableless Linking Unit
CPU	Central Processing Unit
CRC	Cyclic Redundancy Code
CRL	Certificate Revocation List
DC	Direct Current
DFM	Detector Fault Monitor
DHCP	Dynamic Host Configuration Protocol
DNS	Domain Name System
DPR	Dual Port RAM
ELV	Extra Low Voltage
GSPI	Generic Serial Peripheral Interface
HI	High Intensity
HFF	Hardware Fail Flash
HPU	High Power Unit
HTTP	Hypertext Transfer Protocol
HTTPS	HTTP Secure
IC4	Intersection Configurator v.4 (UK controller configuration application)

IDB	Intelligent Detector Backplane
I/O	Input/Output
ITS	Intelligent Traffic Systems
KOP	Kit of Parts
LED	Light Emitting Diode
LMU	Lamp Monitoring Unit
LPU	Logic Power Unit
LSLS	Lamp Switch Low-Voltage Serial
NTP	Network Time Protocol
OCSP	Online Certificate Status Protocol
OTU	Outstation Transmission Unit
OSS	Outstation Support Server (may be stand-alone or part of Stratos)
PCB	Printed Circuit Board
PI	Periodic Inspection
PROM	Programmable Read Only Memory
RAM	Random Access Memory
RCD	Residual Current Device
rms	Root Mean Square
RMS	Remote Monitoring System
RTC	Real Time Clock
SA	Speed Assessment
SDE	Speed Discrimination Equipment
TCP	Transmission Control Protocol
TLS	Transport Layer Security
UDP	User Datagram Protocol
UTC	Urban Traffic Control
VA	Vehicle Actuated

1.7 Third Party Information

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Product Development
Engineering Department
Siemens Mobility Intelligent Traffic Systems
Sopers Lane
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Dorset
BH17 7ER
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All open source software components used within the product are listed on the controller's web and mass storage device interfaces.

1.8 Trademarks

The following terms used in this document are trademarks of their respective owners:

- Android is a trademark of Google Inc.
- Linux is the registered trademark of Linus Torvalds in the U.S. and other countries.
- SD is a trademark of SD-3C, LLC in the United States, other countries or both.
- USB is a trademark of USB Implementers Forum, Inc.
- Windows is a registered trademark of Microsoft Corporation in the United States and other countries.

2 SYSTEM OVERVIEW

The Siemens ST950ELV family is the latest in a long line of highly integrated traffic controllers.

The ST950ELV Controller can be supplied either in a single-door outer case with a 6U logic rack and equipment mounting frame or as a fr5ee-standing rack housing the power supply, CPU card and Lamp Switch cards with space for up to 16 x 4 channel detector cards.

2.1 Features

The main features of the ST950 family are:

- Conforms to the UK Highways Agency specification TR2500
- 32 phases, 32 stages.
- 8 streams.
- 8 maximum green sets.
- 8 hurry calls which are in priority order.
- 8 uni-directional detector loop units.
- Multi-mode operation with stage ripple change facility for improved intersection capacity.
- Fully integrated MOVA7, UTMC OTU and Stratos monitoring functionality
- Fully integrated Light Rapid Transport (LRT) mode for use at Tram / Road intersections.
- Fully configurable lamp sequences for worldwide application.
- Fully integral and configurable lamp monitoring facility.
- Flexible part-time and start-up modes, allowing any stream to be sent in and out of part-time mode without affecting any others.
- Cableless linking (Plan) facility with sophisticated plan timetables and 32 plan groups.
- Event timetable which supports actions based on 32 independent events with easy programming.
- Time system with full date details – automatically time synchronised to central system where the controller linked to Siemens UTMC central system.
- Date stamped rolling log providing detailed history of events and faults, coupled with improved presentation to aid recognition of entries.
- Uncomplicated web browser user interface capable of multi-language support
- Support for up to 240 I/O lines via I/O cards and Intelligent Detector Backplanes
- RS232 and USB interfaces for handset, modem and GPS
- Major configuration changes with signals on

The essential differences between the ST900ELV and the new ST950ELV family of controllers are:

- New CPU Card providing additional functionality and interfaces
- Improved user interfaces including web pages
- I/O card firmware can be updated in-situ.
- Support for existing ST900 equipment such as Gemini and Gemini^2
- Integral MOVA7, OTU functionality and Stratos monitoring options
- Removable Storage device contains junction specific data allowing fast repair by card replacement and storage device transfer
- Extended features licensed through encrypted license card
- Integrated Ethernet interface
- USB interfaces for handset, memory devices, and license card readers
- The ST800/ST900 Extended System Bus interface is no longer provided on the ST950 which means that the IRM, OTU Card, SDE/SA Card no longer supported

2.2 System Components

CPU Card

The CPU Card performs all high level control functions for the junction and communicates with the peripheral I/O cards using high speed serial communication protocols. The physical interfaces are the same as those used in the ST900 family of controllers. An updated I/O card protocol improves system performance and adds functionality. This protocol is known as GSPI - Generic Serial Peripheral Interface. Older I/O cards will need to be updated to allow communication with the ST950. ST950 compatible I/O cards are easily recognized by the text 'I/O CARD 667/1/32990/95x' printed on the board cover.

ELV Lamp Switch Card(s)

ELV Lamp Switch cards (LSLS) provide 32 undedicated switched outputs. The cards and are located within the cabinet and are plugged into a backplanes that terminates the street cables. Very large intersections may have additional Lamp Switch, I/O and Intelligent Detector Backplane cards located in an adjacent cabinet for ease of installation and maintenance.

Power Supplies

The High Power Unit (HPU) module distributes the 48V lamp supply from the Lamp Supply Transformer to the LSLS cards and incorporates the Dim/Bright, A and B relays. This module is mounted on the left hand side of the cabinet close to the lamp supply transformer.

The Logic Power Unit (LPU) module provides logic supplies to the CPU Card and I/O cards and is housed within the 19” logic rack.

I/O Cards

I/O cards take a number of forms, all of which are GSPI peripherals:

- 24in 16out panel mounted module - 667/1/46085/001
- 24in 4out panel mounted module - 667/1/46085/002
- Intelligent Detector Backplane - 667/1/32910/950
- ST950 CPU I/O kit 24in 4out - 667/1/46014/000
- WiMag Standard Interface kit - 667/1/47210/100

The panel mounted modules 667/1/46085/xxx are mounted on the rear panel of the controller cabinet and allow direct termination of street cabling without resorting to the use of additional terminal blocks and soft wire conversion kits.

The ST950ELV CPU I/O card cannot be used in a standard ST950ELV cabinet, it can only be used in 3rd party cabinets.

The Intelligent Detector Backplanes are mounted in the rack. These provide support for the connection of up to 4 standard Loop Detector Cards such as Siemens SLD4. The Backplane connects via a ribbon cable to the Loop Termination Board mounted on the cabinet rear panel. The Loop Termination Board provides the termination point for 16 Loop Feeder pairs without the use of additional terminal blocks and twisted wire kits.

All Loop Detector Cards are powered from a dedicated output of the HPU.

The main components of the ST950 ELV system are shown in Figure 1.

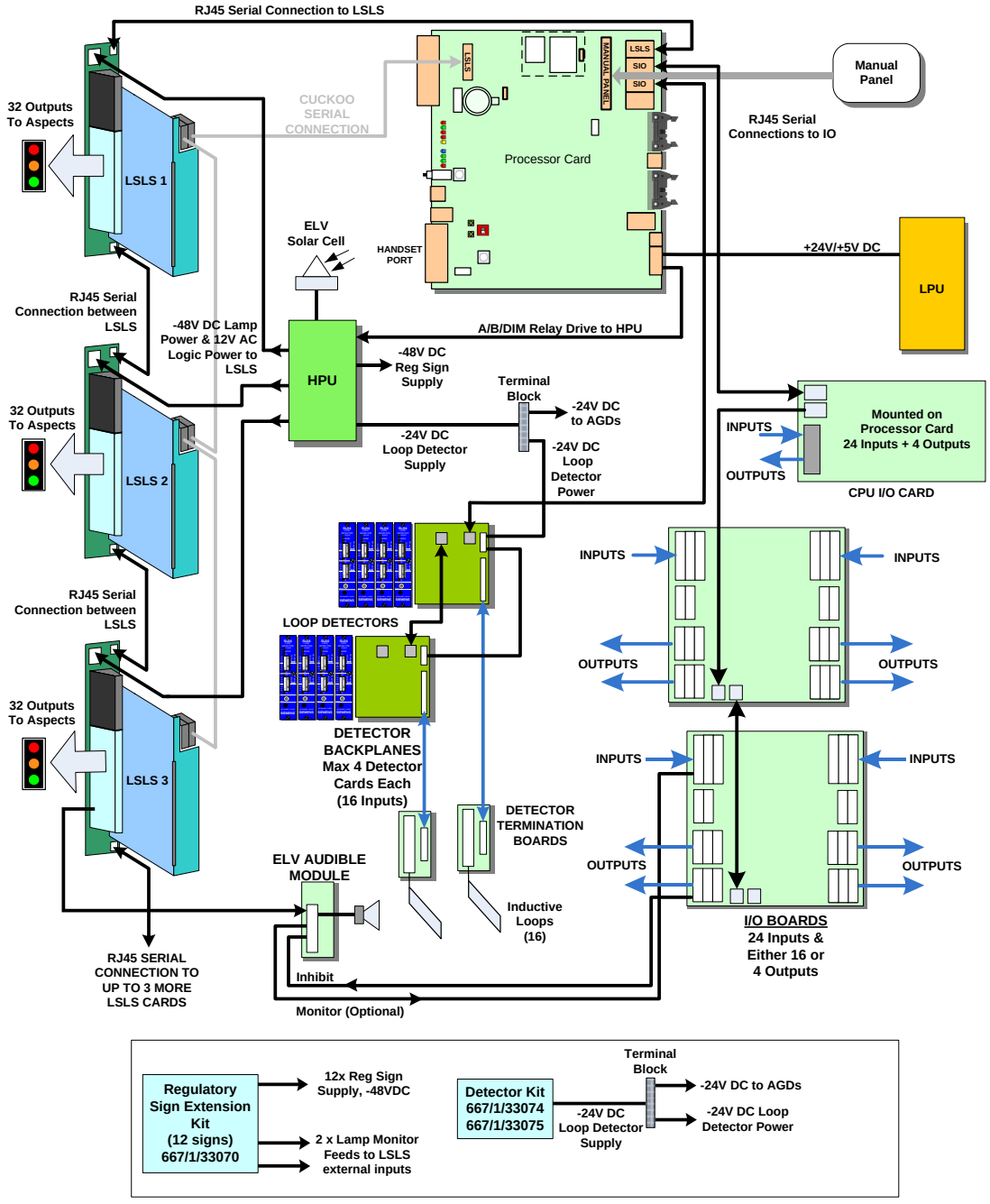


Figure 1 – System Overview

3 ELV HARDWARE OVERVIEW

3.1 The ELV Controller Primary Cabinet

Figure 2 and Figure 3 show the ST950 ELV controller fitted in an ST950 ELV Controller Cabinet.

CET bars are installed in the base of the cabinet. The Master Switch Panel and two LSLS cards are all installed on the right hand side panel of the cabinet. The Lamp Supply Transformer, HPU, third LSLS card and miscellaneous equipment are installed on the left hand side panel of the cabinet. Up to three I/O cards, loop termination cards, Audible Driver Modules, termination blocks and two sets of Cable Trunking are installed on the rear panel of the cabinet.

The 19” Controller Rack is installed in an equipment frame at the front of the cabinet; this frame can be swung open to enable access to the rear of the frame and to the cards and components installed in the cabinet.

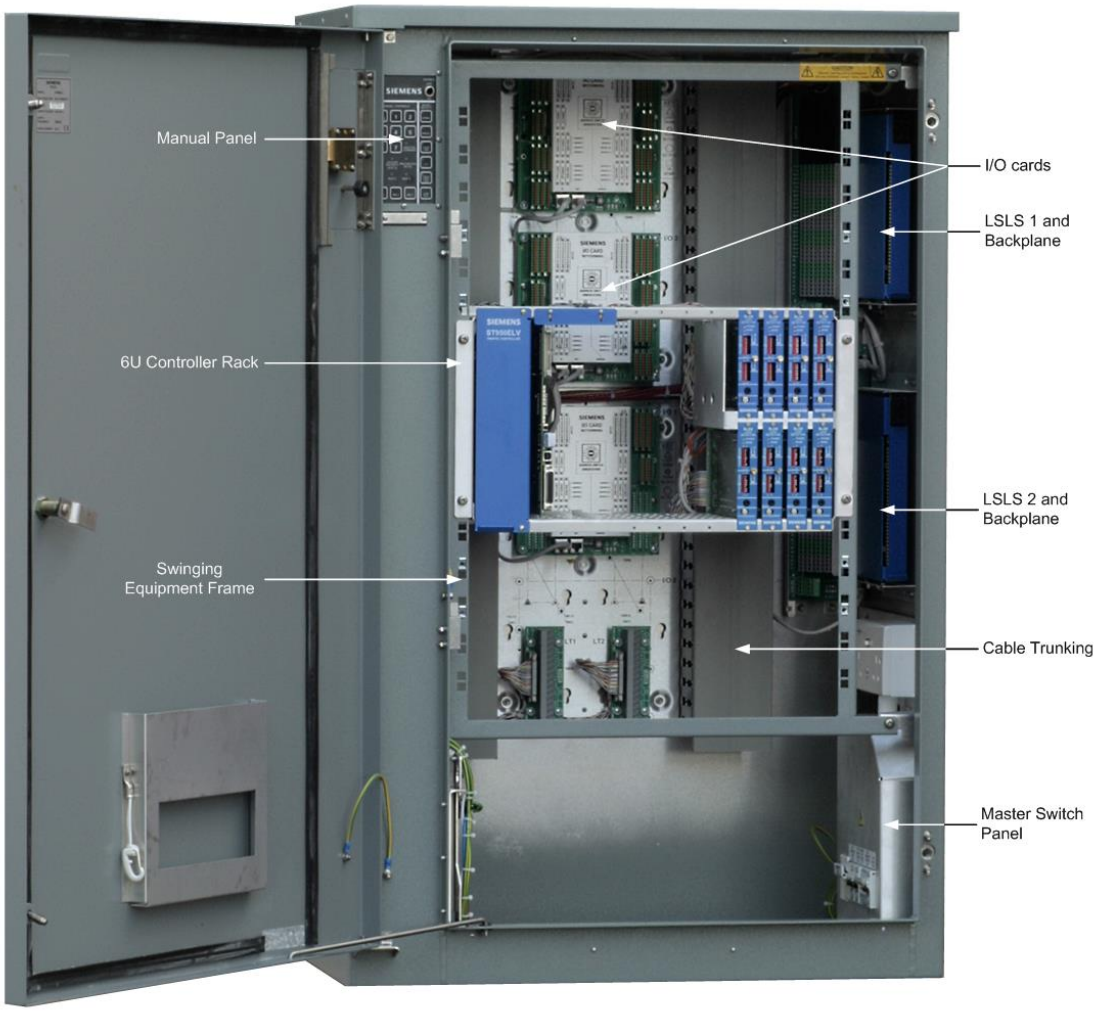


Figure 2 – ST950 ELV Controller Cabinet – View of right side

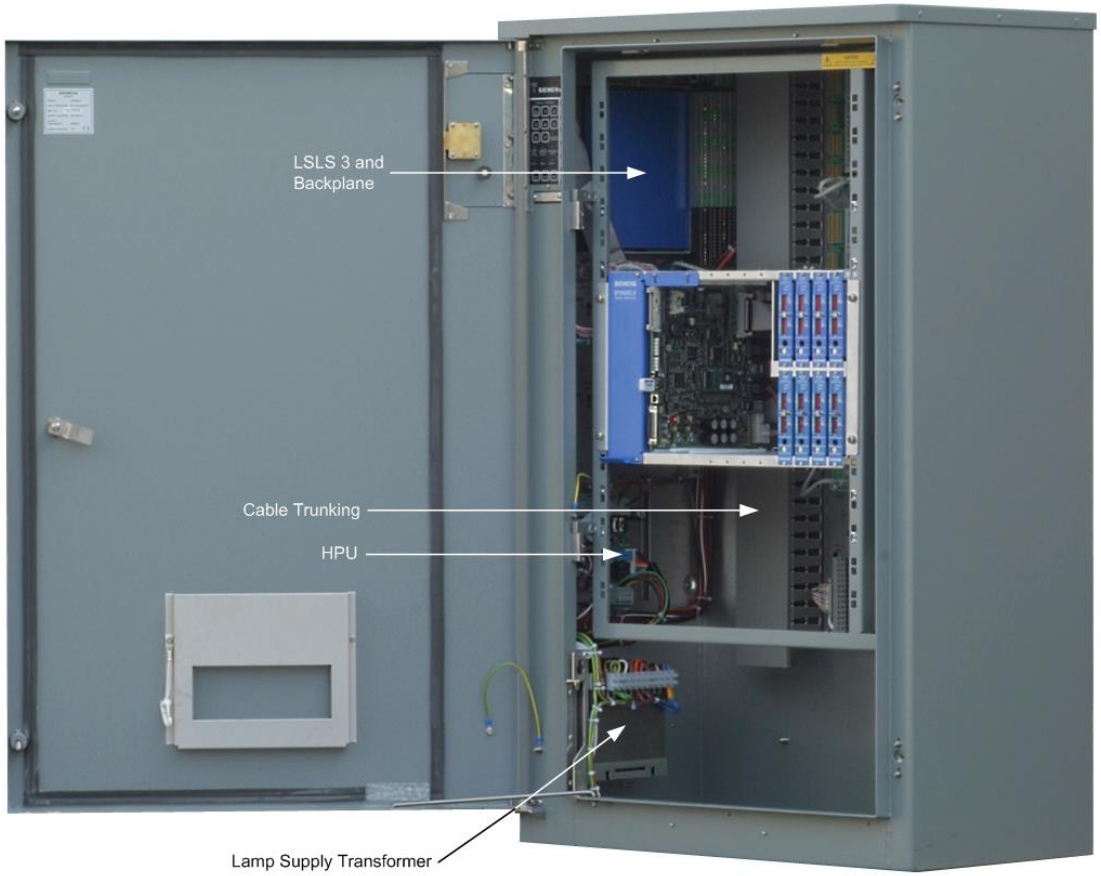


Figure 3 – ST950 ELV Controller Cabinet - View of left side

3.2 The Controller Rack

Figure 4 and Figure 5 shows the ST950ELV controller in a 6U 19" rack.

The 19” Controller Rack is sub-divided into one 6U-high bay and two 3U-high bays, which may be expanded to four 3U-high bays by the addition of a 6U expansion kit. The 6U bay is fitted with (from left to right) LPU and CPU Card.

The four 3U-high bays can be fitted with up to four Intelligent Detector Backplanes, supporting up to 16 Loop Detector cards.

Additional loop detectors may be accommodated in one or two further 3U 19” racks fitted in the swing frame above and/or below the main 6U rack.

Figure 5 shows the rear of the controller rack with two Intelligent Detector Backplanes.

If required, a Gemini^2 unit may be fitted in the bottom right bay, as shown in Figure 4.

The 6U cards are held in the rack by a retaining strip at its upper front edge. To release the cards, loosen the clamping screws and move the retaining strip clear of the card guides.

For some cabinets additional kits of parts are available. These are listed on the ST950ELV Family Tree (667/DZ/45950/000). The kits provide the necessary installation instructions, brackets and other equipment that may be helpful during the installation.

The standard controller items are used with these kits and are also listed in the ST950 Family Tree. Refer to Siemens Poole for the latest copy.

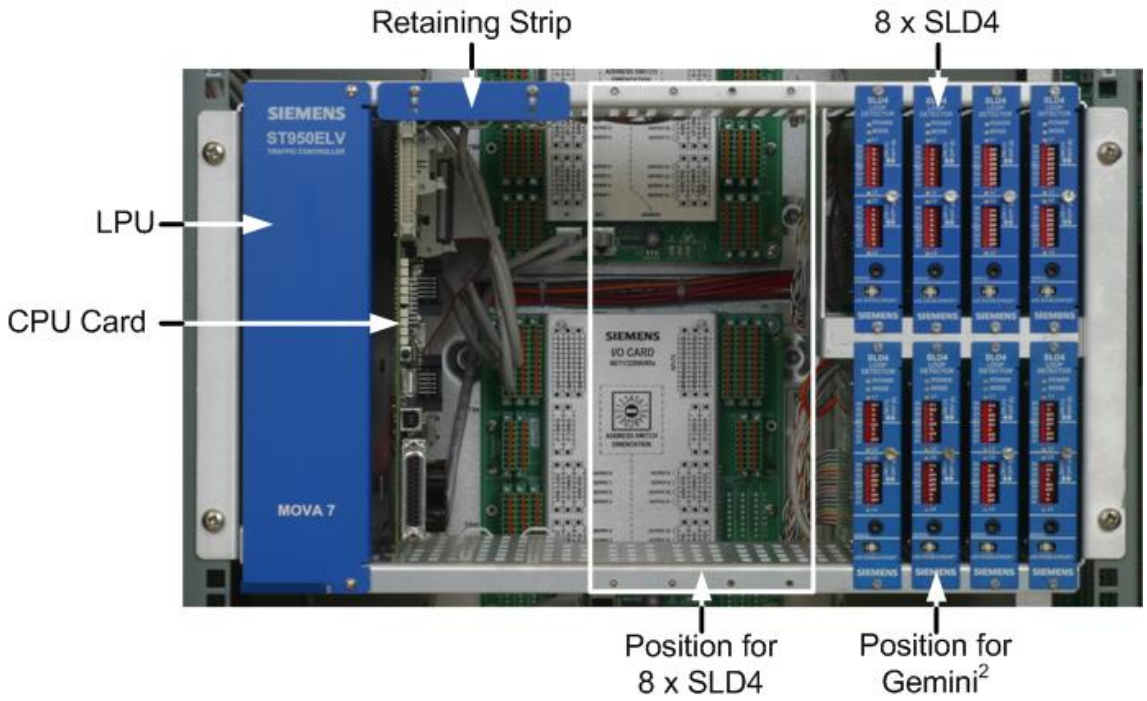


Figure 4 – ST950 ELV 19" Rack - Front

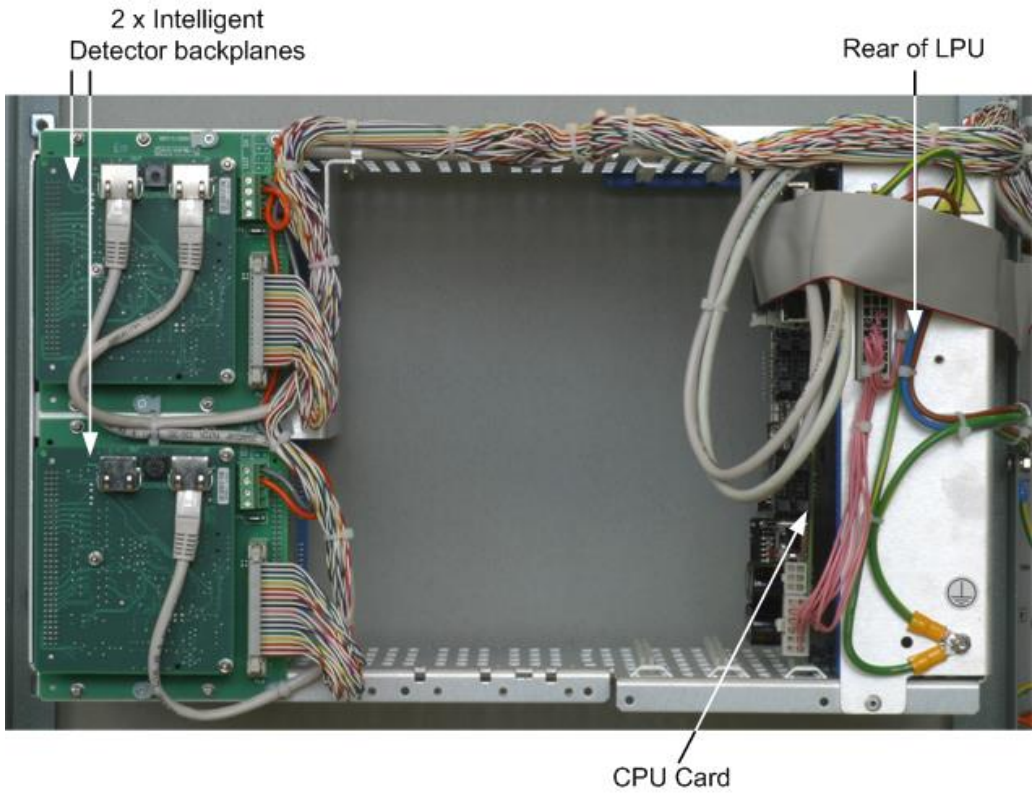


Figure 5 – ST950 ELV 19" Rack - Rear

3.3 ELV Controller Expansion Cabinet

For large junctions, it may be necessary to fit an expansion cabinet adjacent to the primary cabinet. The Expansion Cabinet Kit does not have a connection to the mains supply and is typically used to house IO cards and their associated cabling. Long length RJ45 cables are used to connect the IO cards in the expansion cabinet to the CPU Card in the primary cabinet.

When mains-powered equipment is fitted into the expansion cabinet, an Expansion Cabinet kit ELV Master Switch is required. This kit allows a mains supply to be taken into the expansion cabinet and safely terminated.

When an LSLS is to be fitted into the expansion cabinet, an LSLS Expansion Cabinet Kit is required. This kit includes a 20A lamp transformer, HPU, single LSLS and LSLS Backplane. Additional LSLS cards and LSLS backplanes can then be fitted up to a maximum of 3 LSLS cards in the Expansion Cabinet.

When moving parts to an expansion cabinet, just move what is necessary to accommodate incoming cables. The following order is recommended to minimize work:

1. Loop Detectors
2. I/O Cards
3. LSLS Cards

It is not necessary to have a separate Feeder Pillar for the expansion cabinet.

4 ST950 ELV System Components

This section details the main components of the ST950 ELV system.

4.1 Lamp Supply Transformer

The Lamp Supply transformer provides the high current 48V supply to the ELV signal heads and a separate lower current 48V supply for Regulatory Signs. It additionally provides a low voltage AC supply for the operation of the LSLS card logic and a 24V DC supply for powering Loop Detectors, above ground detectors and the solar cell.

The ELV transformer has two separate primary windings, so that it can be configured for either 220/230/240V/250V operation or for 110/120V operation.

Issue 3 (and lower) Lamp Transformer has primary taps for 220/230/240V operation and 110/120V operation

Issue 4 (and higher) Lamp Transformer has an additional primary tap for 250V operation

Figure 6 to Figure 11 below show the terminations for the issue 4 Lamp Transformer

4.1.1 Procedure for selecting transformer connections:

With a suitable multimeter set to read AC volts, measure the incoming mains supply voltage and select the transformer tapping according to the table below:

Measured Voltage	Select Transformer Tapping:
245V to 276V	250V (see Note above)
235V to 244V	240V
225V to 234V	230V
187V to 224V	220V
115V to 138V	120V
94V to 115V	110V

Table 1 – Lamp Transformer Tappings

For a nominal 230V supply, if the measured voltage is below 196V or above 253V, then advice should be sought from the local electricity supplier

Connections to the transformer are made in accordance with Figure 6 to Figure 11

If a second transformer is fitted as part of the 20A to 40A upgrade kit, both transformers MUST be set to the same tapping selection.

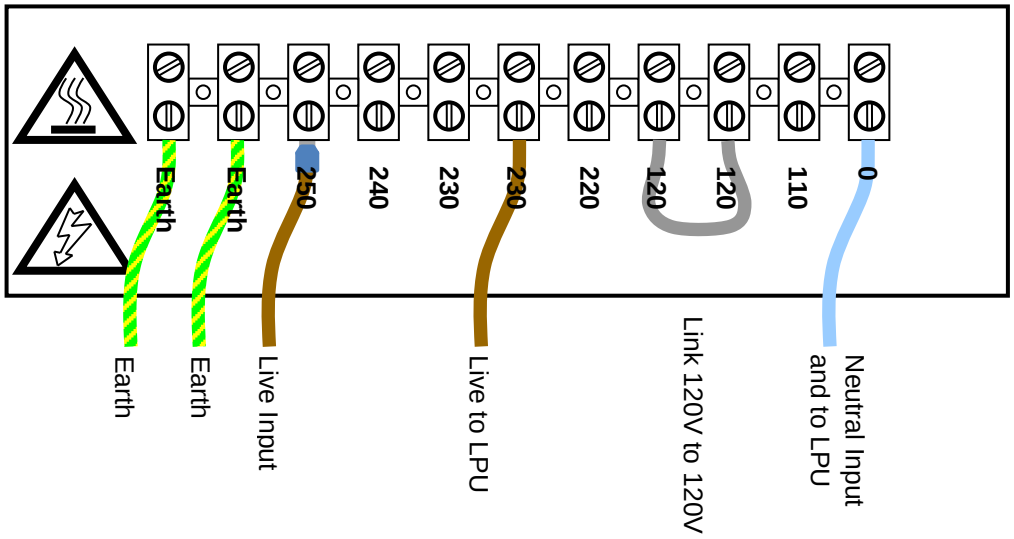


Figure 6 – ELV Transformer Connections: 250V mains

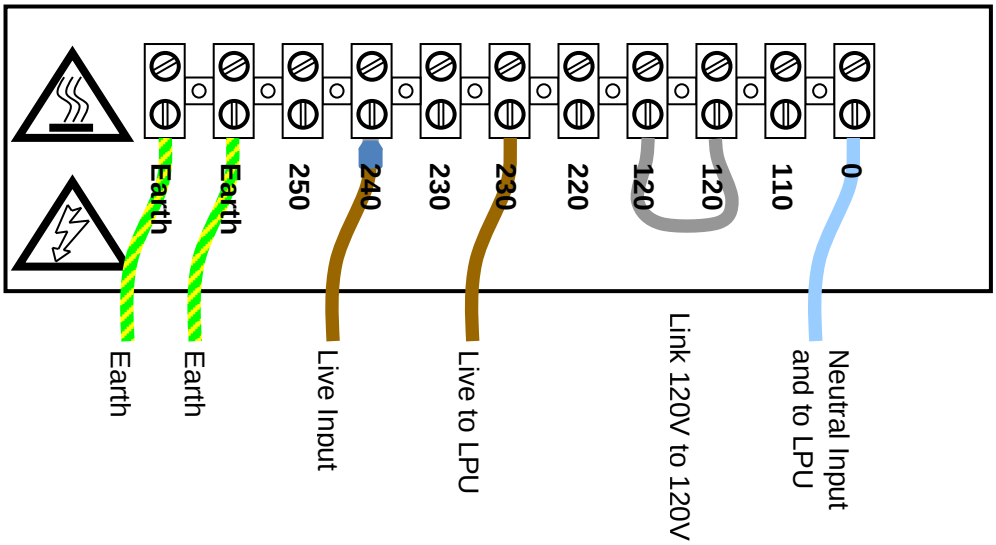


Figure 7 – ELV Transformer Connections: 240V mains

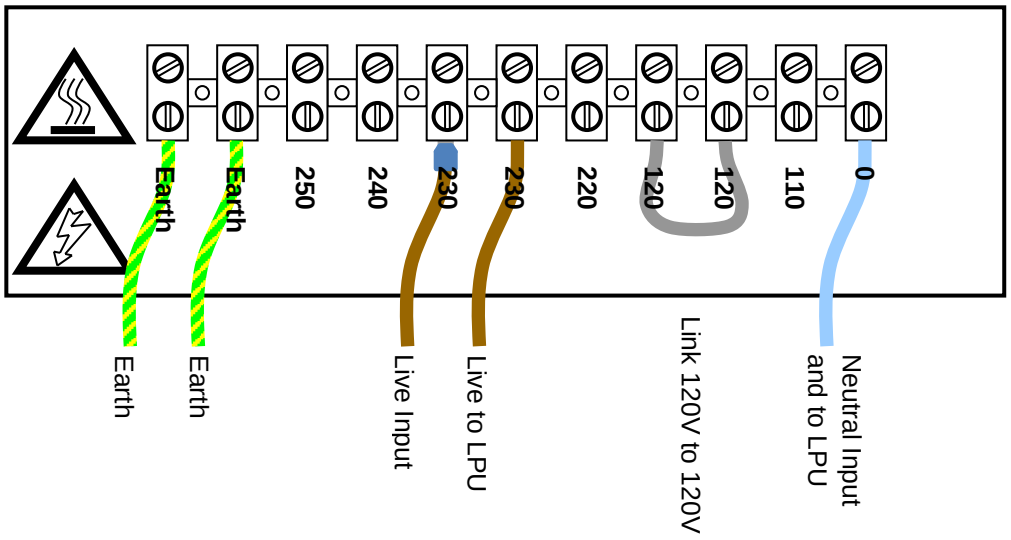


Figure 8 – ELV Transformer Connections: 230V mains

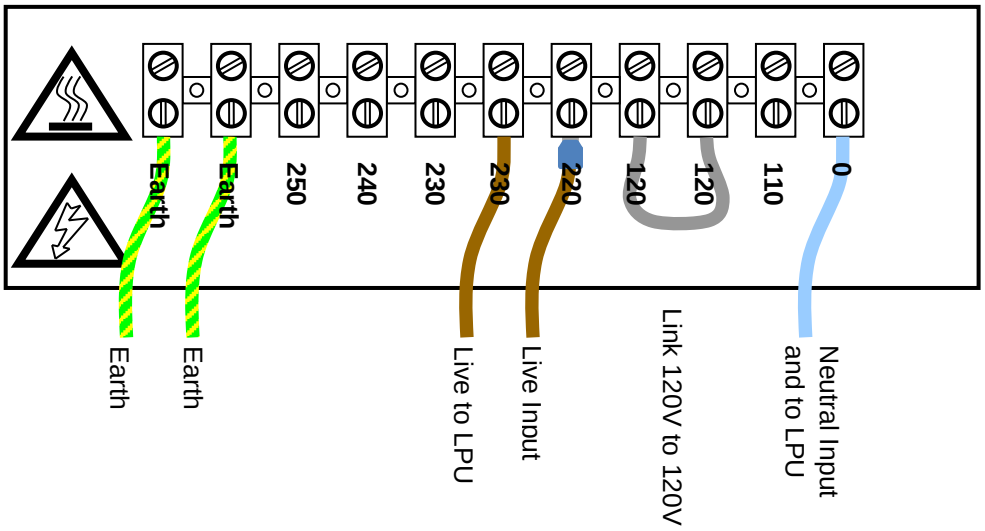


Figure 9 – ELV Transformer Connections: 220V mains

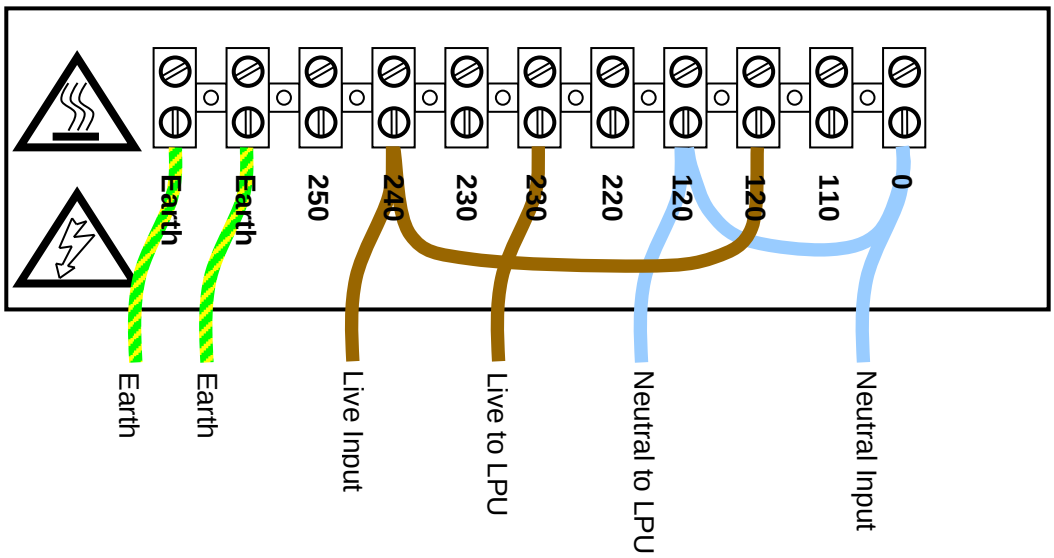


Figure 10 – ELV Transformer Connections: 120V mains

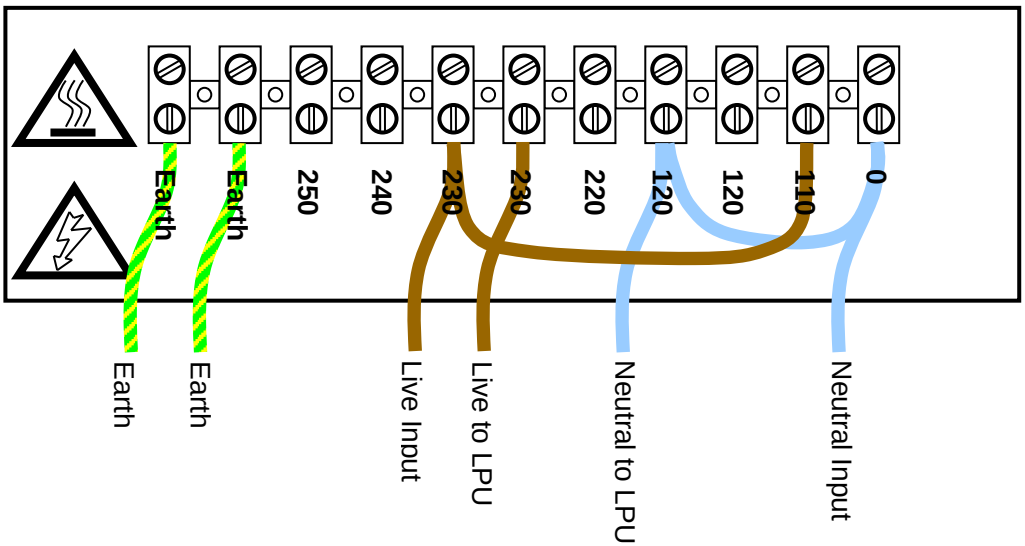


Figure 11 – ELV Transformer Connections: 110V mains

The LPU Mains Live wire is always connected to the extra 230V termination on the ELV transformer.

When operating on 110V or 120V Mains input, the LPU Mains Live wire remains connected to the extra 230V termination. This results in the LPU being supplied with 110V AC.

4.1.2 Low Inrush Transformer:

Siemens have developed a low inrush transformer that allows lower rating protection devices to be used, as shown below: -

Controller MCB changed from 20A type D MCB to 6A type D MCB,

Master Fuse changed from 30A to 16A

Electricity Cut-out fuse changed from 45A to 25A.

The lower rating Electricity Cut-out fuse encourages the Electricity Supplier to provide power without supply metering.

The low inrush transformers are available in 20A only controller cabinets; see the appendix for Part Numbers.

A low inrush transformer weighs about 20kg. In the very unlikely event of a transformer failing, appropriate lifting techniques MUST be used, and leather rigger gloves are recommended.

4.2 High Power Unit (HPU)

The HPU distributes the 48V lamp supply and low voltage logic supply from the Lamp Supply transformer to three LSLS cards. It has monitor circuitry and terminations for the connection of up to eight 48V regulatory signs, provides connections for the Solar Cell and 24V Loop Detector/above ground detector supply and incorporates the Dim/Bright, A and B relays. If the total lamp load exceeds 20A or more then three LSLS cards are required, see section 4.3.

The HPU provides the following outputs:

Supply	Voltage (nominal)	Measures as: (See Note 1)	Connector
Lamp Supply	0V (Earthed)	0V	PL4/6/7/ pins 1,2,3
(Bright)	-48V DC rms nominal	-44.6V DC	PL4/6/7 pins 4.5.6
(Dim)	-27.5V DC rms nominal	-25.4V DC	
Regulatory Supply	0V (Earthed)	0V	SK1 pins 1a, 2a, 3a, 4a, 5a, 6a, 7a, 8a
	-48V DC rms nominal	-44.6V DC	SK1 pins 1b, 2b, 3b, 4b, 5b, 6b, 7b, 8b
LSLS#1 Logic Supply	12.2V AC rms	12.2V AC	PL4 pins 7 and 8
LSLS#2 Logic Supply	12.2V AC rms	12.2V AC	PL6 pins 7 and 8
LSLS#3 Logic Supply	12.2V AC rms	12.2V AC	PL7 pins 7 and 8
Loop Detector Supply	0V (Earthed)	0V	SK2 3a
	-24V DC rms nominal	-20.9V DC	SK2 3b

Table 2 – HPU Outputs

The 48V DC Lamp supply, 48V DC Regulatory sign supply and 24V DC Loop Detector Supplies are all negative with respect to ground i.e. the positive side of each of these supplies is grounded.

Note 1: When measuring any of the DC supplies, a normal multimeter set to DC Volts will NOT show the true rms voltage of the unsmoothed DC waveform. The multimeter will indicate the voltage shown in the "Measures as" column in table above.

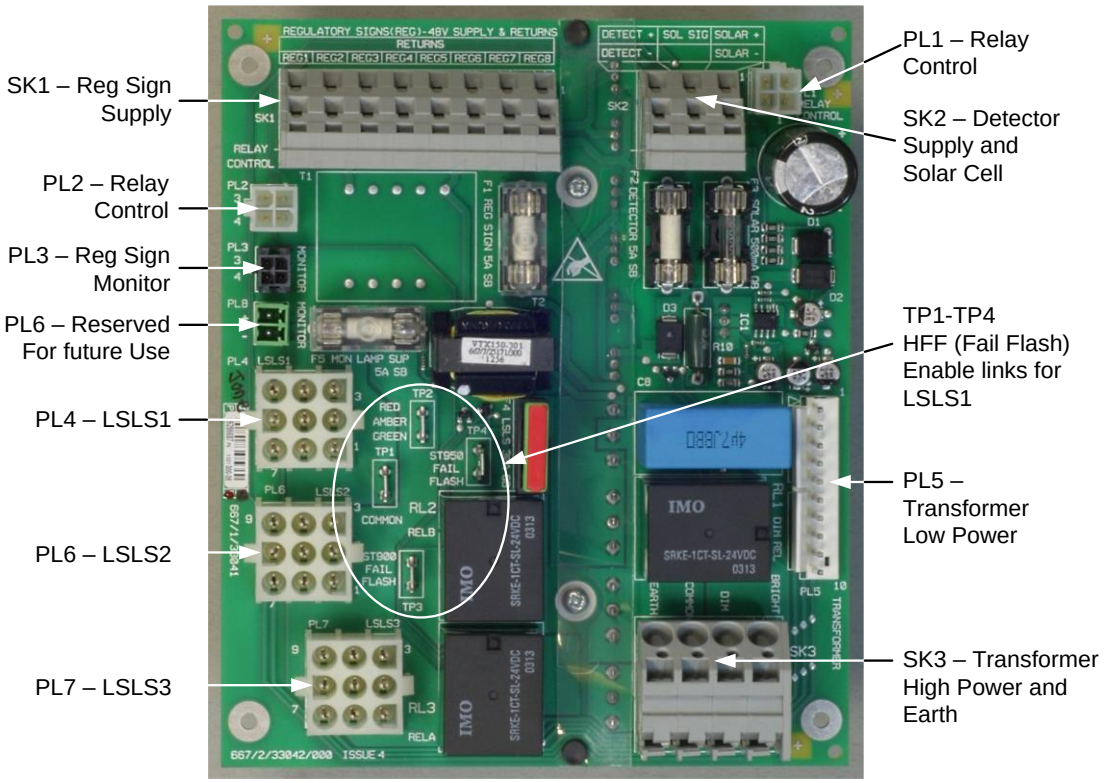


Figure 12 – HPU Card Layout

TP1-TP4 Link

A single link must be installed between TP1 (common) and TP2, TP3 or TP4 depending on how the controller needs to provide the lamp supply for the particular configuration. Figure 13 shows the three possible link positions for UK, Non-UK with or without HFF (No link shown for clarity).

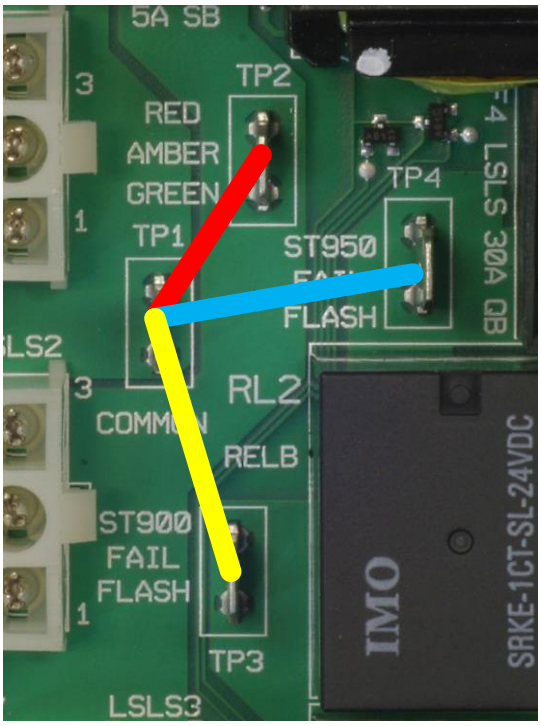


Figure 13 – HPU Card Links

The standard HPU configuration (used for all UK controllers) links TP1 (Common) to TP2 (Red Amber Green). For Hardware Fail Flash controllers (non UK only), the link is fitted between TP1 and TP3 for ST900 Fail Flash operation or TP1 and TP4 for ST950 Fail Flash operation.

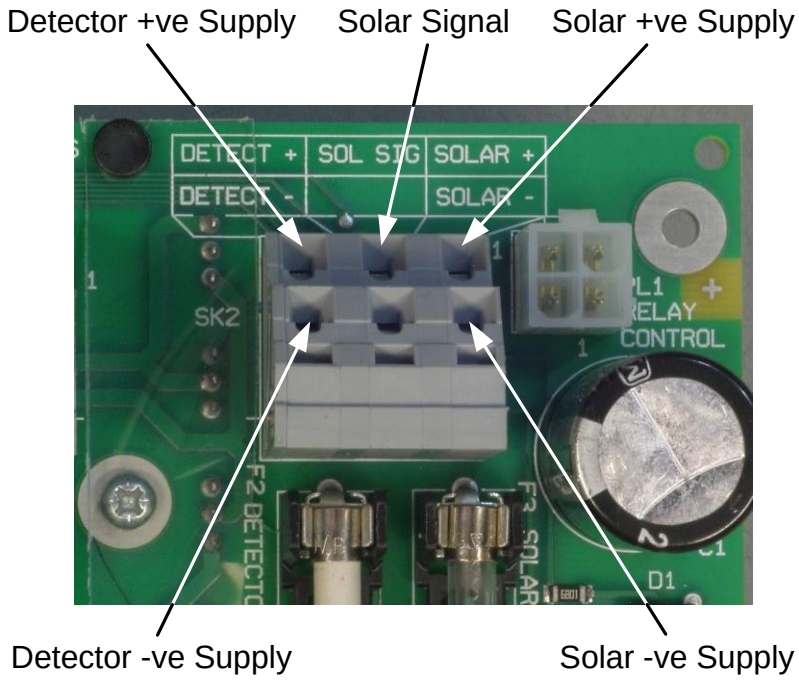


Figure 14 – SK2 Detector Supply and Solar Cell connections

See section 4.17 and Figure 39 for details of the cable connections to the Solar Cell.

The following table details the connections on the HPU.

Socket /Plug	Purpose	Description
SK1	Reg. Signs	-48V DC Connection for 8 off Reg. Signs Reg Sign Return (+) Reg-Sign Supply (-)
SK2	Detector Supply	-24V DC supply for powering Loop Detector Cards and above ground detectors. Connects to a 12-way terminal block on the side panel of the cabinet. Det Com (+) and Det Sup (-)
SK2	Solar Cell	Connection for 24V DC Solar Cell Connect Solar cell supply leads to Solar + and Solar -, observing correct polarity. Connect Solar Cell signal to Sol Sig.
PL1 & PL2	Relay Control	Connection to CPU Card and LPU for relay control. PL1 and PL2 are identical. PL2 connects to Main CPU Card. PL1 connects to PL2 of second HPU unit, if fitted.
PL3	Reg. Sign Monitor	Reg. Sign current monitor output to LSLS card.

PL4, PL6, PL7	LSLS Lamp and Logic supplies	Lamp and logic supply connections to LSLS1, LSLS2, and LSLS3 cards.
PL5	Transformer Low Power	Detector, Reg. Sign, and 3 off LSLS logic supplies.
SK3	Transformer High Power and Earth	Bright, Dim, and Common connections from transformer. Earth connection to earth all supplies on HPU card.

Table 3 – HPU Connections

4.2.1 Regulatory Signs Monitoring

The HPU is equipped with a Regulatory Signs supply as standard (SK1 on the HPU as shown in Figure 12 above). The supply can be monitored for up to eight regulatory signs. If the junction contains more than eight signs in total then a Regulatory Signs Supply and Monitoring kit is needed. This allows a further 12 regulatory signs to be powered and monitored.

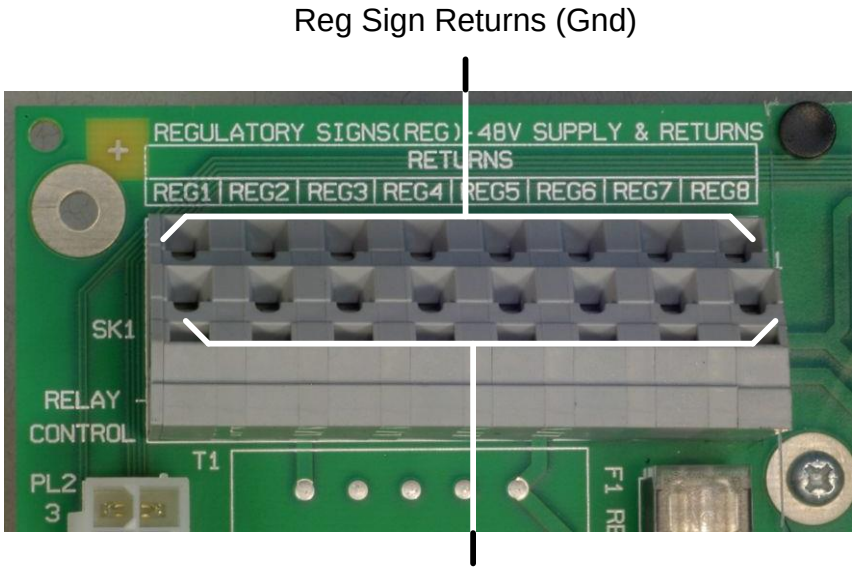


Figure 15 – Regulatory Signs Supply connections

The HPU (and LSLS Card 1 through PL3) are fitted with the circuitry to monitor the regulatory signs. No external torroids are required in order to monitor the regulatory signs. If a second HPU is fitted, this can supply and monitor up to eight more regulatory signs; connect PL3 of HPU2 to the first Reg Sign input on SK5 of the LSLS Card connected to PL4 of HPU2 (i.e. the first LSLS connected to HPU2). LSLS card connections are described in section 4.13.

4.2.2 Regulatory Signs Expansion Kit Monitoring

The regulatory signs extension kit provides for a further twelve ELV regulatory signs. These are arranged in two separately monitored blocks of 6. The kit contains lamp monitoring circuitry which must be linked to the external input(s) of an appropriate LSLS card. Two twisted pair cables, identical to that used for the HPU regulatory sign monitoring are supplied. The blue strand of the cable should be connected closest to the PCB (Return) of the external input.

Recommended Monitoring Channels	
LSLS Card 1 Channel 1	HPU Reg Sign Monitoring
LSLS Card 1 Channel 2	Reg Sign Kit (1) signs 1..6
LSLS Card 1 Channel 3	Reg Sign Kit (1) signs 7..12
LSLS Card 2 Channel 1	Reg Sign Kit (2) signs 1..6
LSLS Card 2 Channel 2	Reg Sign Kit (2) signs 7..12

A single LSLS can monitor a maximum of 18 extension kit regulatory signs plus the eight standard HPU powered signs.

4.3 High-Current Capability Controllers

For Controllers where the total lamp load will not exceed 20A, a single Lamp Supply Transformer and associated 20A HPU are fitted.

For lamp loads up to 40A, an additional Lamp Supply Transformer and additional 20A HPU may be fitted. The additional Transformer and HPU can either be fitted alongside the first transformer and HPU on the side panel of the primary cabinet, or can be fitted in an expansion cabinet.

When fitting a second HPU, a relay control cable must be connected from PL1 of the first HPU to PL2 of the second HPU.

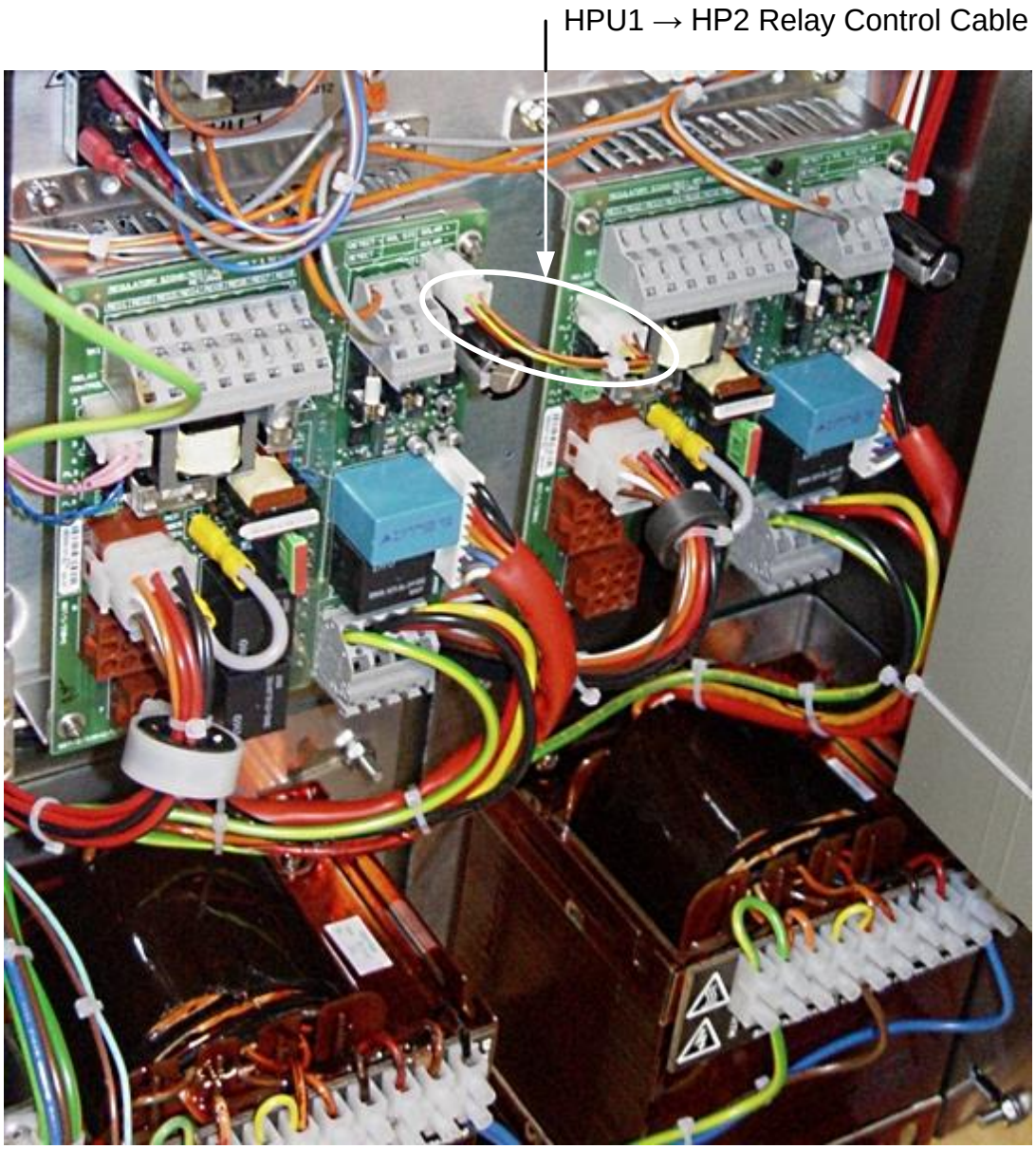


Figure 16 – 20A to 40A Upgrade Kit Installed

If the total lamp load exceeds 20A or more than 3 LSLS cards are required, then the following options are available:

Cabinet	HPU1 & HPU2		Option 1	Option 2	Option 3
Primary Cabinet (20A)	20A	HPU1 PL4	LSLS 1	LSLS 1	LSLS 1
		HPU1 PL6	LSLS 2	LSLS 2	–
		HPU1 PL7	LSLS 3	–	–
Expansion Cabinet (20A)	20A	HPU2 PL4	LSLS 4	LSLS 3	LSLS 2
		HPU2 PL6	LSLS 5	LSLS 4	LSLS 3
		HPU2 PL7	LSLS 6	LSLS 5	LSLS 4

Cabinet	HPU1 & HPU2		Option 4	Option 5
Primary Cabinet (40A)	20A	HPU1 PL4	LSLS 1	LSLS 1
		HPU1 PL6	LSLS 2	–
		HPU1 PL7	–	–
	20A	HPU2 PL4	LSLS 3	LSLS 2
		HPU2 PL6	–	LSLS 3
		HPU2 PL7	–	–

Table 4 – LPU Rear Connections

LSLS 1 must always be connected to PL4 of HPU1.

The allocation of LSLS cards to HPU 1 or HPU 2 is done so that, as far as possible, the total load is distributed evenly across both transformers and HPU, and in no event does the current drawn from either HPU 1 or HPU 2 exceed 20A; this includes regulatory signs but excludes short-term red/amber periods.

The number of LSLS cards connected to HPU1 or fitted in the Primary cabinet can be 1, 2 or 3; HPU1 and the primary cabinet do not need to be filled before moving to HPU2 and optionally an expansion cabinet.

4.4 Logic Power Unit (LPU)

The Logic Power Unit (LPU) is a universal-input mains powered switch-mode converter providing DC for the logic supplies of the CPU Card, I/O Cards and Intelligent Detector Backplanes. The ST950ELV controller requires only the +24V DC supply (Although the 5V supply is routed to the CPU Card as it is used on the ST950LV controller). The +24V DC supply is routed via the CPU Card for distribution to the I/O cards and Intelligent Detector Backplanes via the RJ45 cables.

Position	Function	Termination	
Z32	Safety Earth Connection		
d30	Mains Live Input		
Z28	Mains Live Output (Not Used)		
d26	Mains Neutral Input		
Z24	Mains Neutral Output (Not Used)		
Z12, b12, d12	0V Return for CPU Card	X4	1,2,3
Z10	0V Return for CPU Card	X4	5
d10, b10	+5V DC to CPU Card	X4	9, 10
b8	+24V DC (Not Used)		
Z6	Power Fail to CPU Card (Not Used)	X4	8
d6, b6	+5V DC to CPU Card	X4	11, 12
Z4	+24V DC to HPU	PL2	1
d4	+24V DC to CPU Card	X4	4
b2	0V Return (Not Used)		

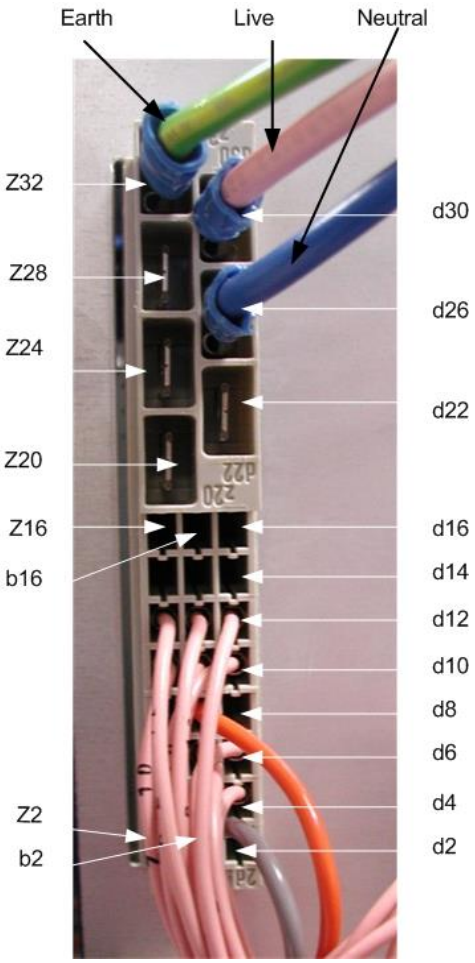


Figure 17 – LPU Rear Connectors

4.5 ST950 ELV CPU Card

Variants

There are two variants of the ST950 CPU card which differ only in the amount of RAM available on the EFC module.

- 667/1/46010/001 – 64M RAM
- 667/1/46010/101 – 128M RAM

The 101 variant is compatible with all applications and is required when connecting to Stratos (see section 7.4.6). See 667/SU/46000/000 for full compatibility information.

General

The CPU Card controls the system. It holds the controller configuration and performs the function of configuration, control and management. The primary external data interfaces are shown in Figure 19 and detailed in Table 5.

One serial phase bus and two GSPI bus connectors are available on 3 separate RJ45 sockets on the rear of the CPU Card. The forth RJ45 socket is reserved for a future GSPI Manual Panel is blanked off and should not be used.

The RJ45 socket marked “LSLS” on the CPU Card must be connected to the LSLS cards in most cases. For controllers where the LSLS cards are located in the 19" rack along with the CPU Card, the front serial phase bus connector is used with a 10way IDC cable link to the 1st LSLS.

The two GSPI interface RJ45 sockets are identical and both marked “SIO”. One of these is connected to the IO cards and the other, to Intelligent Detector Backplanes. It is not important which connector is used for the IO and which is used for the Intelligent Detector Backplanes.

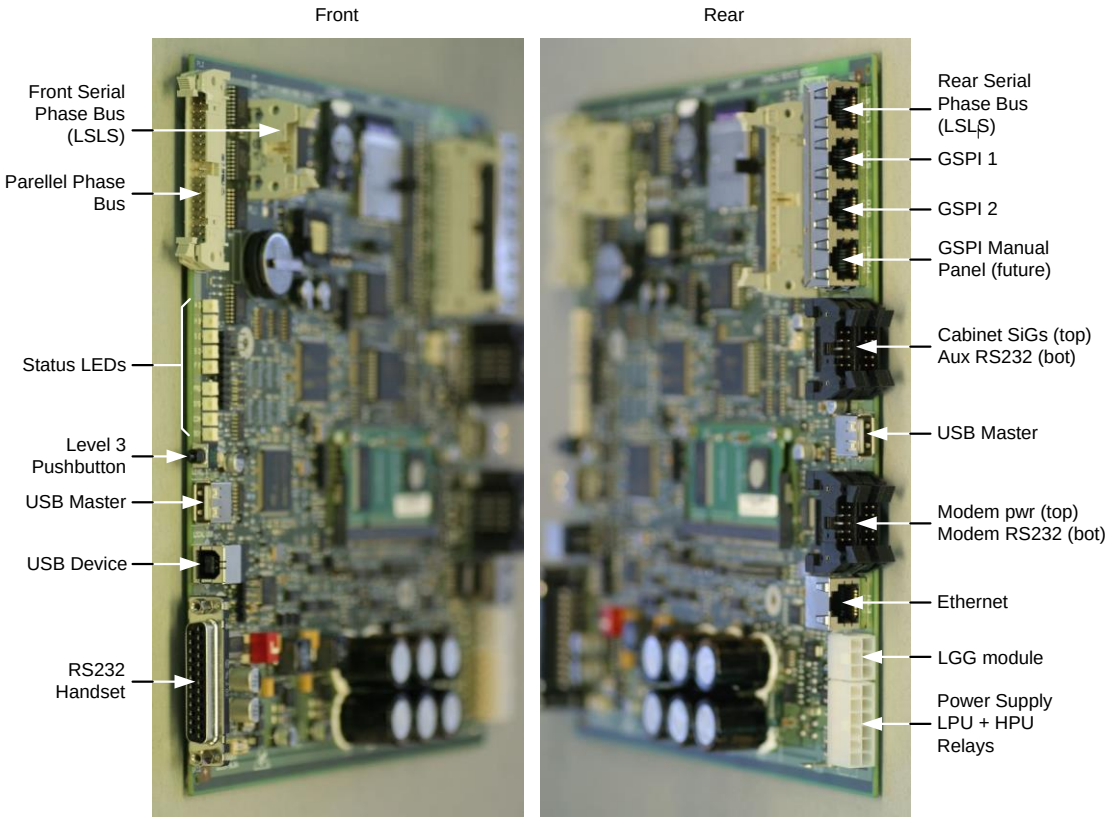


Figure 18 – ST950 ELV CPU Card (front and rear views)

Figure 18 shows the CPU Cards interfaces on the front and rear in the orientation when installed in the logic rack (but without cables for clarity)

The ST950 significant part positions are identified in Figure 19 below and detailed in Table 5.

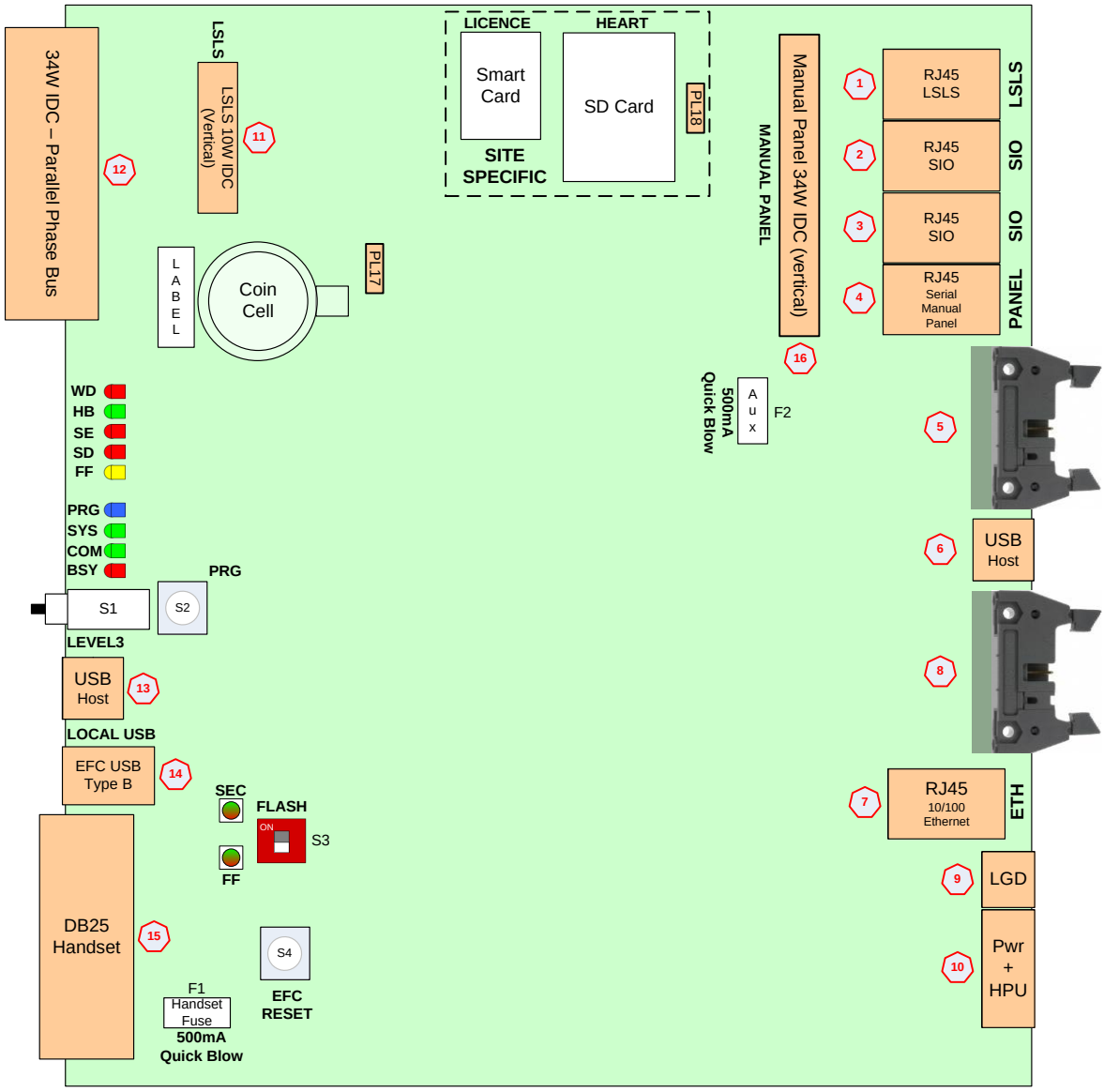


Figure 19 – CPU Card Layout

ID	Description	Connector
1	Serial Phase bus to LSLS cards (LSLS)	RJ45
2	GSPI Bus to I/O Cards (SIO)	RJ45
3	GSPI Bus to I/O Cards (SIO)	RJ45
4	GSPI Manual Panel (PANEL) [Future Use]	RJ45
5	Cabinet Signals (Top) Auxiliary RS232 Connection (Bottom)	Double stacked 10 way IDC Refer to Table 2 for pinout
6	Rear USB Host Port	USB Type A
7	10/100 Ethernet (ETH)	RJ45
8	Modem Power / Ancillary I/O (Top) RS232 Modem Connection (Bottom)	Double stacked 10 way IDC Refer to Table 3 for pinout
9	Battery Backup module connector	6 way Molex Mini-Fit Jr.
10	Power Supply Connector (For HPU/LPU/MDU)	12 way Molex Mini-Fit Jr.
11	Serial Phase bus to LSLS cards when installed in Rack	10 way IDC
12	Parallel Phase Bus to LSCs	34 way IDC
13	Front USB Host Port	USB Type A
14	USB Handset Port	USB Type B
15	RS232 Handset Port	25 way D type – Female
16	Parallel Manual Panel Port	34 way IDC

Table 5 – Connector Functions and Types

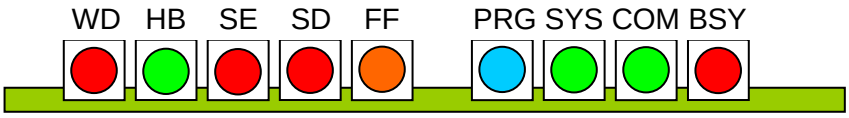
4.5.1 Processor Status LEDs

Overview

The LEDs located on the front of the CPU Card and immediately behind the handset port are used to convey controller operational states and other information to the user.

Front of the CPU Card

The nine LEDs on the front of the CPU Card as shown below (viewed from the front).



The function of each LED is described below.

WD – Watchdog (red)

Illuminated when the Primary CPU is not running or an internal fault has been detected.

HB – Heartbeat (green)

Flashes in a heartbeat pattern	Primary CPU software is operating normally
Flashes slowly (once per second)	Controller self test
Flashes quickly (several times per second)	Non normal operation e.g. startup

SE - System Error (red)

Permanently on	Fault is present, e.g. one or more entries present in the Fault Table
Flashes slowly (with the Heartbeat LED flashing in a heartbeat pattern)	Reserve Mode
Flashes quickly (with the Heartbeat LED flashing in a heartbeat pattern)	Reserve Mode is latched; manual reset required
Flashes quickly along with the Heartbeat LED (both flashing quickly)	Fault with the Primary CPU, e.g. self test fault found
Flashes quickly at power-up (with the Heartbeat LED off)	RTC faulty, e.g. backup support expired

SD – Shutdown (red)

Illuminated when the controller is in the Shutdown Mode i.e. signals are not being controlled.

FF – Fail Flash (yellow)

Flashes when hardware fail flash is active.

PRG – Program (blue)

Flashes to indicate programming of an IC4 configuration and / or new firmware is pending or in progress.

Single pulse	IC4 configuration available for programming
Double pulse	Firmware upgrade available Heart restore pending Wipe request pending
Fast flash	Programming in progress

Solid on	Programming complete, power cycle required

SYS – System (green)

Flashes to indicate status

Slow flash	Normal operation
Medium flash	Normal operation, Fault present
Very fast flash	Restricted mode

COM – Communications (green)

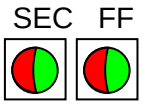
On	Under UTC control, pulses off indicate receipt of messages
Off	Not under UTC control, pulses on indicate receipt of messages

BSY – Busy (red)

Flashes to indicate the system is busy performing an operation that must not be interrupted, for example start up, upgrade, USB "memory stick" style interface is busy. Do not remove USB device or switch off the controller while this LED is flashing.

BEHIND HANDSET CONNECTOR

The pair of multicolour LEDs behind the handset connector are as shown below (viewed from the front of the CPU Card).



The function of each LED is described below.

SEC – SEC Status

Green flash, long on, short off	Awaiting start request from Primary
Green flash, equal on and off	Normal operation
Green flash, short on, long off	Shutdown
Red	SEC requested controller shutdown

FF – Fail Flash Status

Green flash, equal on and off	Normal operation

4.5.2 Connector Pinouts

Connectors 5 and 8 are fitted with long latches that are suitable for use with Berg housings and individual wire connections. The four connectors that may require user wiring are detailed below:

Table 2 - Double Stacked 10W IDC – Top: Cabinet Signals Bottom: Aux RS232

Location	Pin	Function
Top	1	Not Used (because +5V on connector 8)
	2	Not Used (because +5V on connector 8)
	3	Signals on/off switch signal input
	4	Signals on/off switch return (0V)
	5	Cabinet Alarm LED Drive + +5V via 150R resistor
	6	Cabinet Alarm LED Drive - MOSFET open drain output
	7	Door Switch signal
	8	Door switch return (0V)
	9	Reset fault log button input signal
	10	Reset fault log button return (0V)
Bottom	11	+5V Fused (500mA)
	12	RS232 DSR (Input)
	13	RS232 RxD (Input)
	14	RS232 RTS (Output)
	15	RS232 TxD (Output)
	16	RS232 CTS (Input)
	17	RS232 DTR (Output)
	18	Not Used
	19	0V
	20	Not Used

Functions:

Signals on/off switch (3,4) – This input allows an external switch to be used to control the signals on/off state. If either the internal (on the manual panel) or external switches are in the ‘on’ position the signals are requested on. (switch closed = signals on)

Cabinet Alarm LED Drive (5,6) – This output allows an external LED indicator to be installed to indicate the cabinet alarm state. This output is current limited to 33mA under short circuit conditions.

Door Switch (7,8) – This input allows an external switch to be used to connect a cabinet door switch. (switch closed = door closed) If either this input or the standard manual panel indicate door closed the controller door state will be closed.

Reset fault log button (9,10) – This input allows an external push button to be used to reset major faults in the fault log in the same manner as RFL=1 would do from the handset.

Bottom connector – Serial port used to connect an optional GPS unit (used to maintain the clock).

Table 3 - Double Stacked 10W IDC- Top: Modem Power + Monitors, Bottom: EFC Modem

Location	Pin	Function
Top	1	Modem +5V DC fused output from MDU/LPU (not battery backed)
	2	Connected to pin 1 above
	3	Modem 0V DC output (+5V return)
	4	Connected to pin 3 above
	5	Isolated Shutdown O/P +
	6	Isolated Shutdown O/P -
	7	External supply monitor signal (digital)
	8	External supply monitor signal return (0V)
	9	External supply monitor signal (analog)
	10	External supply monitor signal return (0V)
Bottom	11	RS232 DCD (Input)
	12	RS232 DSR (Input)
	13	RS232 RxD (Input)
	14	RS232 RTS (Output)
	15	RS232 TxD (Output)
	16	RS232 CTS (Input)
	17	RS232 DTR (Output)
	18	RS232 RI (Input)
	19	0V
	20	Not Used

Functions:

Modem 5V Supply (1,2 & 3,4) – This output provides a regulated 5V supply with active current limiting set at approximately 700mA. This supply output is NOT battery backed.

Isolated Shutdown Output (5,6) – These two pins provide an opto-isolated controller shutdown signal. The + signal is the collector and the – signal is the emitter of the opto transistor. The output is active low (ie low impedance) when the controller is in the shutdown state. The maximum current that this output can pass is 25mA and suitable external devices must be employed to ensure that this figure is not exceeded otherwise damage to the ST950 board will occur.

Digital External Supply Monitor (7,8) – For future use.
Analog External Supply Monitor (9,10) – For future use.

Bottom connector – Serial port for future use.

The double stacked connectors are numbered as shown in Figure 2 below:

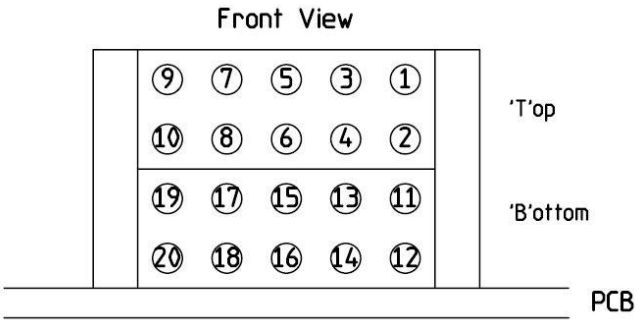


Figure 2 – Double stacked connector pin numbering

4.5.3 Links, Switches and Fuses

Before the controller is switched on, the switches and links on the CPU Card must be checked to ensure they are set correctly. Also the firmware should be checked to ensure that the correct version (as specified on the IC4 printout) is loaded.

The switch and link settings are mainly related to the hardware fail flash facility; their locations and option selections are shown in Figure 19.

HFF only flashes signals on LSLS #1.

Link Functions

PL18 - Enable Remote Reboot

This link must be in place to enable the remote reboot function. If the user does not wish this function to be available the link should be removed.

PL17 - RTC Backup capacitors - This link should always be in place.

Switch Functions

S1 – Level 3 push button – used to gain level 3 access on the controller.

S2 – Program push button used to invoke the programming sequence to update firmware and/or controller configuration. This button is only active when the lamps are switched off.

S3 – Enable Fail Flash switch. To make use of this feature the controller is required to be configured correctly.

S4 – Reset EFC push button. This push button is reserved for engineering use and should NOT be pressed.

4.6 Fuses

There are a number of user replaceable fuses present on the board that provide protection where power supplies from the system leave the board to power the users equipment.

When replacing a fuse it is important to fit the correct type for continued protection of the ST950 CPU Card and users equipment.

F1 – Handset – 500mA Quick blow

F2 – Aux RS232 Modem power supply output – 500mA Quick blow

The replacement fuse for F1 and F2 is Siemens part number 518/4/97070/004. This part number calls up the holder and fuse. Remove the fuse and discard the holder.

4.7 Heart of the Controller

The heart of the Controller uses an SD card to provide transferable storage for controller firmware, configurations and logs.

The formatting of the card is such that it is not readable in a PC. There are no user files accessible on the card.

Should it need to be removed or replaced the following procedure should be followed:

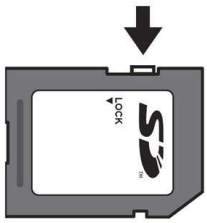
Power down the controller.

Unplug connectors and slide the CPU card free of the rack so that the top edge of the card can be accessed.

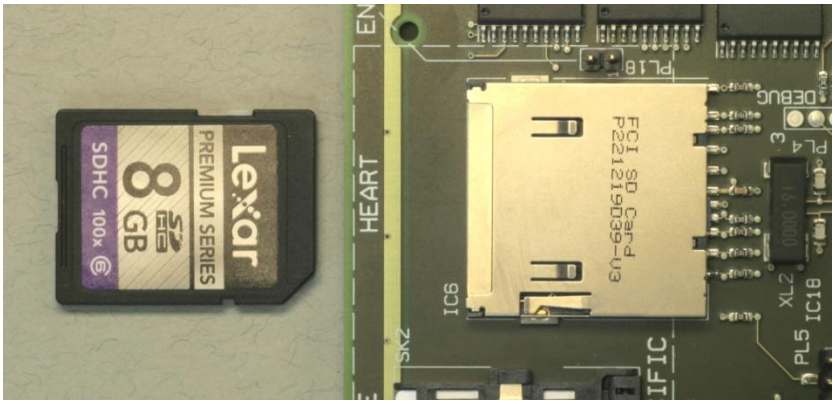
Push the card into the socket slightly until it ‘clicks’ then release pressure. The card can now be pulled from the socket.

To insert a card, align it with the socket with the contacts facing PCB and closest to the socket. Slide it into the socket and apply slight pressure until it ‘clicks’. The card is now located correctly. The photos below show the correct orientation for the card.

Note: It is important that the card is not write protected. The ‘lock’ switch must be in the position shown in the diagram below:



SD card Write Enable switch position



SD Card Orientation

✗ SD card partially inserted - incorrect

✓ SD card fully inserted - correct

4.8 Gemini2

For information regarding the Gemini2 equipment, see:

667/HB/32600/000 - Gemini2 Traffic Outstation Handbook

4.9 I/O Cards

The I/O card provides a rugged interface for up to 24 digital inputs and up to 16 changeover outputs for the connection of pushbuttons, loop detectors and above ground detectors, or to provide a free-standing UTC Interface or for linking between controllers.

A sub-equipped variant of this card is also available, fitted with only 4 changeover outputs. If the IC4 Configuration requires the 24 in / 4 out variant but one is not available, then a 24 in / 16 out card can be fitted in its place.

The I/O card connects to the CPU Card or previous I/O card via the GSPI interface cable through which the card also obtains its power supply.

The first three I/O cards may be fitted in the primary cabinet. Additional I/O cards may be fitted in an adjacent expansion cabinet.

The number of I/O cards that may be fitted is subject to limitations. See the ST950 Family General Handbook for details.

The IO card is safety-protected by a fuse. Situated beneath the metal cover plate. Should the fuse fail, the card will indicate a major fault and the card should be replaced. Do not replace the fuse as the card will have been damaged and must be replaced.

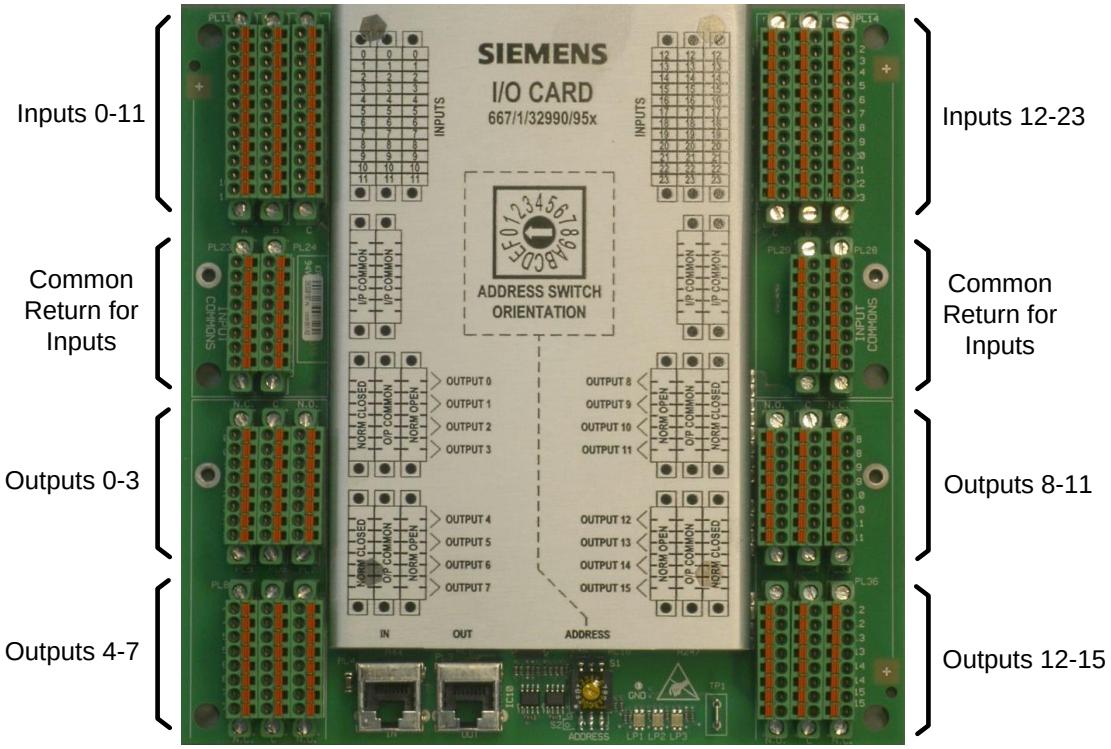
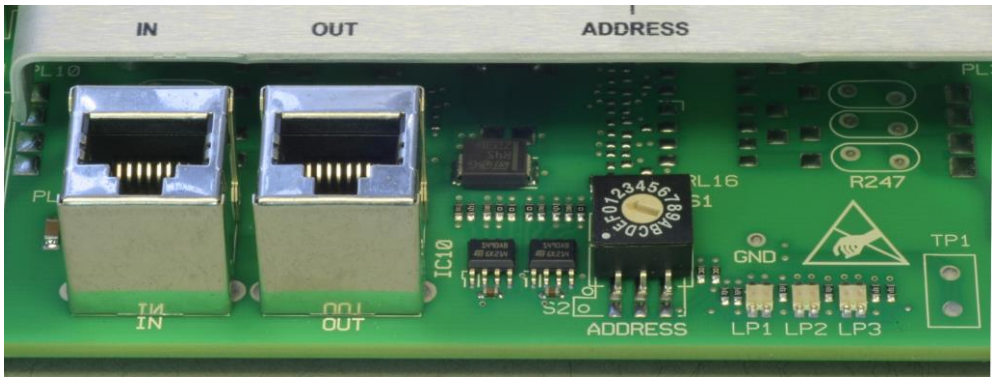


Figure 20 – I/O Card (Showing 16-output variant)



GSPI comms input from Processor Card or Previous IO card

GSPI comms output to next IO card

Address switch

Status LEDs

Figure 21 – I/O Card Address Switch and LEDs

4.9.1 I/O Card Status LEDs

The I/O card has three tri-colour status LEDs as shown in

Figure 21, which are used to indicate various conditions, as follows:

Comms Active LED (LP1)	Software Run LED (LP2)	Watchdog LED (LP3)	State
Yellow	Yellow	Off	Processor Reset
Yellow	Yellow	Red	Watchdog Failure
Off	Green Steady	Off	Performing Start Up
Red	Green Flash	Off	Awaiting Start
Green Toggle on Receipt of Message*	Green Flash	Off	Communications Active
Off	Green / Red Alternating	Off	Invalid Address
(As above depending on state)	Red Flash	Off	Major Fault Detected

* - May flash so fast that it looks like Green Steady.

Table 6 – I/O Card LEDs

Conditions other than those identified above should not occur and can be treated as faults.

4.9.2 I/O Card Rotary Address Switch

This screwdriver-adjustable switch is located on the I/O card(s) as shown in

Figure 21 and is set up for the card address (before the controller is powered up) in accordance with the appropriate Works Specification. The valid address range is 1 through 15 (where A to F denote 10 to 15 respectively). Address 0 is the default address switch position for spare cards.

The address range is shared with the Intelligent Detector Backplane cards and must be unique.

4.10 CPU I/O Card

The CPU I/O card is designed to provide an 'integrated' I/O capability for 'smaller' controllers. The card is mounted onto the CPU Card as shown below and provides 24 inputs and 4 changeover outputs. All Inputs and outputs are TR2523:2005 compatible. LEDs and GSPI ports are as described above for standard IO cards and the CPU IO card has a fixed address: 1.

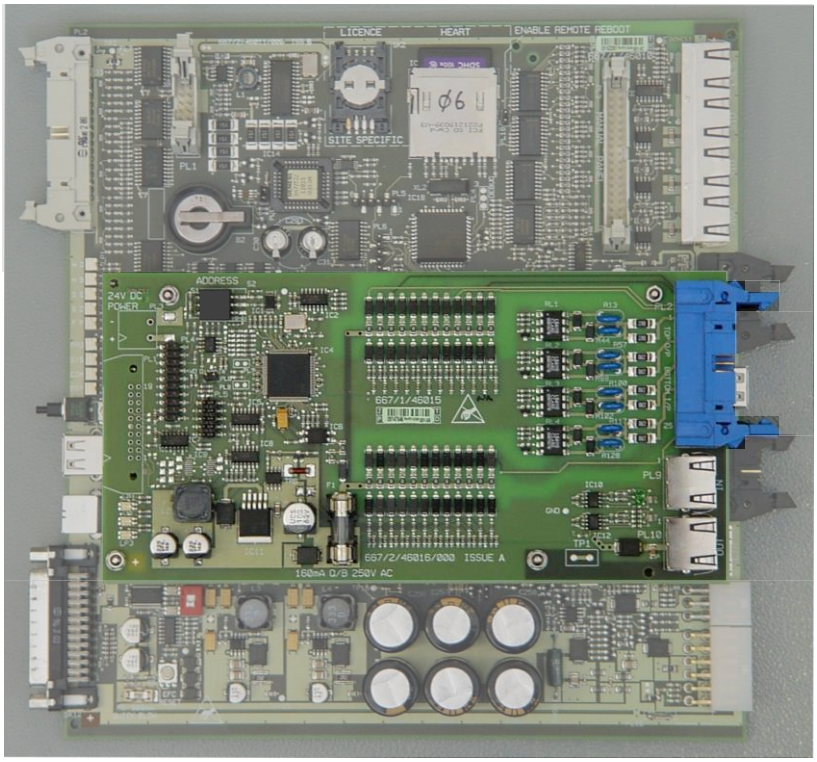


Figure 22 – CPU I/O Card

Pin	Top Row	Bottom Row
1	Output 1 Common	Input 1
2	Connected to Pin 1	Input 2
3	Output 1 Normally Open	Input 3
4	Output 1 Normally Closed	Input 4
5	N.C.	Input 5
6	N.C.	Input 6
7	Output 2 Common	Input 7
8	Connected to Pin 7	Input 8
9	Output 2 Normally Open	Input 9
10	Output 2 Normally Closed	Input 10

11	N.C.	Input 11
12	N.C.	Input 12
13	Output 3 Common	Input 13
14	Connected to Pin 13	Input 14
15	Output 3 Normally Open	Input 15
16	Output 3 Normally Closed	Input 16
17	N.C.	Input 17
18	N.C.	Input 18
19	Output 4 Common	Input 19
20	Connected to Pin 19	Input 20
21	Output 4 Normally Open	Input 21
22	Output 4 Normally Closed	Input 22
23	N.C.	Input 23
24	N.C.	Input 24
25	0V	0V
26	0V	0V

Table 7 - CPU IO Card Connector Pin Out

4.11 Intelligent Detector Backplane Card

The Intelligent Detector Backplane provides an interface for up to 4 loop detector cards, each loop detector card connecting to 4 loops.

The Intelligent Detector Backplane connects to the CPU Card or previous Intelligent Detector Backplane via the GSPI interface serial cable through which the card also obtains its power supply.

The Loop Detector supply is cabled separately as shown in Figure 23. This supply is normally -24V DC from the HPU, but can be provided from a separate transformer.

A twisted ribbon cable provides the connection between the loop detector cards and the road loops, via the loop termination card. The /950 variant also includes additional connectors to allow the SLD4 loop detector auto-configuration communications link to be wired between multiple backplanes within a controller.

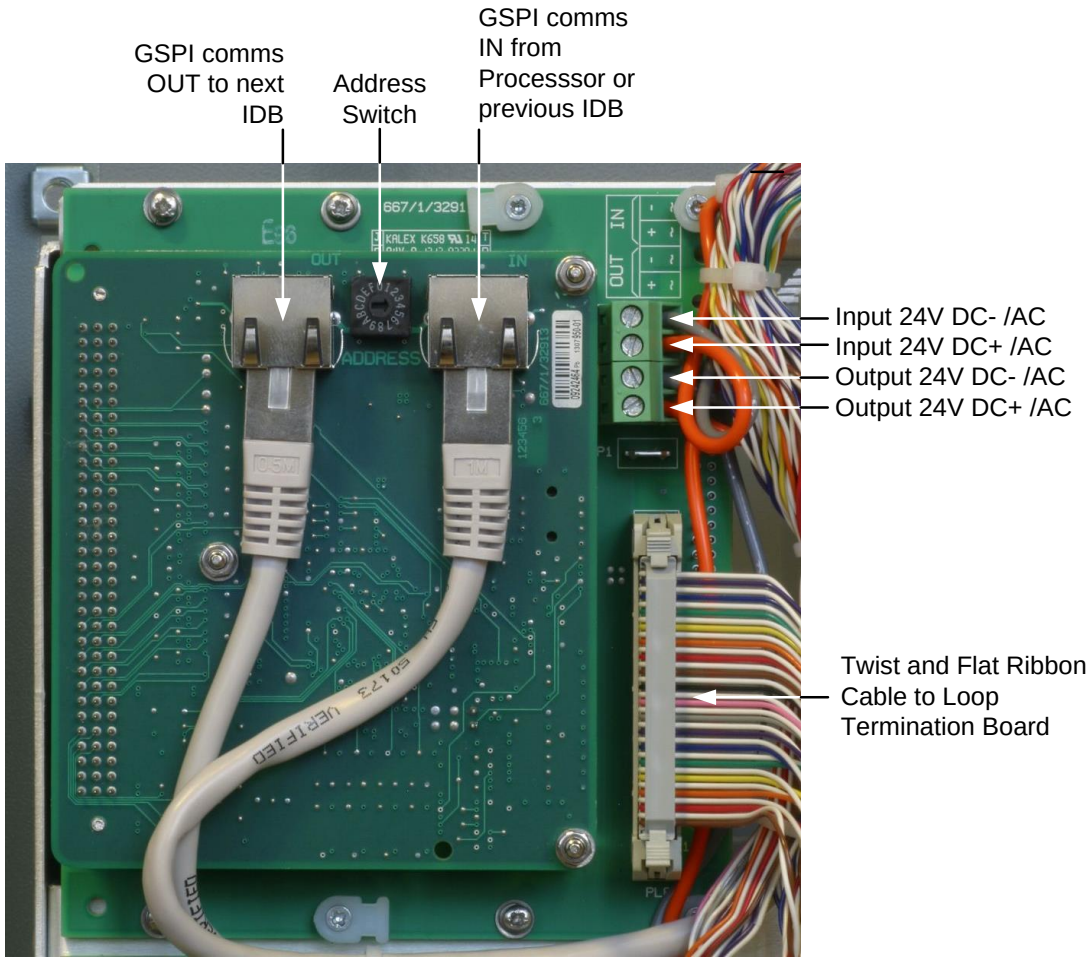


Figure 23 – Intelligent Detector Backplane (rear view)

4.11.1 Intelligent Detector Backplane Card LEDs

The Intelligent Detector Backplane Card has three tri-colour status LEDs which are identical to the LEDs on the I/O card as described in section 4.9.1 above. It should be noted that these LEDs are viewed from above and are seen in reverse order (i.e. LP3, LP2 and LP1 from left to right). For this reason, the table below shows the LEDs in the order they are seen.

Watchdog LED (LP3)	Software Run LED (LP2)	Comms Active LED (LP1)	State
Off	Yellow	Yellow	Processor Reset
Red	Yellow	Yellow	Watchdog Failure
Off	Green Steady	Off	Performing Start Up
Off	Green Flash	Red	Awaiting Start
Off	Green Flash	Green Toggle on Receipt of Message*	Communications Active

Watchdog LED (LP3)	Software Run LED (LP2)	Comms Active LED (LP1)	State
Off	Green / Red Alternating	Off	Invalid Address
Off	Red Flash	(As above depending on state)	Major Fault Detected

* - May flash so fast that it looks like Green Steady.

Table 8 – Intelligent Detector Backplane Card LEDs

Conditions other than those identified above should not occur and can be treated as faults.

4.11.2 Intelligent Detector Backplane Card Rotary Address Switch

This screwdriver-adjustable switch is located on the Intelligent Detector Backplane card(s) as shown in Figure 23 and is set up for the card address (before the controller is powered up) in accordance with the appropriate Works Specification. The valid address range is 1 through 15 (where A to F denote 10 to 15 respectively). Address 0 is the default address switch position for spare cards.

The address range is shared with the I/O cards and must be unique.

4.11.3 Loop Detector Power

The power for the Loop Detector cards is taken from the 12-way Loop Detector Supply Terminal Block TBZ on the side termination panel or from a separate -24V DC supply. See Figure 24 for the power connections on the Intelligent Detector Backplane.

The Loop Detector Supply Termination Block TBZ is powered from the HPU and is capable of supplying a maximum of 2.8A at -24V DC for above ground detectors and Loop Detector Cards.

If the total current drawn by the Loop Detector Cards and above ground detectors exceeds 2.8A, then an additional power supply kit must be fitted into the cabinet. Both 50VA and 160VA DC kits are available. See the ST950 Family General Handbook.

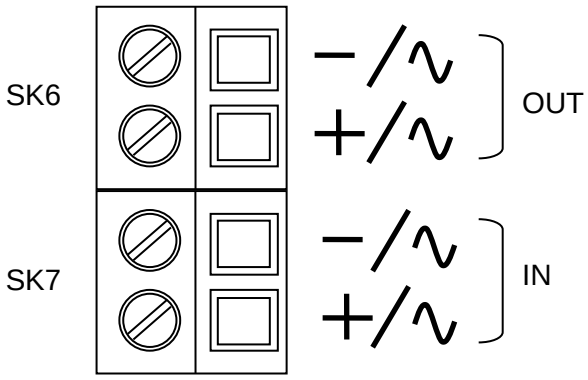


Figure 24 – SK6 and SK7 Connections for Loop Detector Power

4.12 Loop Detector Cards

The Loop Detector cards pick up the Loop Detector Power from SK7 on the Intelligent Detector Backplane Card. that they are plugged into.

Further information regarding Loop Detector Cards is available in the following documents:

667/HB/45200/000 - SLD4 Loop Detector Handbook or

667/HB/27663/000 - ST4S Loop Detector Handbook

4.13 LSLS Card and Backplane

The LSLS card provides 32 uncommitted current and voltage monitored switched outputs to the ELV signal aspects. Each LSLS card is fitted into an LSLS backplane on the side panels of the cabinet. A maximum of 3 LSLS cards can be fitted into an ST950 ELV controller cabinet. A further 3 additional LSLS cards can be fitted in an adjacent expansion cabinet.

The LSLS backplane terminates the street cabling, allowing connection of up to 4 wires for each of the 32 aspect drive outputs and gives a total of 64 return terminations.

In addition, the LSLS backplane provides a connection for:

- The power supplied via the HPU
- Daisy-chained connections for the high-speed serial communications from the CPU Card or previous LSLS card
- Inputs for monitoring regulatory sign current
- A means of setting the address of the LSLS card.

IC4 can be used to print self-adhesive labels for the LSLS backplane to identify the phase and colour of each street termination.

Each of the 32 outputs has an associated LED showing the status of that output. The LED is tri-colour and should be the appropriate colour assigned to the output (except during Self Test when all LED's illuminate yellow).

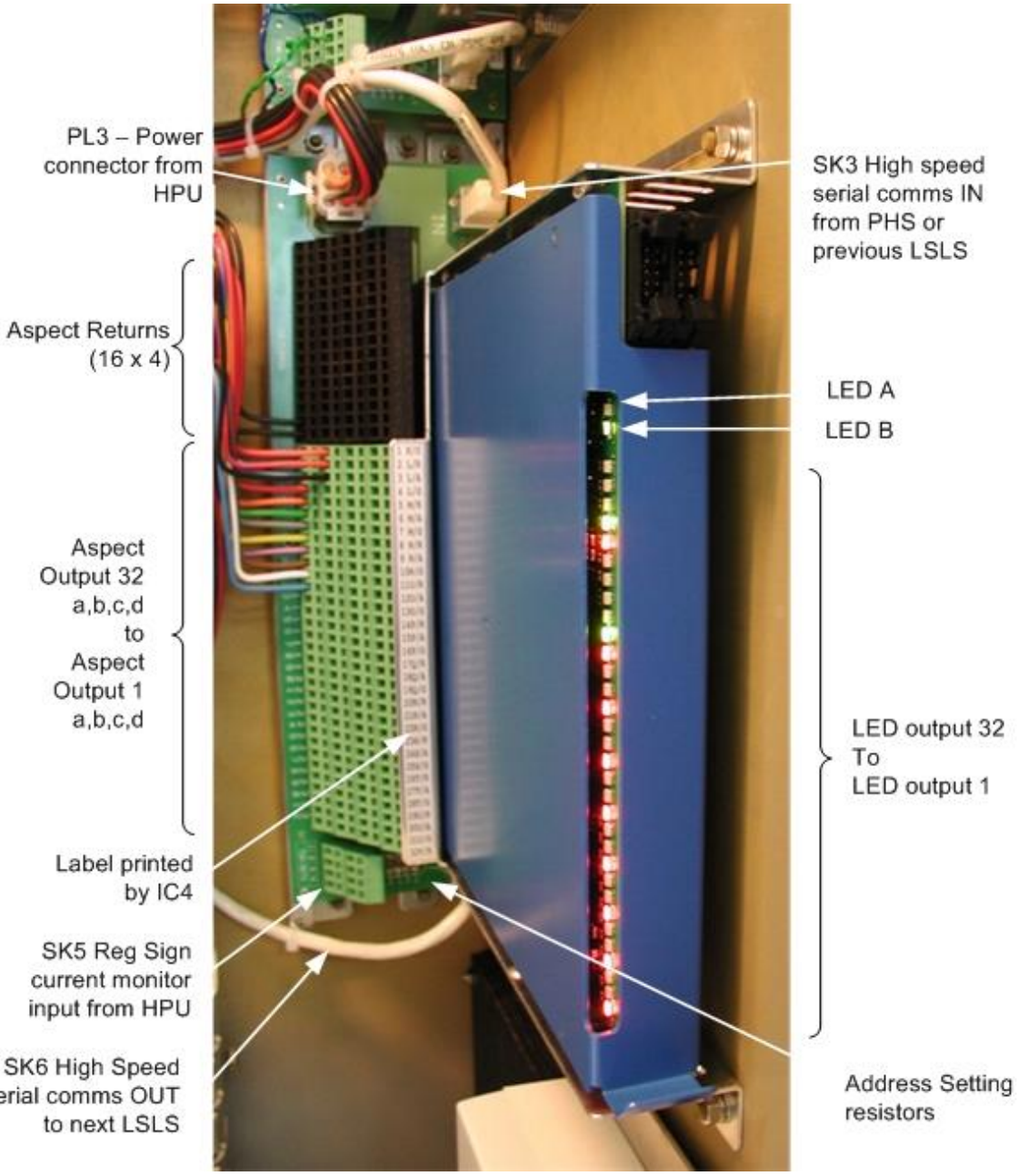


Figure 25 – LSLS Card and Backplane

4.13.1 LSLS Outputs

The LSLS outputs can be configured to be lamp monitored. Typically, outputs that drive Aspects, Pedestrian Waits, Pedestrian Red and Green Nearsides and Demand/Wait Indicators can be lamp monitored. Outputs that drive Tactiles and/or

Audibles cannot be lamp monitored due to the nature of the load that these devices present to the LSLS.

Where an output is used to drive a combination of Pedestrian Nearside Green and Audible and/or Tactile units, it is NOT possible to enable lamp monitoring on this output.

See the ST950 Family General Handbook for the number and combinations of devices that can be fitted to an LSLS output.

4.13.2 LSLS Addressing

The LSLS card address is set by physically removing one or more of the resistors labelled R1 to R4 on the LSLS backplane.

This is done during manufacture, but if an LSLS backplane is replaced in the field, it is important that the card address is configured correctly. The valid address range is 1 through 6. Figure 26 below shows the address set to 1.

Configuring the address simply requires that the resistors are completely removed by cutting through the component legs. The address range is NOT shared with the I/O cards or Intelligent Detector Backplanes.

The address is set according to the following table:

	LSLS1	LSLS2	LSLS3	LSLS4	LSLS5	LSLS6
R1	Removed	Fitted	Fitted	Fitted	Removed	Fitted
R2	Fitted	Removed	Fitted	Fitted	Fitted	Removed
R3	Fitted	Fitted	Removed	Fitted	Fitted	Fitted
R4	Fitted	Fitted	Fitted	Removed	Removed	Removed

Table 9 – LSLS Addressing

If an address is incorrectly configured, the missing resistor(s) can be replaced with wire links soldered directly across the copper pads.

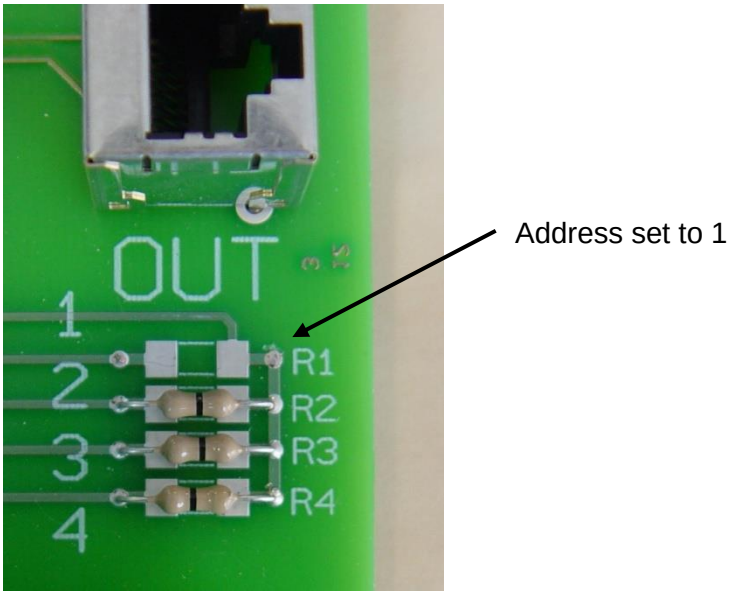


Figure 26 – LSLS Card Addressing

4.13.3 LSLS Status LEDs

The LSLS has two tri-colour status LEDs as shown in Figure 25 which are used to indicate various conditions as follows. Conditions other than those identified should not occur and so can be treated as faults.

LED A	LED B	Meaning	Possible Cause
Yellow	Yellow	Reset	Start up (if brief) Comms lost to main processor (if brief) Hardware fault (otherwise)
Red continuous	any	Major fault	The LSLS has detected a major fault
Alternate green		Peripheral download	LSLS powered up with peripheral download link present
Off	Red flash	Awaiting start	LSLS powered up Comms lost to main processor
Off	Yellow flash	Downloading	Main processor is downloading to LSLS
Off	Green flash	Normal operation	Download complete and comms with main processor established.

Table 10 – LSLS LEDs

4.14 Manual Panel

The Manual Panel provides a direct means of manually controlling the junction in a safe manner. The panel cable connects directly to the CPU Card as shown in Figure 19.

The full intersection manual panel is shown in Figure 27 below.

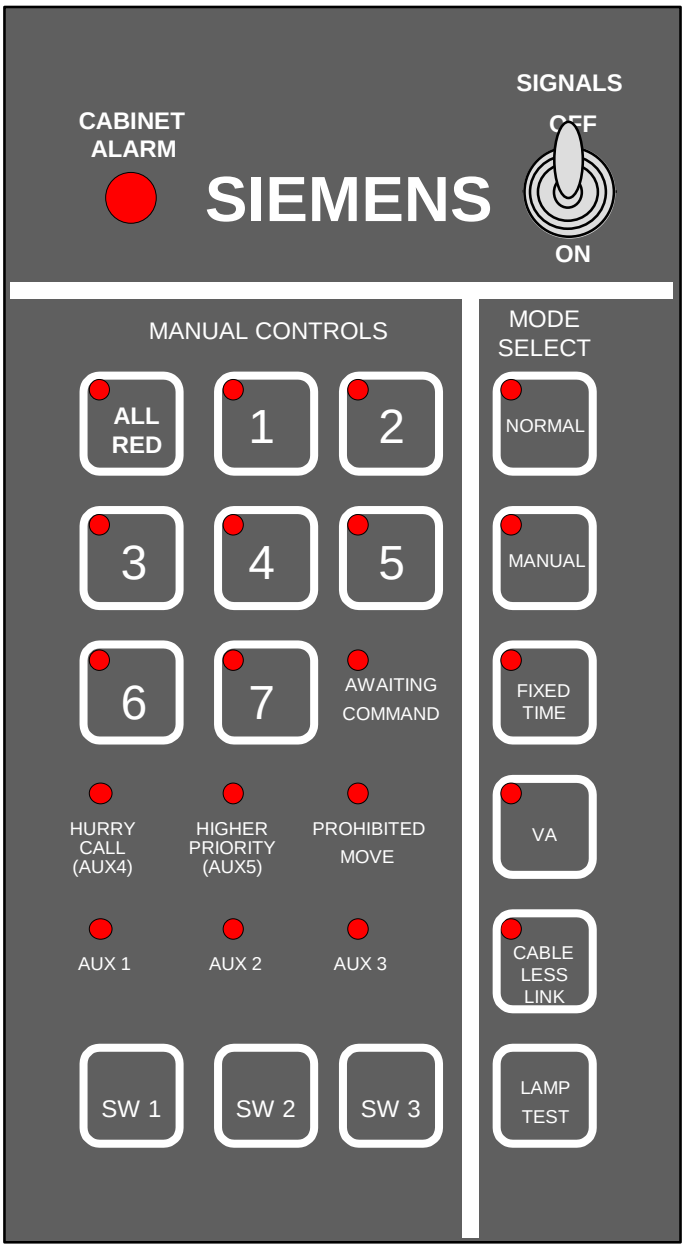


Figure 27 – Manual Panel

4.14.1 Manual Panel LEDs

The LEDs on the Manual Panel are used to identify which stage is active and to display status.

Several versions of the Manual Panel are available and some of the indicators in the following summary may not be present in a particular example.

Button	Function
MANUAL BUTTON INDICATORS	Indicate the stage (or combinations of stage for parallel stage streaming) that the controller has reached when in manual mode. While the controller is moving to the stage, the indicator flashes. When the stage is reached, the indicator stops flashing and remains illuminated.
MODE SELECT	Indicate what mode has been selected. If the mode is unavailable, then the indicator flashes. Note that during the start-up sequence, the indicator for the selected mode flashes, since the controller is in start-up mode, which is always the highest priority. When the start-up is complete, the indicator for the selected mode normally stops flashing and remains on steady. If 'Normal' mode is selected, then the controller also illuminates one of the other mode indicators if the controller is running that mode, e.g. VA.
AWAITING COMMAND LED	Under manual control only, this LED illuminates at the end of the minimum green period, signifying that a new stage may be selected by the stage select pushbuttons. Selection of a stage before the LED is lit is prevented and any such selection is ignored.
PROHIBITED MOVE LED	This LED illuminates if a prohibited stage to stage movement is attempted while under manual control. It remains illuminated until a permitted move is made.
HURRY CALL (AUX 4) LED	Illuminates during all modes of control when there is a hurry call being serviced, or can be configured for an auxiliary function.
HIGHER PRIORITY (AUX 5) LED	Illuminates when there is a mode with a higher priority than manual mode, such as UTC Control, or can be configured for an auxiliary function.
AUX 1 - AUX 3 LEDs	These LEDs can be configured to display auxiliary functions active such as Dim Override.

4.14.2 Signals On/Off Switch

The lamp supply to the phase switch cards is removed immediately OFF is selected on the SIGNALS OFF/ON switch, extinguishing the signals.

Care should be taken to ensure safe traffic conditions before operating the switch.

With the OFF position selected, normal microprocessor control operations continue and the phase selections being implemented can be observed on the Lamp Switch indicators.

Switching the Manual Panel Signals On/Off switch to “Off” does not guarantee isolation of the equipment.

When the switch is returned to the ON position, the signals turn on in the required switch on sequence.

4.14.3 Lamp Test Button

A button on the Manual Panel enables the indicators on the panel, including the Cabinet Alarm Lamp, to be checked.

When the button is pressed, all LEDs on the Manual Panel should light. The lamp test is carried out under software control, and although correct results indicate that the processor is communicating with the Manual Panel, it does not guarantee that no faults are present.

4.14.4 Stage Select Buttons (All Red, 1 - 7)

With Manual mode selected (Manual LED lit), the keys ALL RED, 1 - 7 select the configured stage (or combination of stages) provided the AWAITING COMMAND indicator is illuminated and a prohibited stage move is not requested.

4.14.5 Mode Select Buttons (Manual, VA, Fixed Time, Etc)

These keys select the required mode for the controller.

The controller can be configured so that manual mode is only available if a handset is plugged in. An alternative configuration is such that manual mode may only be selected following a specific handset command (see MND command).

4.15 Audible Driver Module

4.15.1 Audible Driver Module - Single Output type (obsolete)

The original style of Audible Driver Module (pictured in Figure 28 below) was able to drive either loud or quiet audible indicators, but not both. This module has been superseded by an updated version (see section 4.15.4) which offers backwards compatibility, but also permits both loud and quiet audible indicators to be driven from a single module. Information on the original single-output module is retained here to allow servicing of the original module.

In order to drive audible indicators, an Audible Driver Module Kit of Parts is required. The module is powered from the phase Green of the relevant pedestrian phase output of the LSLS card and provides a regulated 12V DC to the audible indicators.

The module can be connected to an I/O card to allow operation to be inhibited (for example at night).

The Audible Driver Module will operate at both dim and bright lamp voltages.

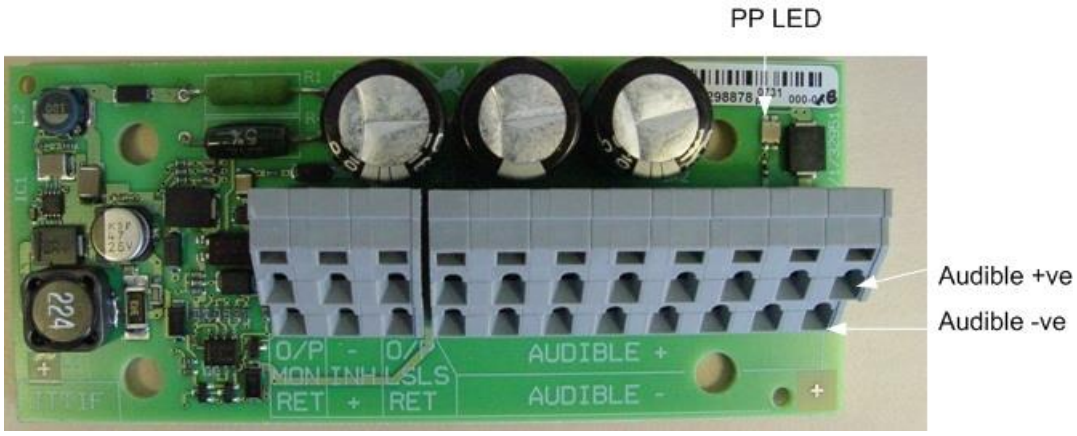


Figure 28 – Audible Driver Module – Single Output type

The Power Present (PP) LED on the module lights when the audibles are being driven. Each Audible Driver Module can drive up to 8 audibles. It is recommended that all audibles connected to an Audible Driver Module are the same type.

Audible indicators recommended are:

- Sonalert Mallory SC682P
- Highland Electronics SC682P
- Roxborough SPCI535A4
- Askari (Tone22 – variable volume)

The above indicators are functional equivalents. Any audible indicator that operates from a nominal 12V DC supply and takes a maximum of 18mA may be used as an alternative to the above.

The Audible Driver Module is connected as shown in Figure 29 below and is mounted on the rear panel in the controller cabinet using the screws supplied in the KOP.

Where more than 8 audible units need to be driven simultaneously, it is acceptable to connect up to 4 Audible Driver Modules in parallel to each LSLS output, giving up to 32 audible units per LSLS output.

In order for the Audible Driver Module to operate, the two “Inhibit +” and “Inhibit –” connections on the Audible Driver Module must be shorted together. Where it is desired to switch off the Audible Driver at certain times of the day, the Inhibit connections can be connected to the ‘Common’ and ‘Normally Open’ connections of an I/O card.

Where two Audible Driver Modules are connected in parallel, it is important that the “INH -” connections are paralleled and the “INH +” connections are paralleled. Do NOT connect “INH +” of one Audible Driver Module to “INH -” of another.

Tactiles and/or Audibles must not be paralleled with Pedestrian Greens if the Pedestrian Green is to be lamp-monitored.

A maximum of 4 Tactile Units and 1 Audible Driver Module (8 sounders) or 2 Tactile Units and 2 Audible Drivers (16 sounders) can be simultaneously driven from one LSLS output.

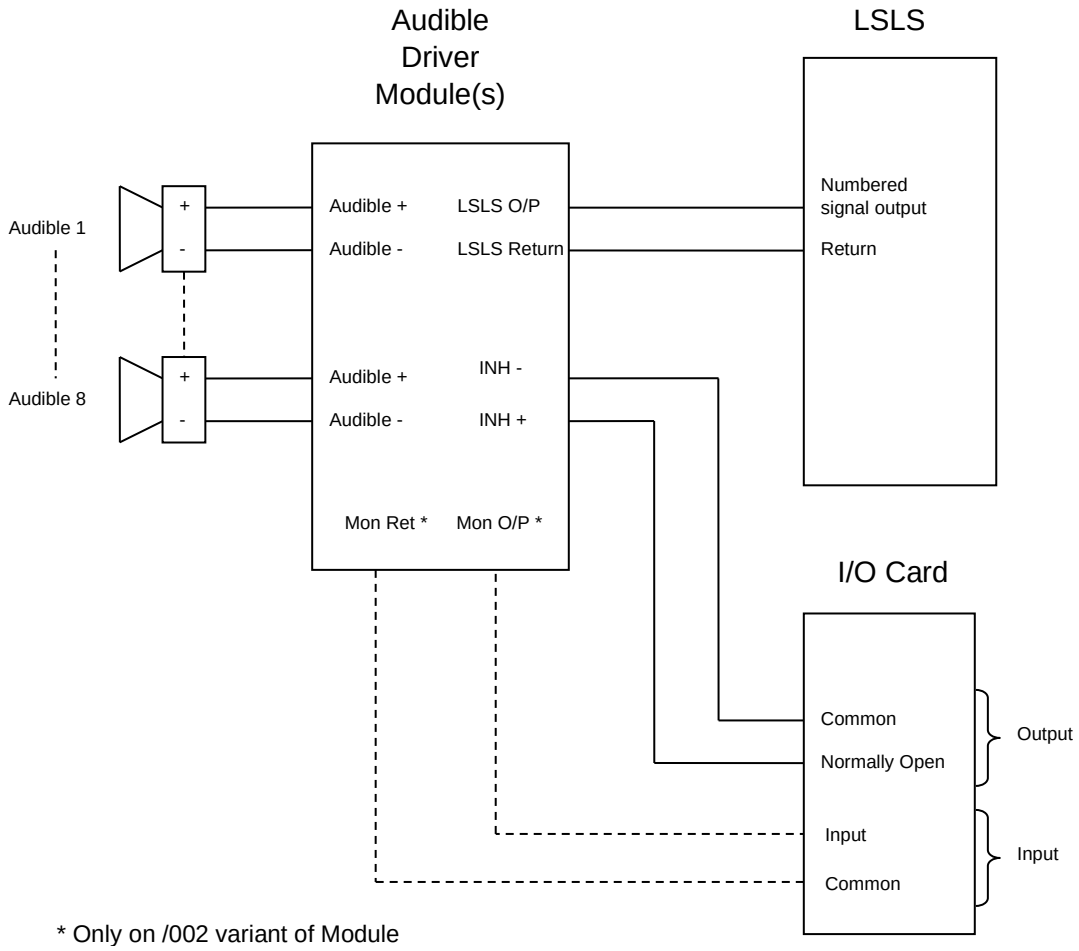


Figure 29 – Audible Driver Module Connections – Single Output type

4.15.2 Monitored Audibles – Single Output type

The /002 variant of the Audible Driver Module has an opto-isolated Monitor Output that is open-circuit when the audible is voltage is less than 5V and short-circuit when the audible output has a voltage present of more than 5V. This allows independent monitoring of the voltage on the audible output. The Monitor Output can be wired directly to an input of the I/O card.

4.15.3 Dual Level Audibles – Single Output type

The recommended technique for connecting Dual Level Audibles (for the single-output type) is shown in Figure 30.

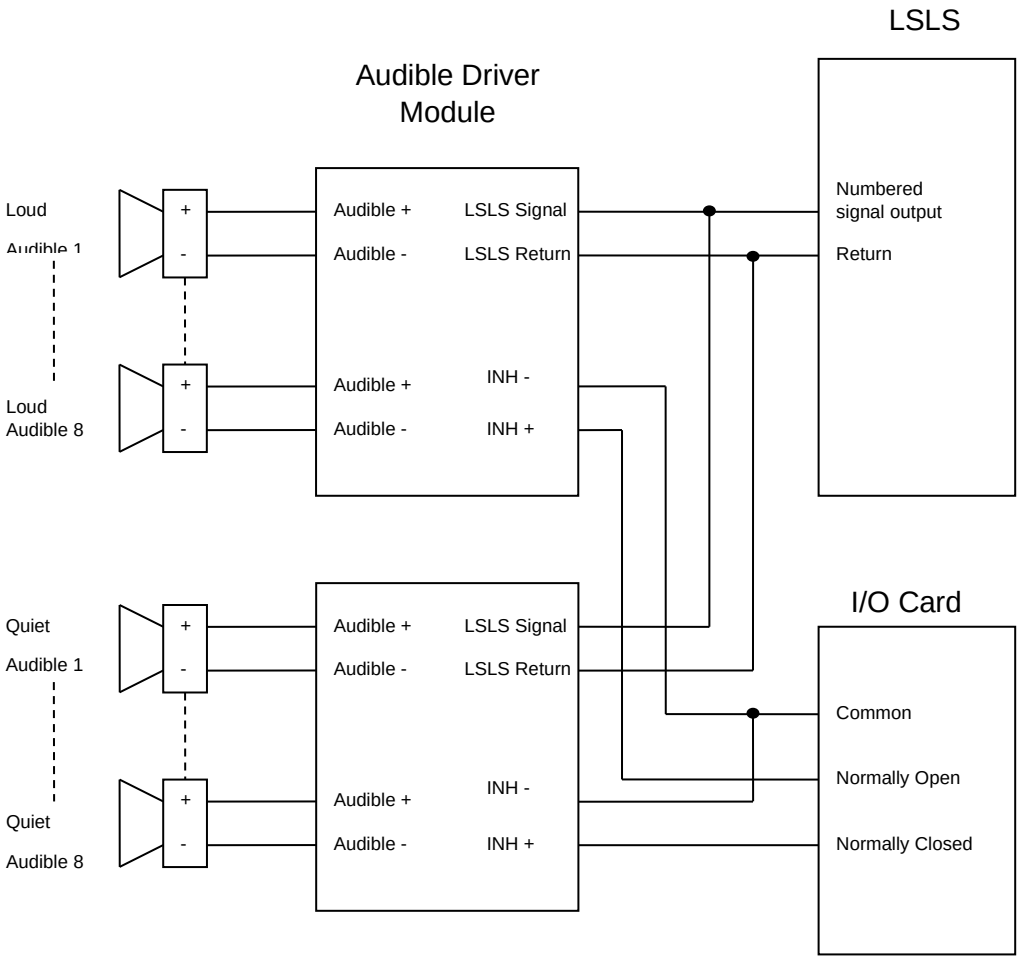


Figure 30 – Dual Level Audible Driver Module Connections – Single Output type

4.15.4 Audible Driver Module - Dual Output type

In order to drive audible indicators, an Audible Driver Module Kit of Parts (KOP) is required – Siemens part number 667/1/32955/000. The module is powered from the phase Green of the relevant pedestrian phase output of the LSLS card and provides a regulated 12V DC to the audible indicators.

The module can be connected to an I/O card to allow operation to be inhibited (for example at night), and to allow switching from Loud to Quiet audible indicators.

The Audible Driver Module will operate at both dim and bright lamp voltages.

CAUTION

Do not touch components on the Module: voltages of up to 81V peak could be present, and components could be hot

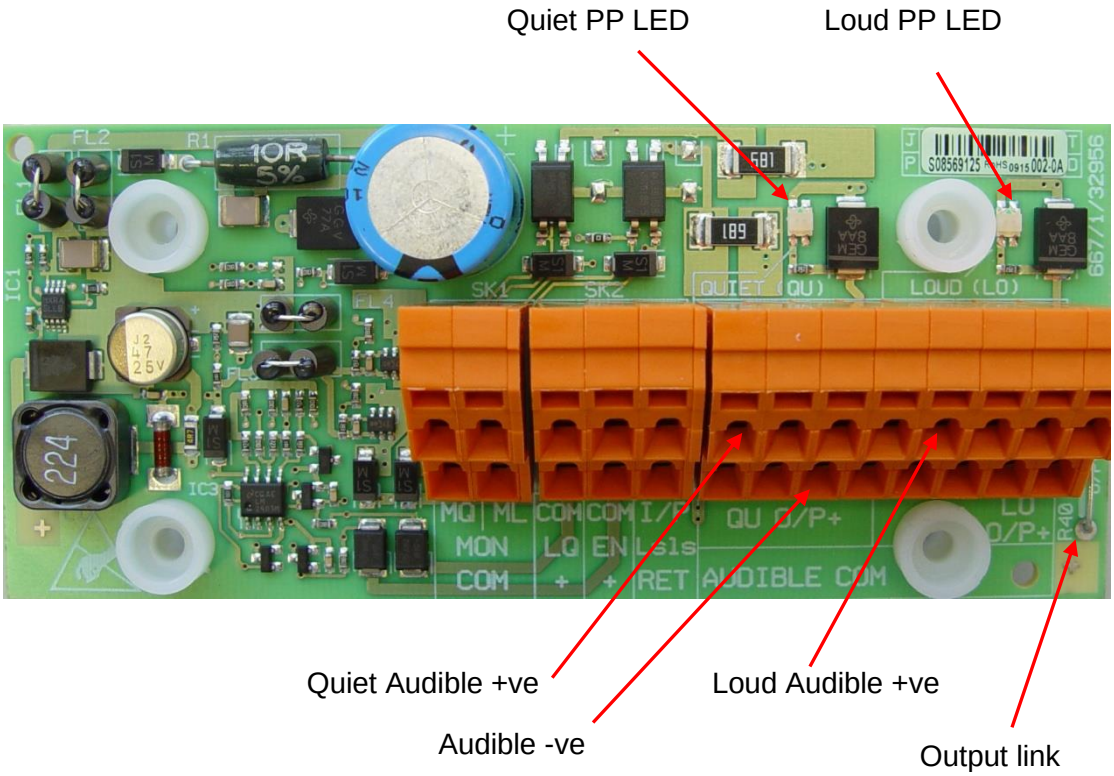


Figure 31 – Audible Driver Module

The updated Audible Driver Module provides 4 outputs for Loud indicators and 4 outputs for Quiet indicators. A link position is normally fitted to connect these outputs together, giving 8 audible indicator outputs which are energised whether Loud or Quiet is selected (this gives full compatibility to the previous version of the Module). Cutting the output link allows separate control of Loud and Quiet outputs.

Separate monitor circuits are provided for Loud and Quiet outputs, but note that Special Conditioning is required to perform the monitoring.

There are separate Power Present (PP) LEDs on the module, for Loud and Quiet outputs, which light when the audibles are being driven. It is recommended that all audibles connected to an Audible Driver Module are the same type.

- Audible indicators recommended are:
- Sonalert Mallory SC682P
- Askari (Tone22 – variable volume)

The above indicators are functional equivalents. Any audible indicator that operates from a nominal 12V DC supply and takes a maximum of 18mA may be used as an alternative to the above.

The Audible Driver Module is mounted on the rear panel in the controller cabinet using the screws supplied in the KOP. When Loud/Quiet switching is not required, the Audible Driver Module is connected as shown in Figure 32 below.

In order for the Audible Driver Module to operate, the EN (Enable) "+" and "COM" connections on the Audible Driver Module must be shorted together. Where it is desired to switch off the Audible Driver at certain times of the day, the Enable connections can be connected to the 'Common' and 'Normally Open' connections of an I/O card.

When it is desired to switch audibles from Loud to Quiet operation (eg at different times of day), the Output Link (R40) must be cut, and Quiet audibles must be connected to Quiet Output + (QU O/P+) with Loud audibles connected to Loud Output + (LO O/P+). The LQ input "+" and "COM" must then be connected to the 'Common' and 'Normally Open' connections of an I/O card output, such that the LQ input is open circuit for Loud operation, and short circuit for Quiet operation.

Where more than 8 audible units need to be driven simultaneously, it is acceptable to connect up to 4 Audible Driver Modules in parallel to each LSLS output, giving up to 32 audible units per LSLS output.

Tactiles and/or Audibles must not be paralleled with Pedestrian Greens if the Pedestrian Green is to be lamp-monitored.

Where two or more Audible Driver Modules are connected in parallel, it is important that the connections for EN and LQ are paralleled so that the "COM" connections both go to I/O card 'Common', and the "+" connections to I/O card 'Normally Open'. Do NOT connect "COM" of one Audible Driver Module to "+" of another. See Figure 33.

In systems with Audibles on more than one Green phase, there must be no connection of AUDIBLE COM or LQ/EN COM between the units. This requires that LQ and EN inputs are connected to separate I/O Card outputs. See Figure 34.

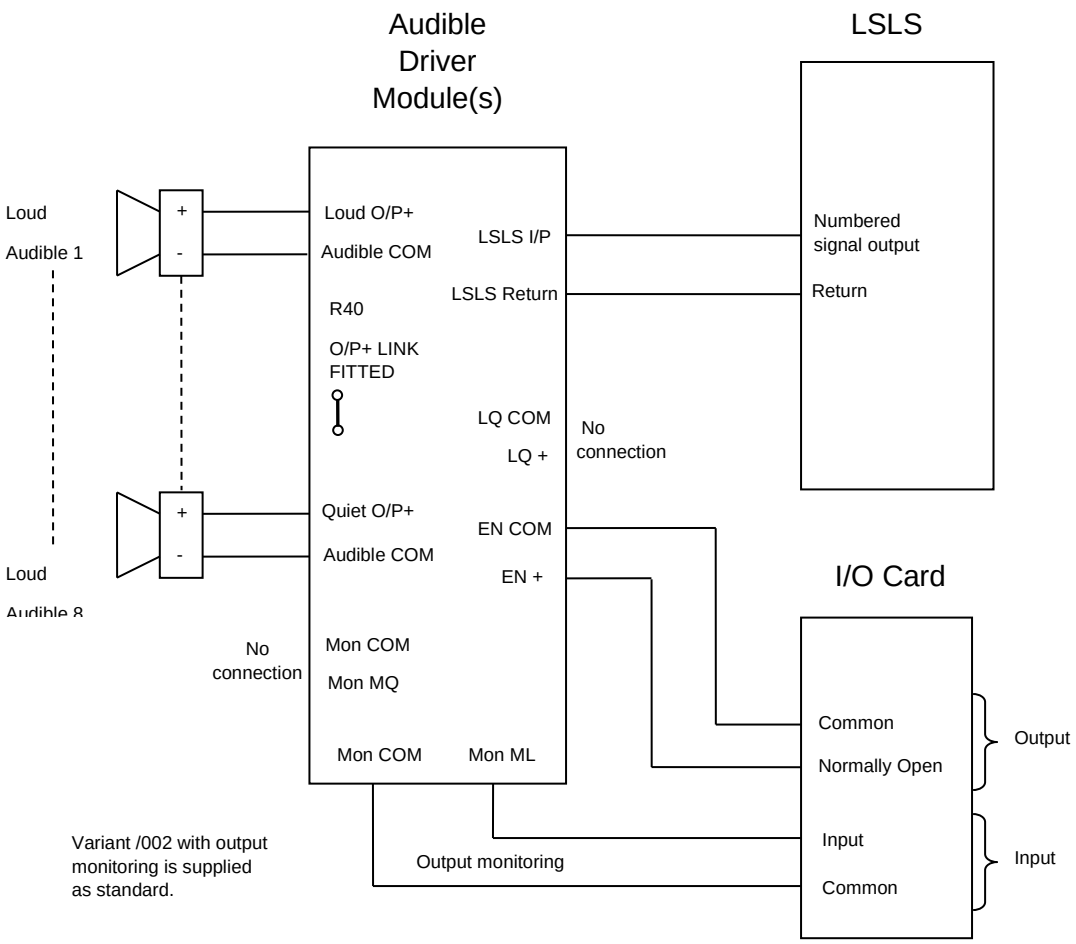


Figure 32 – Audible Driver Module Connections – Loud only

4 Tactile Units and 1 Audible Driver Module (8 sounders) or 2 Tactile Units and 2 Audible Drivers (16 sounders) can be simultaneously driven from one LSLS output.

Note 1: The MON COM connections are not connected to AUDIBLE COM or LQ/EN COM. AUDIBLE COM and LQ/EN COM are not the same as COMMON on I/O Card inputs: AUDIBLE COM and LQ/EN COM are connected to the LSLS I/P and are 'energised' when the green phase is active, whereas COMMON on the I/O Card input is grounded.

Note 2: Output Monitoring is performed using Special Conditioning. If more than one Audible Module is connected, the Monitor outputs must be taken to separate digital inputs, with separate blocks of Special Conditioning code used to monitor each Audible Driver Module.

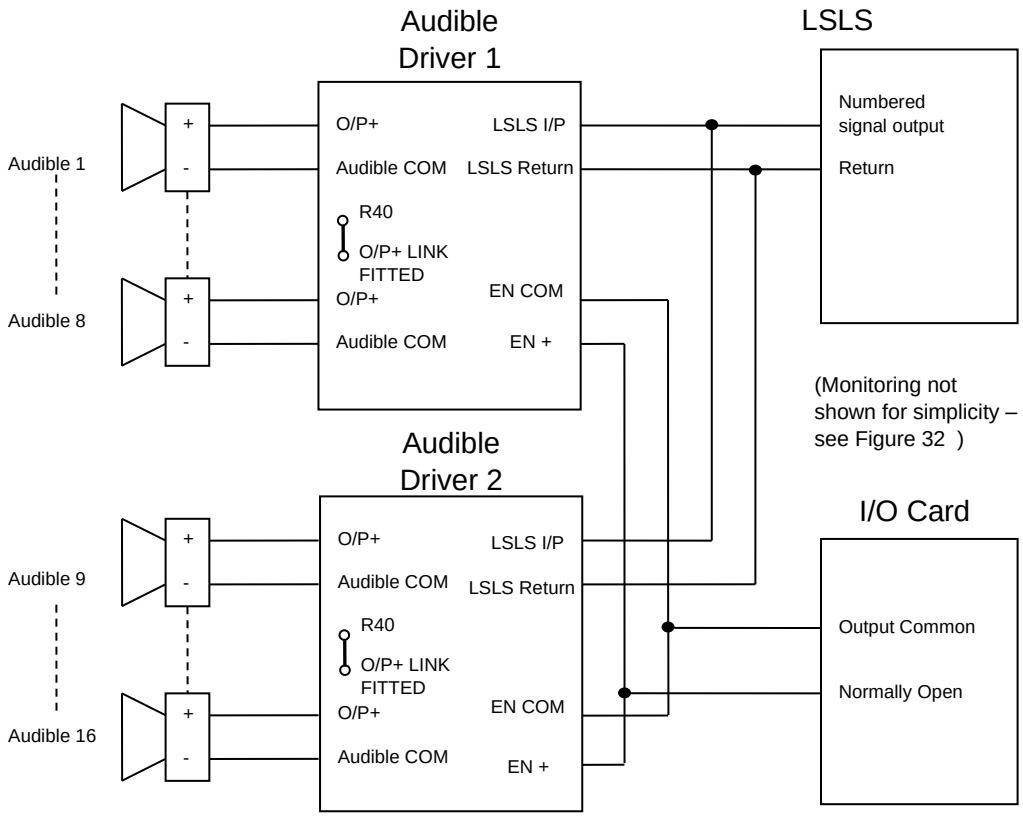


Figure 33 – Audible Driver Module Connections – Parallel Modules

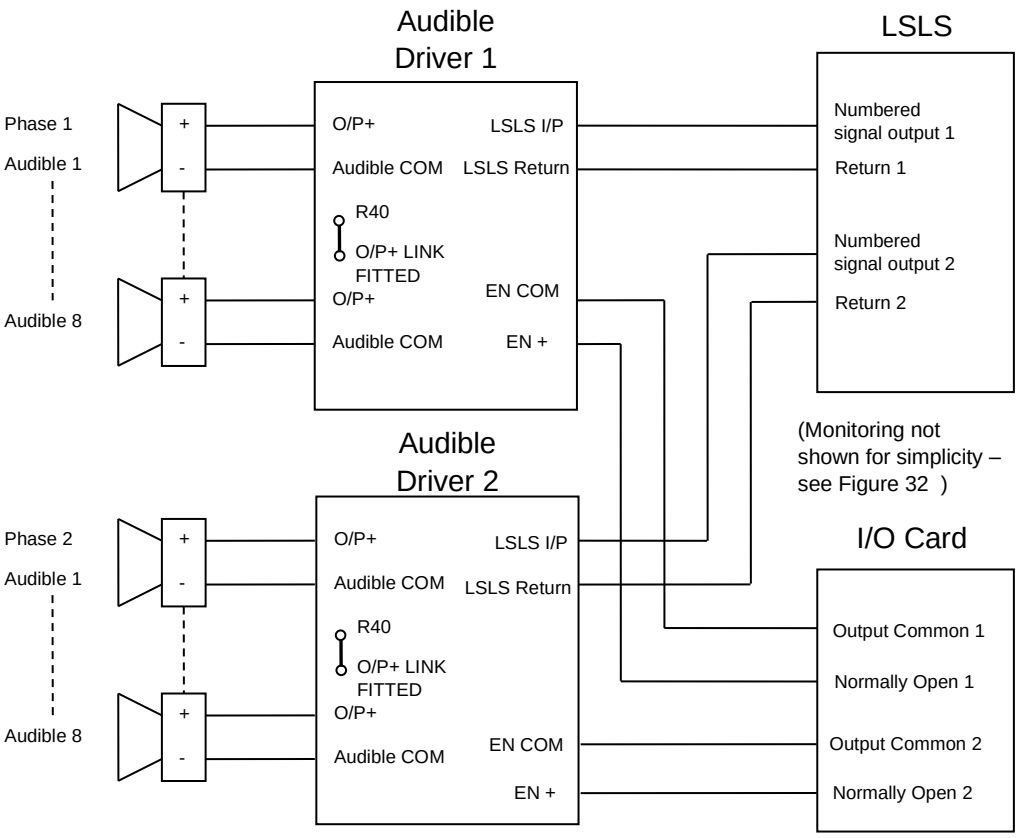


Figure 34 – Audible Driver Module Connections – Separate phases

4.15.5 Connections for Dual Level Audibles - Dual Output type

The recommended technique for connecting Dual Level Audibles is shown in

Figure 35. Link R40 must be cut. Although only 4 outputs are provided for each type of Audible, the Module is capable of driving up to 8 Audibles at Quiet or 8 Audibles at Loud (for example, using a white terminal strip to expand the wire connections).

If it is not required to disable all audibles at any time, a local wire link from

EN + to EN COM can be fitted instead of a connection to an I/O Card output. Separate monitoring of Loud and Quiet outputs is provided by the Audible Driver Module, but only one wire interconnecting the I/O Card 'Input Common' pins and the Audible Driver Module 'Mon COM' pins is required.

Note that Special Conditioning is required to perform the monitoring.

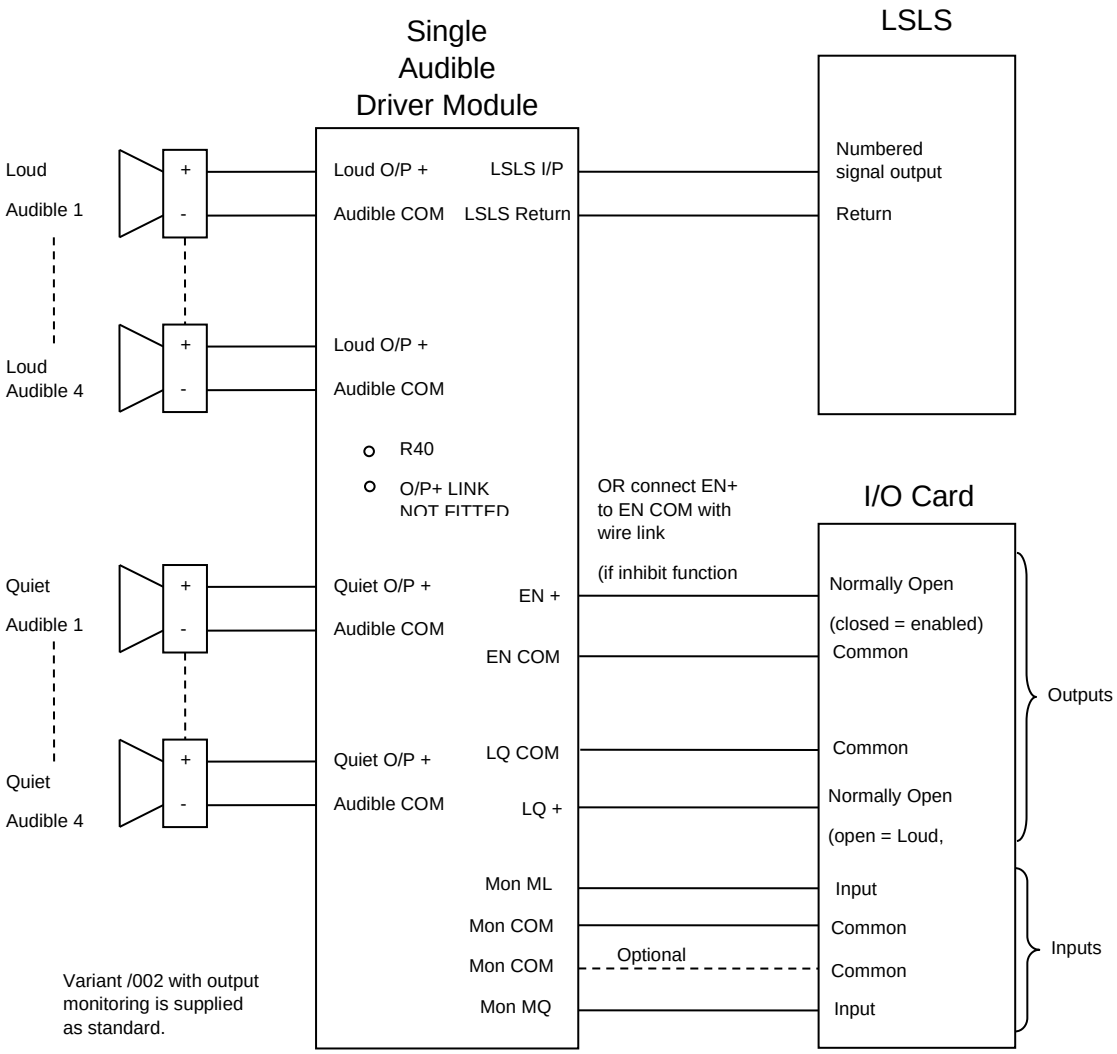


Figure 35 – Dual Level Audible Driver Module Connections

4.16 Pedestrian Tactile Indicators

The ST950 ELV controller can be fitted with either switched or non-switched tactiles.

Non-switched tactiles are wired directly across the pedestrian green. Whenever the pedestrian green is illuminated, the tactile rotates. These tactiles must not be used at crossings with a flashing green man period.

The connections required for a non-switched tactile are shown in Figure 36

Switched tactiles are tactiles that can be disabled when required by use of an IO card output.

The connections required for a switched tactile are shown in Figure 37

Some manufacturer's tactiles (e.g. Radix Traffic ITE220) also have a fault output that can be wired back to an input of a digital IO card in the controller cabinet. This fault output has the following functionality:

ITE220 Function	Fault Output
Tactile not powered	Open-circuit
Tactile powered and stalled (held or stuck)	Open-circuit
Tactile powered and motor open or short circuit	Open-circuit
Tactile powered and cone able to rotate	Closed-circuit

Special conditioning in the controller will discriminate between short-duration fault conditions (such as the tactile being temporarily held stalled) and a permanent fault that requires maintenance.

The connections required for a switched tactile with fault output is shown in Figure 38

There are several mounting options for the tactile controller module;

When using tactiles with integrated motor and drive module, the assembly can be mounted in the pedestrian indicator.

When using tactiles with separate motor and drive module , the drive module can be mounted inside the nearest Helios signal head (the recommended position for mounting the tactile controller is at the top of the Amber aspect case – see Helios General Handbook 667/HB/30000/000) or the drive module can be mounted inside the traffic controller cabinet.

Figure 36, Figure 37 and Figure 38 show how tactiles can be connected to an ELV traffic controller.

A maximum of 4 tactiles (either switched or non-switched types) can be driven in parallel from a single LSLS output.

Tactiles and/or Audibles must not be paralleled with Pedestrian Greens if the Pedestrian Green is to be lamp monitored.

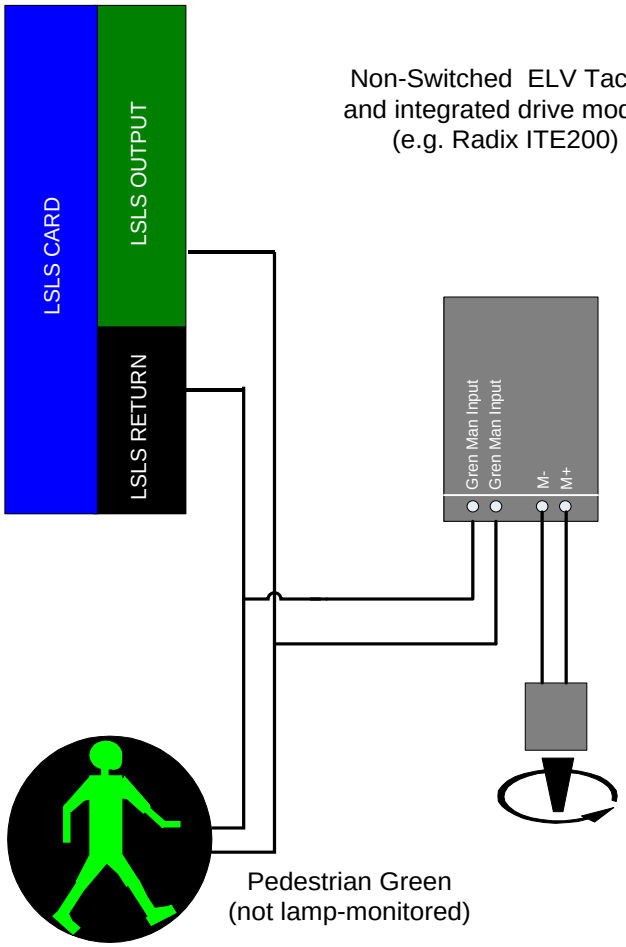


Figure 36 – Pedestrian Green-Man drive and non-switched Tactile connections

A non-switched tactile must not be used at a crossing with a flashing green man period. For crossings with a flashing green man period, a switched tactile must always be used and the tactile drive period limited to the solid-green period of the pedestrian green by means of the enable input of the tactile.

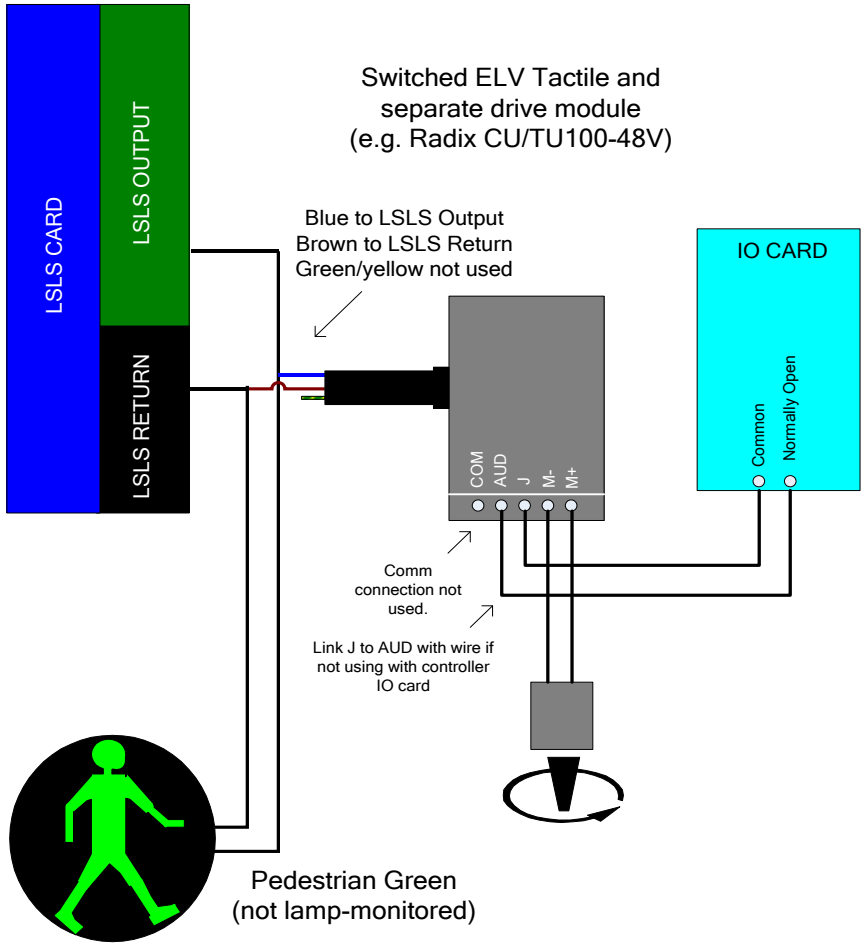


Figure 37 – Pedestrian Green-Man drive and switched Tactile connections

The ITE220 should be installed in preference to the CU/TU100-48V wherever possible

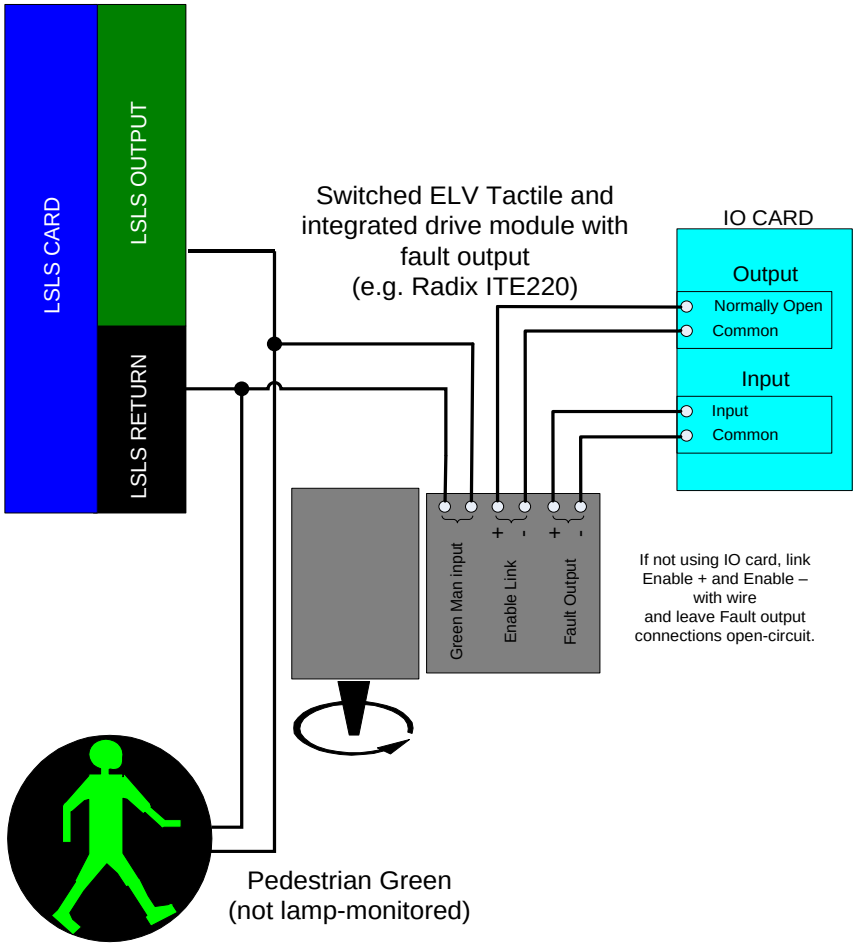


Figure 38 – Pedestrian Green-Man drive and switched Tactile connections with fault output

Do not try to use a single common return between the tactile and the IO card (ie do not link the IO card “Input Common” to “Output Common”)

If wiring tactiles in parallel:

Connect Enable + of each tactile together and Enable – of each tactile together (if used)

Similarly, connect the Fault Output + or each tactile together and Fault Output – of each tactile together (if used)

4.17 ELV Solar Cell

The ELV Solar Cell connects directly to the HPU connector SK2 as shown in Figure 39 below.

The solar cell is powered from -24V DC from the HPU.

For the controller to be able to switch between dim and bright correctly, it is important that LSLS1 is connected to the PL4 of the HPU.

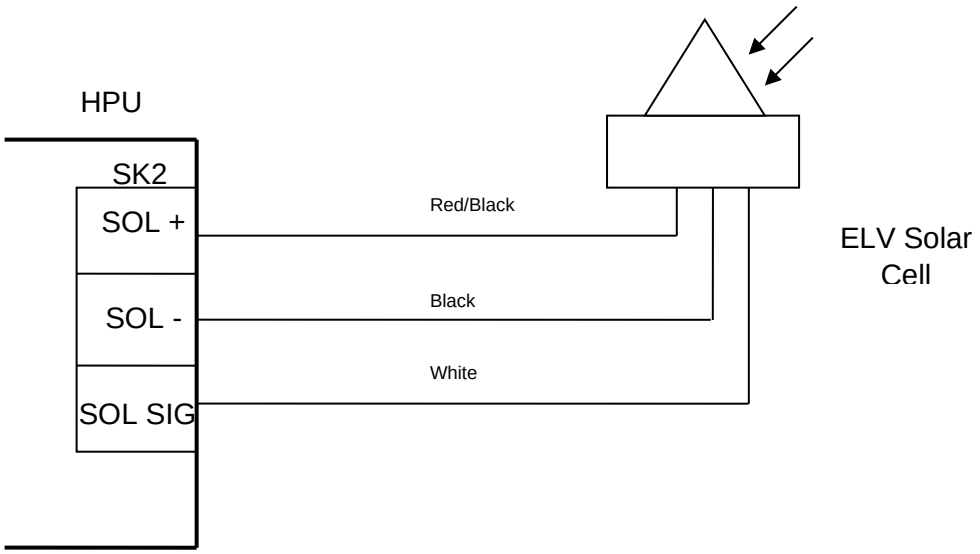


Figure 39 – Solar Cell Connections

4.18 Above Ground Detectors

Above-ground detectors provide detection for pedestrians and vehicles. The power for the detector is taken from the 12-way Loop Detector terminal block or, if more current is required than this supply can support (2.8A) a separate -24V DC supply (2A or 6A) can be fitted.

The detector outputs connect directly to the I/O card inputs.

See the documentation relevant to the particular detector devices being used.

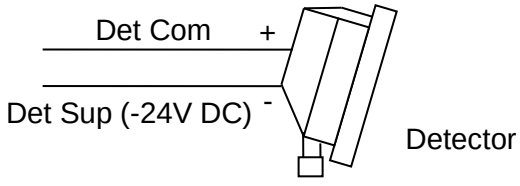


Figure 40 – Above-Ground Detector Connections

4.19 Regulatory Signs Expansion Kit

The regulatory sign expansion kit is required whenever the number of ELV regulatory signs exceeds the basic capacity of the ST950ELV (8 signs). It consists

of a separate transformer and PCB module for powering a further 12 signs. Lamp monitoring is performed (if required) by two LSLS external monitor input channels.

The wiring between the transformer and PCB module is detailed by drawing 667/GA/33070/000 (sheet 2) which is supplied with the ELV Regulatory Sign Extension Kit. The kit is installed above the HPU on the left hand wall of the controller cabinet with the additional transformer mounted above the PCB module.

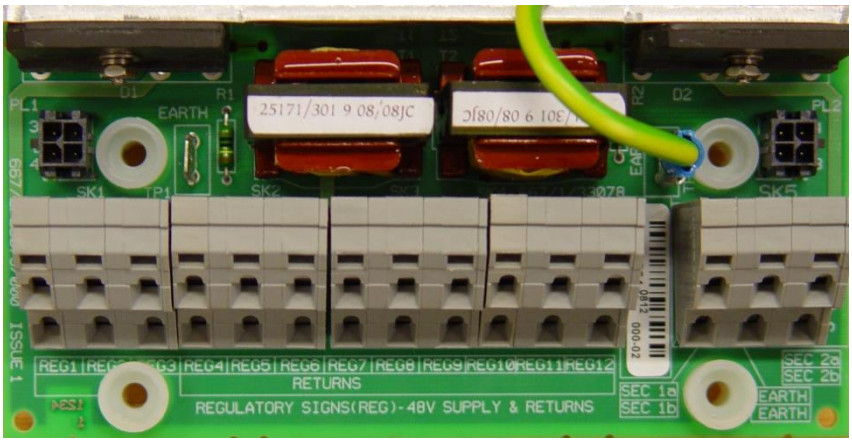


Figure 41 – Regulatory Expansion PCB Module

Care should be taken to avoid direct contact between the cabling and the heatsink at the rear of the expansion kit module. The module is secured to the cabinet with 4 screws (supplied with the kit). The transformer is attached to the cabinet directly above the PCB module.

The street cabling to the regulatory signs is connected to the cage-clamp connector block located on the expansion kit PCB module. Up to twelve regulatory signs may be connected, arranged in two groups of six [These are labelled REG1..REG12 on the PCB ident in the same manner as the HPU reg. sign connections]. The connection point closest to the p.c.b. is the common return connection.

A common return may be utilised for regulatory signs. If using a common return, ensure the cable loading limits are not exceeded.

Two twisted pair cables connect the LSLS module external (toroid) inputs to the current output connectors of the module. These are located at either end of the PCB module and use four way Molex style connectors.

Take care to observe the polarity of the connections when terminating the cable at the LSLS cage clamp connector. The blue wire must be closest to the PCB.

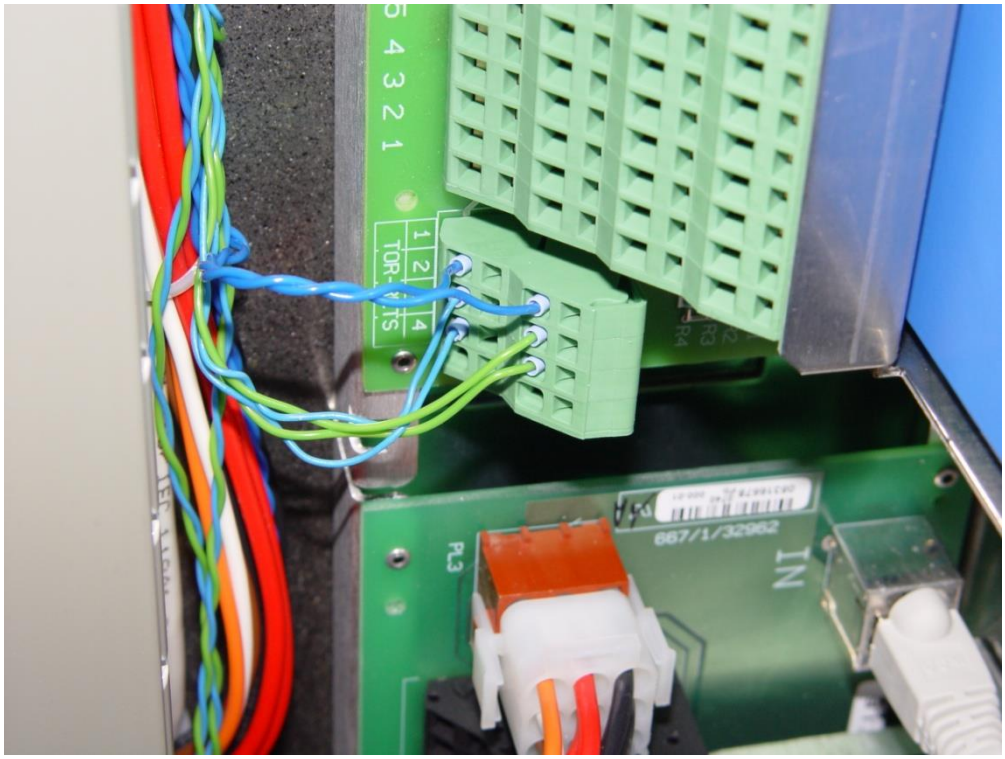


Figure 42 – LSLS Cable Terminations from Expansion Kit

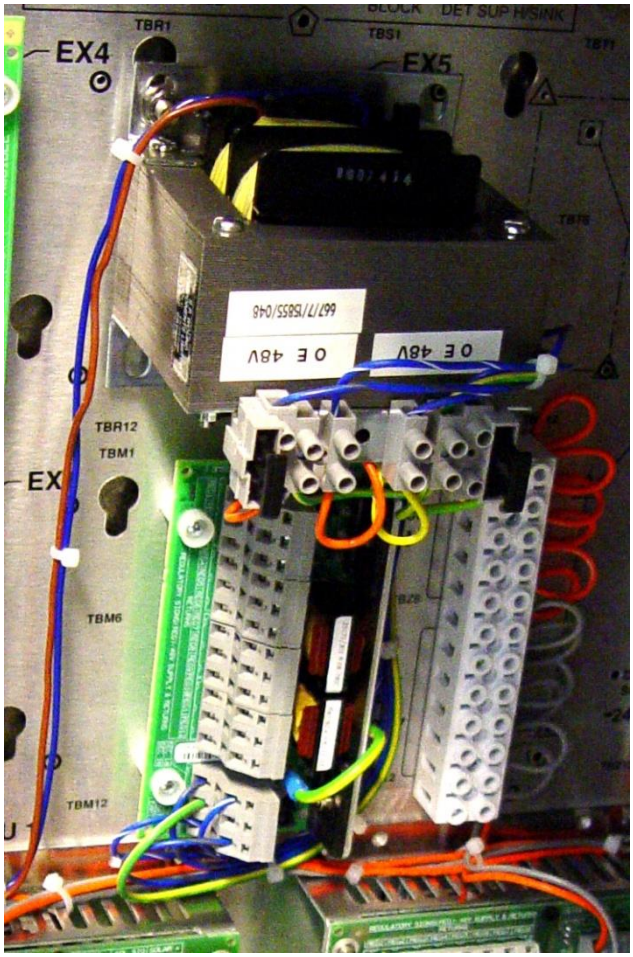


Figure 43 – Expansion Kit Installed

The transformer has two independent secondary windings. These must be connected to the PCB module with full observance of the colour coding indicated on the wiring diagram. The secondary windings attach through the separate six way cage clamp connector. Do not earth either winding at the transformer. The earth connection should be made at the central connection point of the PCB module power connector. Refer to drawing 667/GA/33070/000 for further details.

Each regulatory sign consumes about 7 Watts; for six regulatory signs, the lamp load would be 7 x 6 = 42 Watts

4.20 Detector Power Extension Kits

Two kits are available:

50VA – 667/1/33075

160VA – 667/1/33074

The number of detectors which can be powered from the ST950 may be extended by the addition of a 50VA or 160VA additional power supply kit. The photograph shows a 50VA kit partially installed in a 40Amp controller (two HPU's).

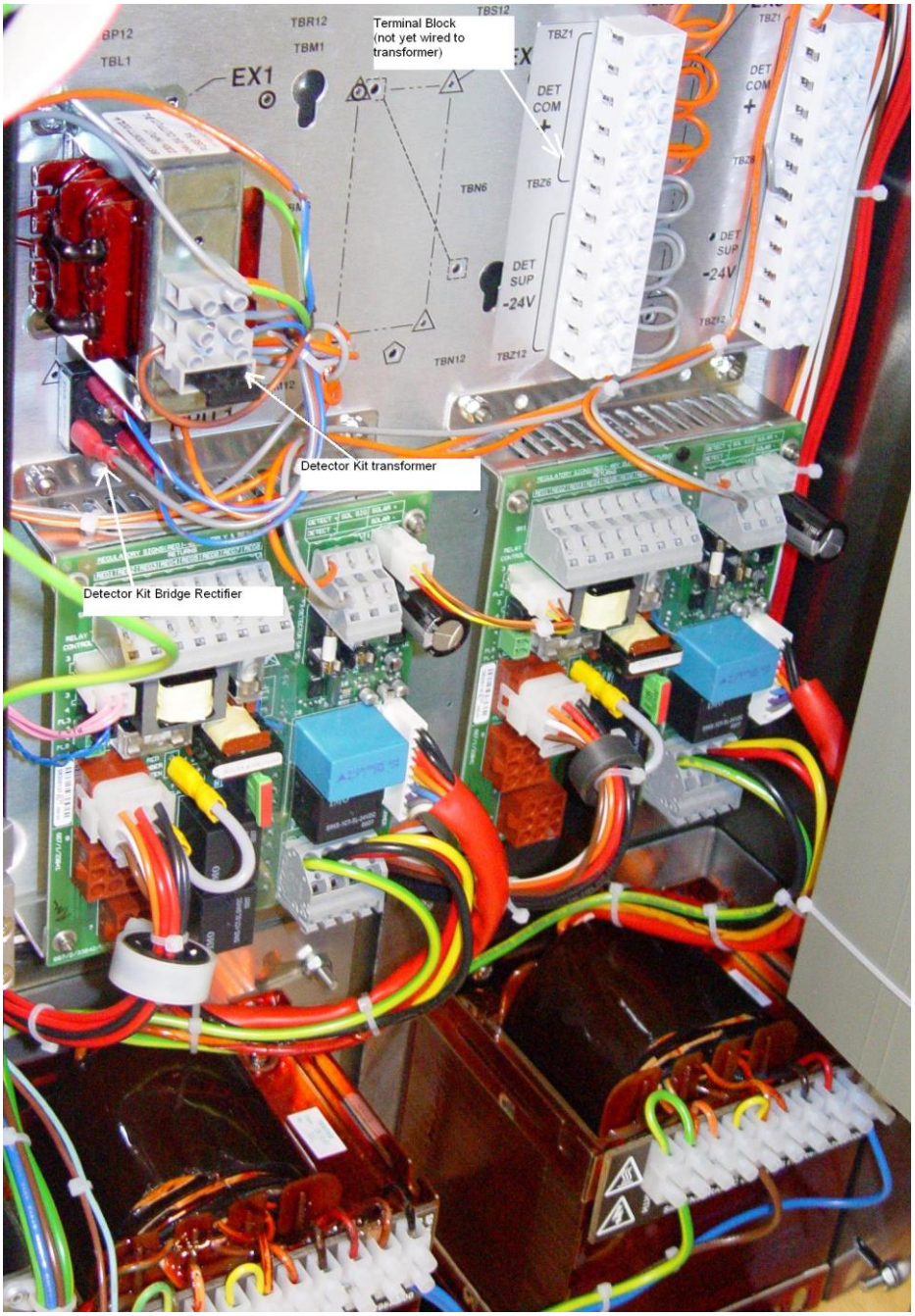
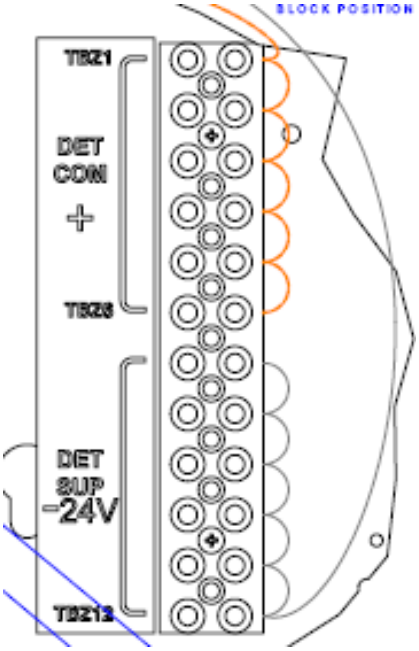


Figure 44 – 50VA Detector Extension Kit installed

The detector power kits are mounted within the cabinet above the HPU units on the left hand side of the controller cabinet. Mains power is derived from the master control switch panel. The rectified DC supply is generated by a bridge rectifier which is also mounted to the cabinet.

The output of the supply is available at a terminal block to the right of the transformer. This is labelled as shown below:



Full installation detail can be found in drawings 667/GA/33075/000 and 667/GA/33074/000. The secondary windings of the transformer should not be earthed directly.

4.21 ELV Compatible Nearside, Wait and Demand

Compatible units are clearly marked with ELV labels both externally and internally. However, PCB assemblies can become swapped during servicing which may then cause lamp monitoring failures. The Siemens Nearside and Wait/Demand units are only fully compatible with ELV controllers when fitted with PCB issues as shown in the table below.

Nearside Unit	PCB Assembly	ELV Compatible
Nearside Aspects	667/1/30695/001	Issue 9 and above.
	667/1/30695/002	Issue 9 and above.
	667/1/30695/003	Issue 9 and above.
	667/1/30695/004	Issue 10 and above.
	667/1/30695/005	Issue 9 and above.
	667/1/30695/006	Issue 10 and above.
LED Wait	667/1/30211/001	Issue 4 and above.
LED Call Demand	667/1/30680/001	Issue 3 and above.

Visual identification of the ELV compatible assemblies is described within the

Appendix – Visual Identification of ELV PCB. assemblies in the Helios General Handbook 667/HB/30000/000 revision 14 onwards.

5 USER INTERFACE

The user interface is fully described in the User Interface Guide 667/HU/46000/000. This section gives a brief overview of the user interface.

5.1 Connection

There are several way for the user to connect to the controller:

- RS232 Handset Port
- USB Handset Port
- WiFi
- Ethernet Port

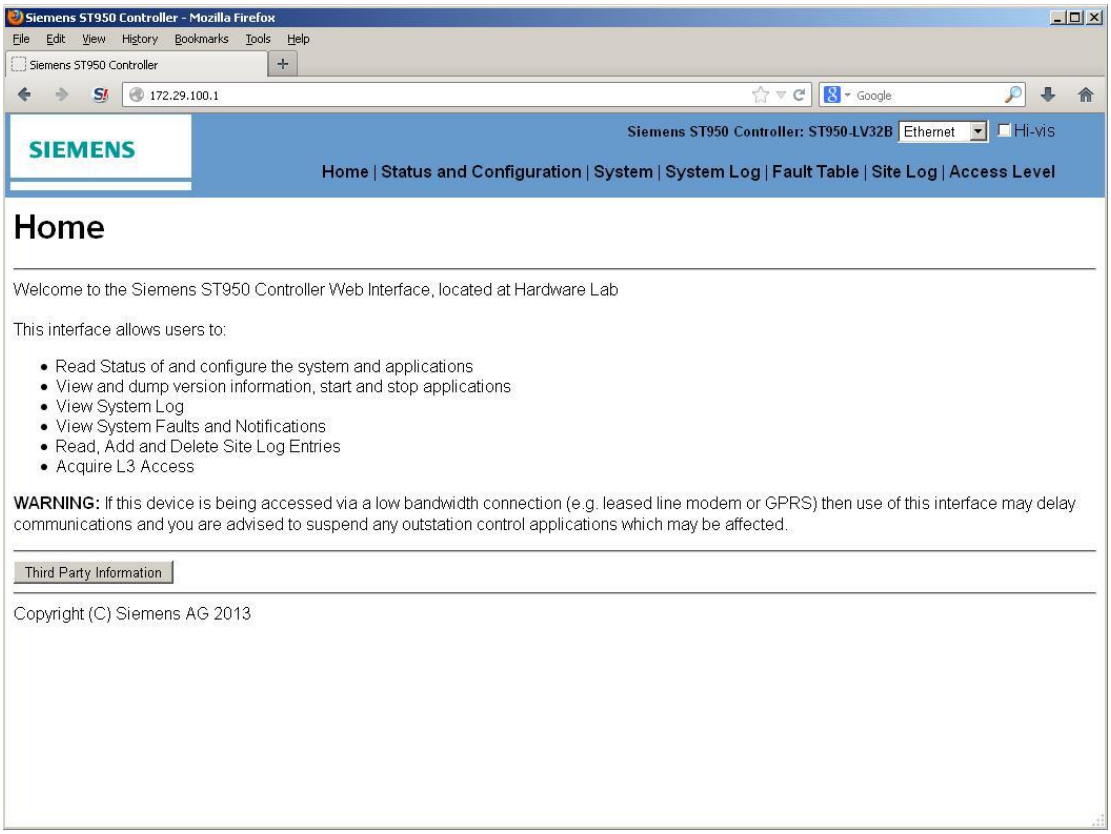
A driver needs to be installed in order to use the USB Handset port. A suitable driver for Windows is provided by the controller and can be installed on connection to the controller.

5.2 Types of User Interface

There are three styles of user interface.

5.2.1 Web Browser

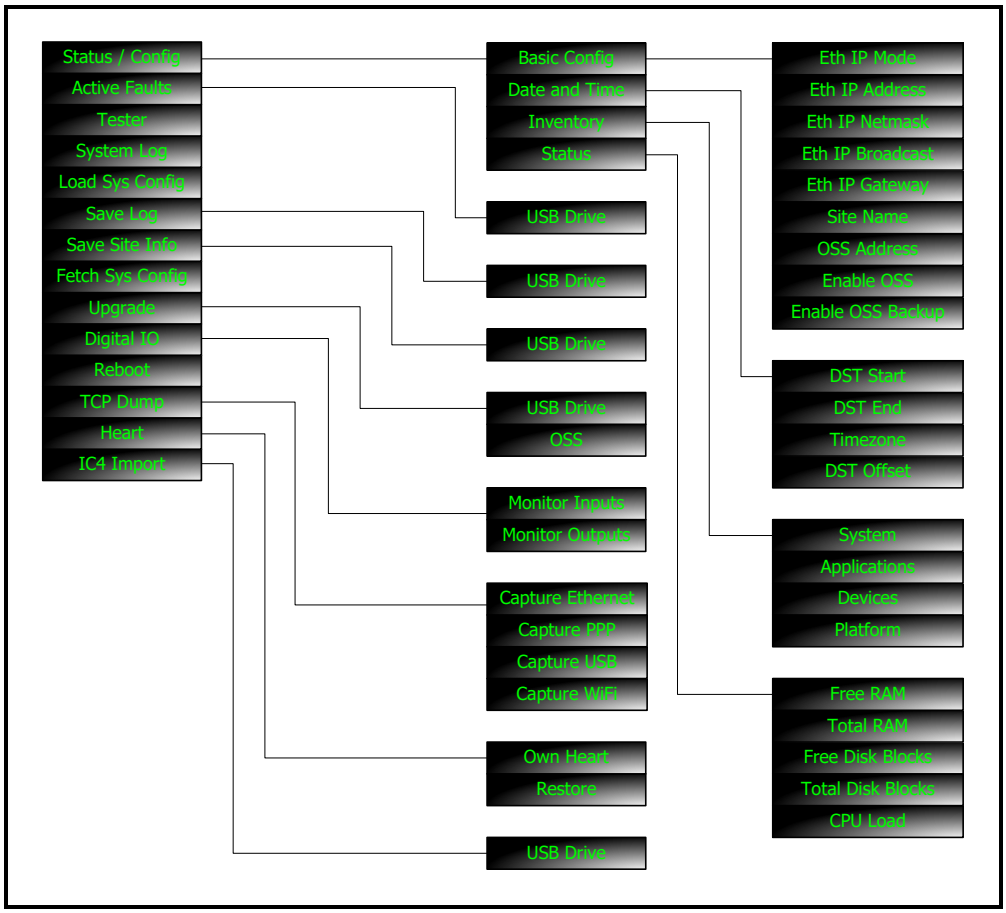
The controller web interface provides full control and monitoring of the controller. It is available over the USB handset and network connections.



5.2.2 WIZ

WIZ gives a menu driven handset facility which allows the user to perform various system functions and access various status and configuration items. It is available through the RS232 handset port and virtual terminal connections (*telnet* in 3 and earlier, *ssh* in later).

The menu structure is outlined in the following diagram.



5.2.3 Handset

Access to controller and GVP handset commands is supported. These are available through the RS232 handset port and virtual terminal connections (*telnet* or *ssh*) and are fully described in 667/HH/46000/000 (controller handset) and 667/HB/31760/000 (GVP handset).

6 FITTING THE CONTROLLER INTO ALTERNATIVE CABINETS

The controller rack may be fitted into enclosures other than the single sided ST950ELV cabinet. In the UK, the controller may only be fitted into an HA-approved enclosure.

The procedure for fitting an ST950ELV controller into an alternative enclosure is very dependent on the type of enclosure and the type and position of existing equipment. For this reason it is not possible to define in detail exactly what needs to be done.

Detailed installation instructions are included in the drawings contained in the kit relevant to the cabinet.

When fitting an ST950ELV controller into an enclosure other than an ST950ELV cabinet, a different type of 6U rack is required (a so-called ‘cuckoo’ rack). This rack houses up to three LSLS cards and has two 3U high bays which can be fitted with up to two Intelligent Detector Backplanes, supporting a maximum of eight Loop Detector cards.

For some cabinets additional kits of parts are available. These provide brackets and other equipment that may be helpful during the installation. The kits are listed on 667/DZ/46950/000 and contain the necessary installation instructions.

The standard controller items are used with these kits and are listed in the ST950 Family Tree (667/DZ/46950/000). Refer to Siemens Poole for the latest copy.

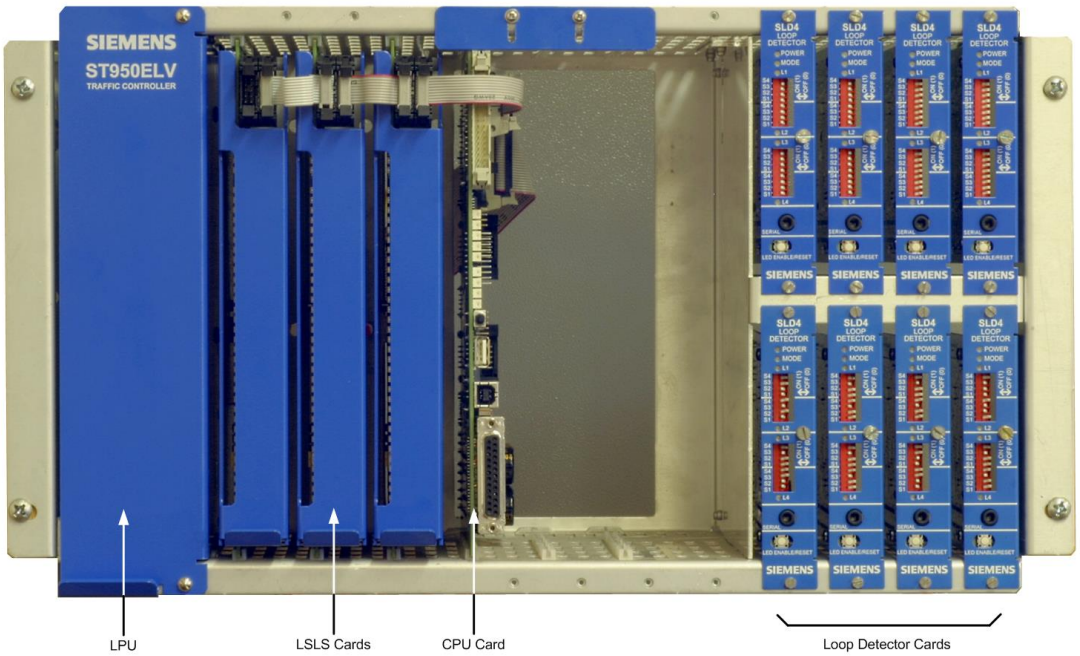


Figure 45 – ST950 ELV Rack for fitting in Alternative Cabinets (front)

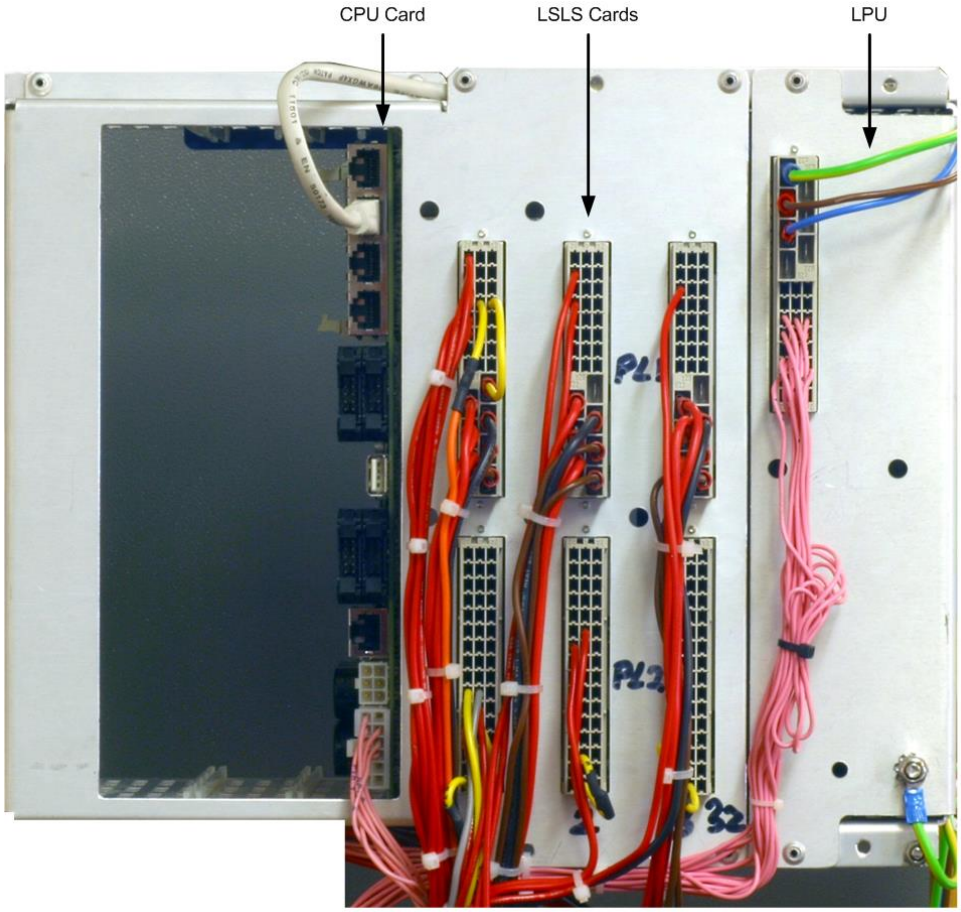
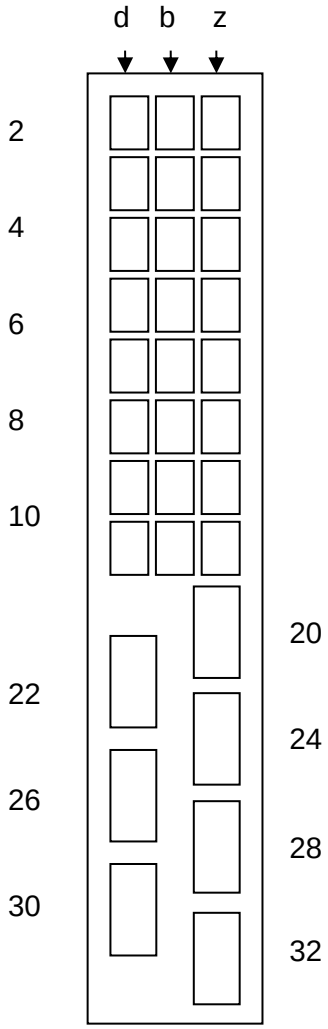


Figure 46 – ST950 ELV Rack for fitting in Alternative Cabinets (rear)

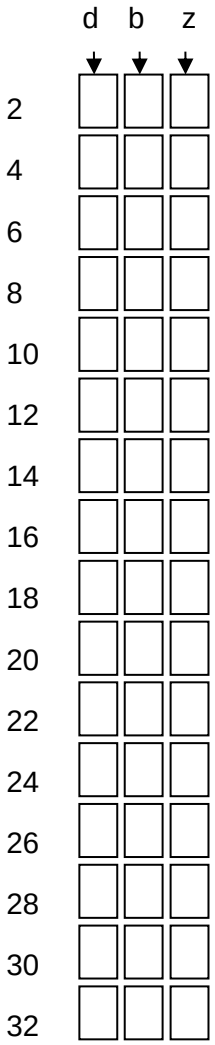
In a ‘cuckoo’ rack, the RJ45 serial cables between the CPU Card and the LSLS cards are replaced by 10-way ribbon cables connected in a daisy-chain between the CPU Card and the LSLS cards across the front of the rack.

The address of each LSLS card is set by connecting the appropriate ADDRESS pin to ADDRESS RET on the rear connector as shown in Figure 47



Pin	d	b	z
2	Output 32		
4	Output 31		
6	Output 30		
8	Output 29	from HPU PL4 pin 9	Opto 1 Ret
10	Output 28	Toroid Ret	Toroid Ret
12	Output 27	Toroid 1	Toroid 2
14	Output 26	Toroid 3	Toroid 4
16	Output 25	Output 24	Toroid Ret
20			0V Lamp Supply input
22	-48V Lamp Supply input		
24			0V Lamp Supply input
26	-48V Lamp Supply input		
28			AC Logic Supply input
30	-48V Lamp Supply input		
32			AC Logic Supply Input

Figure 47 – LSLS Rear Connections (top)



Pin	d	b	z
2	Output 23		
4	Output 21	Output 22	
6	Output 19	Output 20	
8	Output 17	Output 18	
10	Output 15	Output 16	
12	Output 13	Output 14	
14	Output 11	Output 12	
16	Output 9	Output 10	
18	Output 7	Output 8	
20	Output 5	Output 6	
22	Output 3	Output 4	
24	Output 1	Output 2	
26	Address 4		
28	Address 3		
30	Address 2		
32	Address 1	Address Ret	

Figure 48 – LSLS Rear Connections (bottom)

7 INSTALLATION AND COMMISSIONING PROCEDURE

7.1 Service-Centre Cabinet Testing

With reference to the Works Specification, check that:

- The cabinet is free from external physical damage
- The correct cards have been supplied and fitted in the correct positions.
- The socketed devices are securely fitted (including Heart and Licence card).
- The correct configuration is loaded into the CPU Card
- The links and address switches are correctly set on each card
- All fuses are fitted securely and are of the correct rating
- The primary connections to the Lamp Supply Transformer have been set to the correct voltage
- The connections between the Lamp Transformer secondary and the HPU are correct and are secure
- All plugs and sockets are securely mated
- All fixings are tight – especially those securing cards to side or back panels of the cabinet.

Power the cabinet on and run the self-test.

- Check the IC4 Configuration Id Code by navigating to the web page:

  Status and Configuration → Controller → IC4 Config

  and check that the IC4 Configuration Id Code displayed is the same value that is printed on the first page of the IC4 printout (IC4 Configuration Id Code)

  The RS232 handset command 'CIC' can also be used to check the IC4 Id against the IC4 printout.

- Check the IC4 Checksum value by navigating to the web page:

  Status and Configuration → Controller → IC4 Config

  and check that the Checksum displayed is the same value that is printed on the first page of the IC4 printout (Configuration Check Value)

  The RS232 handset command 'CRC' can also be used to check the CRC value against the IC4 printout.

Finally, before the cabinet leaves the Service Centre:

- Tighten the screws on the swing-frame
- Place the Junction Plan, the IC4 Printout and the Site Logbook into the pocket inside the door of the controller
- Close and lock the controller door with both key and T-bar locks
- Re-package the cabinet with the protective packaging.

The key lock should not be operated unless the screw locks are tight, i.e. Unlock the case before undoing the screw lock and only lock the case after tightening the screw locks.

7.2 Checking Site Suitability

The controller outer case is installed to suit local conditions, but subject to the following limitations:

(i) The position of the controller is as shown on the relevant site-to-scale drawing, (STS)

(ii) No part of the controller is less than 457mm (18 inches) from the kerbside unless agreed with the customer.

When it is necessary to site the controller less than 2 metres from the outer edge of the kerb, the access doors and panels should not open over or toward the carriageway. Where no pedestrian guard rails are fitted, then a clearance of at least 600mm shall be left between the outer case and kerb edge so that guard rails may be installed at a later date without the need to disturb the controller installation.

(iii) The controller door(s) should be easily accessible and not extend over the roadway or obstruct the footpath when opened. The door describes an arc of approx. 710mm radius from the left-hand front corner. Note that the controller door swings open through 180°.

(iv) Any person having control over the junction, whether manual control or stimulating some other system interface to test the controller's response, MUST have a good view of the intersection.

(v) When the controller is to be located on unmade ground (e.g. a grass verge) it is recommended that paving slabs or a concrete standing be provided at ground level under all access doors and panels. The hard standing shall extend a minimum distance of 900mm away from the main doors, extending the full width of the case, and at least 800mm away from the side of the case with a flap, again extending the full width of that side.

Customers may specify particular requirements.

The door of the controller must have ground clearance of at least 30mm over its whole opening arc.

7.2.1 Site Cable Installation

If new site cabling is being installed, refer to the following:

667/DS/20664/048 - Traffic Signal Junction Cable Design & Certification for ELV Systems

If common neutral return connections are used it is possible for the failure of a return connection to cause unexpected signal displays, where one or more signals within a given signal head are incorrectly illuminated simultaneously. This lack of neutral return connection is not detectable by the controller because the signal voltage presented at the

controller terminals does not exceed the required thresholds for conflict or correspondence monitoring. It is therefore **essential** that individual neutral returns are used for each green signal.

The signal connections in the pole cap MUST be kept physically apart from other connections (above ground detectors etc) in order to minimise the risk of short-circuits between the two.

7.3 Cabinet Installation

Prior to any installation works, firstly make sure that the cabinet has been delivered to site without external physical damage.

The electronics should be removed from the controller and stored separately if:

- The controller cabinet cannot be made waterproof
- The cabinet will be un-powered and may suffer from condensation, moisture ingress and/or animal/insect infestation
- There is a risk of the cabinet being damaged on-site
- The cabinet will be left in an un-powered state for a prolonged period.

7.3.1 Order of Installation

- Remove the electronics from the controller
- Remove the stool from the case, if not already separate
- Remove the CET bars from the stool
- Install the stool into the ground
- Run cables to the controller.
- Re-fit the CET bars to the stool
- Terminate the cable armouring to the CET bars
- Test the cables
- Re-fit the controller case to the stool
- In-fill the stool
- Seal the base
- Refit the electronics

7.3.2 Removal of Controller Electronics

Ensure the Master Switch is in the OFF position

Remove all PCBs and the Mains Distribution Unit from the rack. Swing the rack forward and unscrew the retaining bolts for the back plate of the rack. Tie this plate to a convenient point on the rear face of the cabinet. Lift off the complete rack assembly from the hinge pins.

The controller outer case is now ready for installation.

7.3.3 Removal of Stool from Outer case

This action may not be necessary as some controllers are delivered to site with the stool already separate from the outer case ready for installation. If they are assembled, separate the stool by removing its four nuts, bolts and washers and lift the rest of the assembly off the stool.

The recommended method of installation is to install the stool without any CET bars or Master Switch Panel.

As an alternative the outer case, stool and CET bar(s) only may be installed as a complete assembly. However, firstly the outer case and stool must be separated to fit the seal.

7.3.4 Removal of CET bars

The CET bars are fitted to the outercase by nuts, bolts and washers, which should be removed and stored with the bars.

7.3.5 Installation of 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 49 for the general method of installation and dimensions. Ensure that enough clearance is left around the stool to enable the fitting of the CET bars and outercase fixings.

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

The controller 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 be fitted the correct way round with the holes to the front, as shown in Figure 49. Adjustment may be required to ensure that the outercase 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.

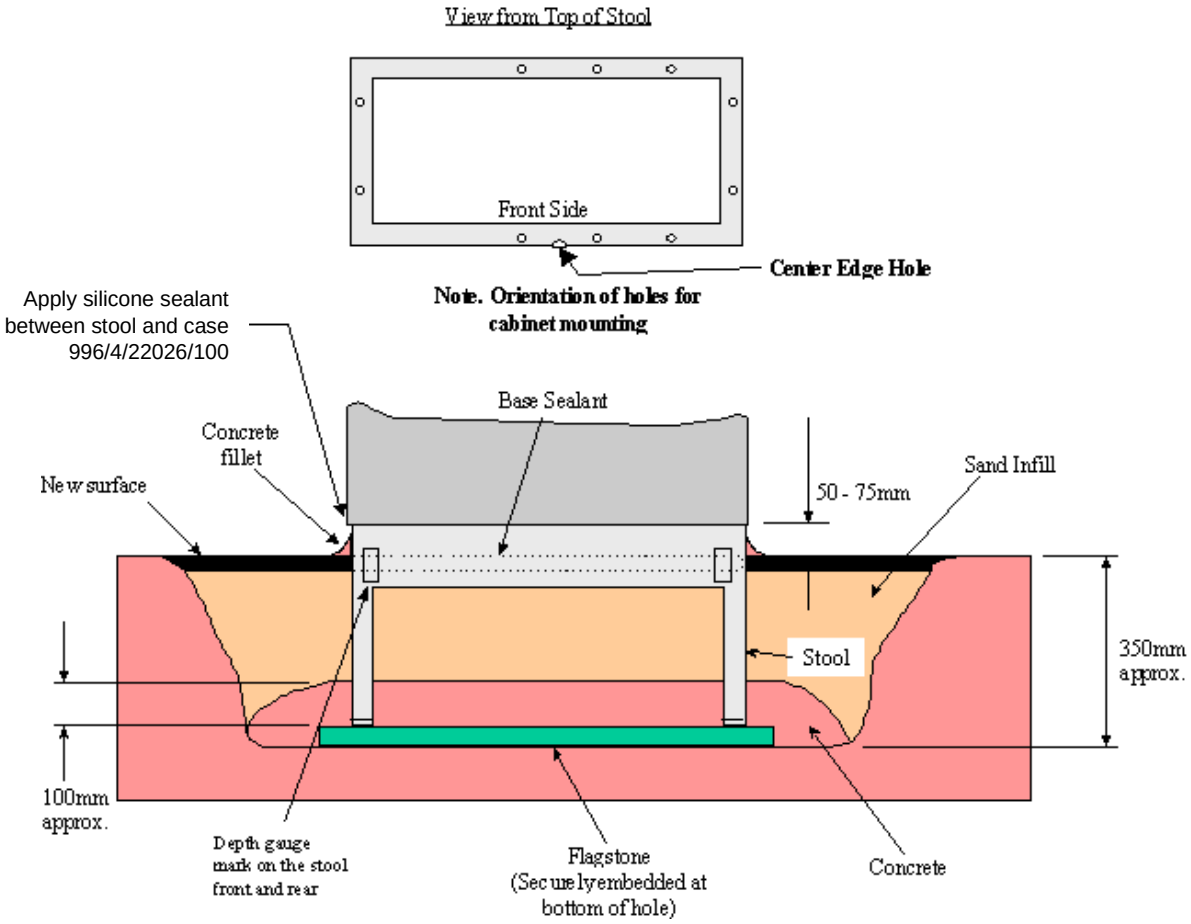


Figure 49 - Stool Installation

7.3.6 Cable Installation to Controller

Wiring runs should be made neatly and routed to allow enough spare cables for possible changes/additions at a later date.

Spare cores are to be bundled and routed to a convenient position clear of the mains. The ends are to be insulated to make the loom secured. Spare cores of ELV cables are to be loomed separately to the cores of LV cables. Note: normally spare cores are earthed at the controller end, as this makes Periodic Inspection Insulation Resistance testing much easier.

If cable idents are required then these are fitted to cores before termination.

All cables into the controller should be fed into the outer case as close to their termination positions as possible. This is to prevent unnecessary damage being caused should any cables need to be moved once they are in place. Care must be taken not to obstruct the Electricity Supply Company cut out with any cabling.

7.3.7 Refitting CET bars

Re-fit the CET bars in the most suitable positions to suit the cable run.

7.3.8 Terminate the cable armouring

The outer sheathing must be stripped to expose the armouring. It is suggested that between 15mm and 30mm of the inner sheathing Is left 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 armoured wires and tightened up. The cable sleeve must be stripped from the armouring approx. 0 to 2mm below the level of the CET ring. See Figure 50 for details.

The inner sheathing is removed to expose the individual leads, which are connected to associated terminals, leaving sufficient spare length for re-making off the ends should this become necessary. Unused leads should be left with sufficient length to enable them to be connected to any terminal should this subsequently become necessary.

When the detector loop tails have been terminated, the connection to the Loop Detector Termination Board must be made with wires twisted together as pairs.

Cables must be identified as to their destinations. Additional cable idents may be required on specific contracts.

After the site cabling has been terminated, additionally check:

The cable connections to the CET bars are tight

The street cables are terminated correctly into the appropriate connectors.

7.3.9 Cable Testing

Site cabling must be tested against the requirements of the following:

667/HE/20664/000 – Installation and Commissioning Handbook – Installation Testing (General)

667/HE/20664/000 (issue 12 or later) has been updated to include important information regarding the testing of cables on an ELV site.

Do NOT test ELV site cabling without reference to this document!

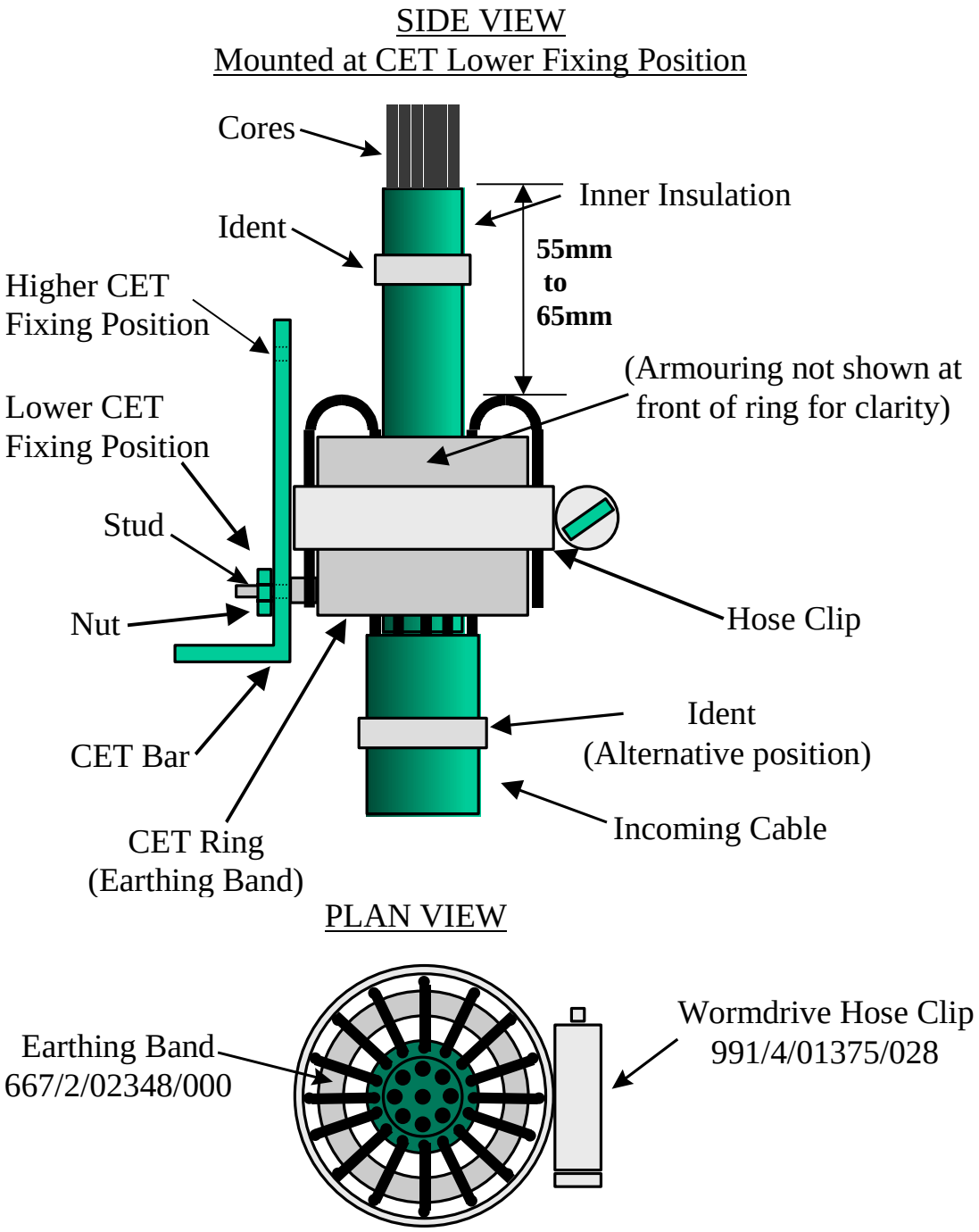


Figure 50 - Termination of Armoured Cable to CET bar

7.3.10 Re-fit the Cabinet to the Stool

If the controller cabinet was not installed with the mounting stool then it should be done as follows:

Clean the top surface of the stool and the lower surface of the cabinet that will be in contact when the cabinet is fitted. Apply a bead of silicone sealant around the edge of the stool.

Apply silicone sealant (ref. part no. 996/4/22026/100) to the top surface of the stool (enough to ensure that a good seal between the stool and the cabinet will be made.

The cabinet is installed by lowering it onto the stool and fitting the retaining bolts.

When fitting the cabinet onto the stool, make sure that all the cables are in their correct position with regard to the CET bar. Once the cabinet has been secured, moving of the cables could cause damage.

7.3.11 Back-fill and In-fill the Stool

On completion of the cable tests the controller cabinet and stool can be back-filled by the civils team using the appropriate material for the site layout. Once the back-fill is completed in-fill with kiln dried sand , taking care that the compacted sand is at ground level when finished.

If any of the cables were replaced or moved during the installation of the controller cabinet then the kiln dried sand in-filling must be made good before the sealing compound is introduced.

NOTE: The back-fill must be brought to a level such that once the decorative top surface is completed that the finish is at the surrounding ground level, particularly paying attention to any hard standing around the controller base.

7.3.12 Sealing the Base

To prevent condensation and infestation in the controller cabinet the base MUST be sealed as soon as possible after the controller has been installed. If any of the cables were replaced or moved during the installation of the controller the kiln dried sand in-filling must be made good before the sealing compound is introduced.

The in-filling, kiln dried sand, must be brought to ground level or above and compacted. Make sure that the kiln dried sand is level or slightly sloped down where it meets the cables so it will not prevent the sealant meeting the cable.

The sealant should be poured all around the cables and to a height which, when the sealant is set, gives a total covering not less than 6.5mm thick over the base of the controller cabinet base. Use between 2.0 to 3.0 litres of approved epoxy resin for the large controller cabinet base and 2.0 Litres for the small controller cabinet base this will give an adequate and even cover.

This will act as a preventative barrier against the ingress of moisture and animal/insect infestation.

A concrete fillet around the outside of the stool may be completed before or after the epoxy sealing to suit site conditions.

Should the controller cabinet base/stool NOT be in-filled with kiln dried sand and sealed with an approved epoxy resin the controller electronics/electrical circuits may be damaged.

7.3.13 Re-fit the Controller Electronics

Re-fit the electronics into the controller case, checking that:

- All cards are seated correctly in their sockets
- The primary connections to the Lamp Supply Transformer have been set to the correct voltage (Refer to section **4.1.1**)
- The connections between the Lamp Transformer secondary and the HPU are correct and are secure
- All plugs and sockets are securely mated
- All fixings are tight – especially those securing cards to side or back panels of the cabinet.

7.4 Controller Commissioning

The ST950 family of controllers support both the traditional RS232 handset port and now a USB handset port. The traditional handset commands are supported but the user will find that the web interface provides a more detailed view of the controller status to allow easier testing and commissioning.

7.4.1 Controller Setup

The following steps should be performed during commissioning:

- If required, remove the CPU Card and fit the optional RTC battery backup kit (section 7.4.2)
- Load the IC4 configuration (section 7.4.3)
- Add the required Licence(s) (section 7.4.4)
- If required, configure the communications systems (e.g. IP data) (section 7.4.5)
- If required, configure and start MOVA referring to the MOVA7 handbook - 667/HB/46000/003
- If required, configure and start UTC referring to the UTMC OTU handbook - 667/HB/46000/004
- If required, start the Controller Monitor application to report controller status to Stratos
- Set the controller date and time (section 7.4.8)
- Bag all signal heads
- Perform Lamp tests to ensure correct wiring (section 7.4.9)
- Learn the lamp loads (section 7.4.10)
- Perform Solar Cell testing (section 7.4.11)

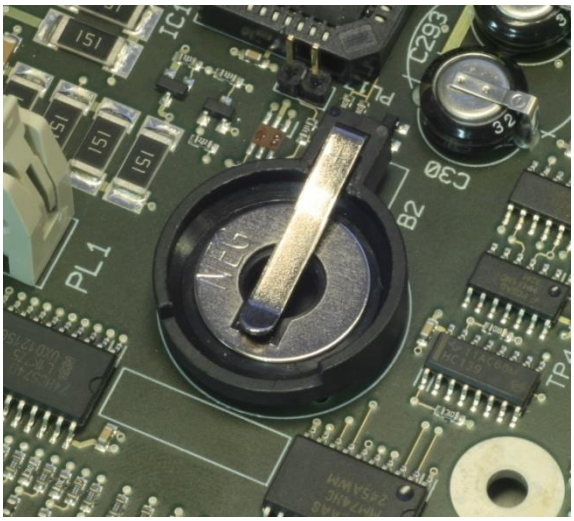
- Perform Junction Testing (section 7.4.12)
- Extract site information for review with customer (section 7.4.14)
- When satisfied with the configuration and operation of the controller, consider refreshing the latest restore point and retaining it so that this configuration can be restored if necessary in future. See the ST950 User Interface Handbook (667/HU/46000/000) for further information.

7.4.2 RTC battery backup kit

The optional battery backup kit for the RTC is provided with a lithium coin cell (CR2032 or equivalant) that is fitted into a socket on the ST950 CPU Card. Without this optional kit the RTC is maintained using supercaps which will provide 48hrs of backup in the event of a power failure. If the RTC is required to be backed up for longer periods this kit should be used and the coin cell fitted as shown below:

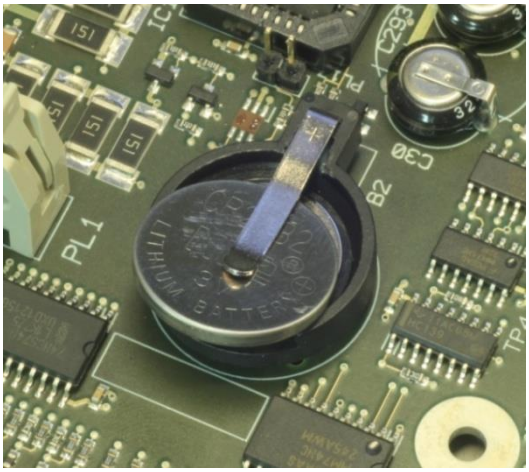
With the optional RTC battery backup in place the RTC backup period will be in excess of three years. The recommended battery replacement period is three years

Ensure that the coin cell is correctly oriented – positive side uppermost as shown in the sequence of photos below.

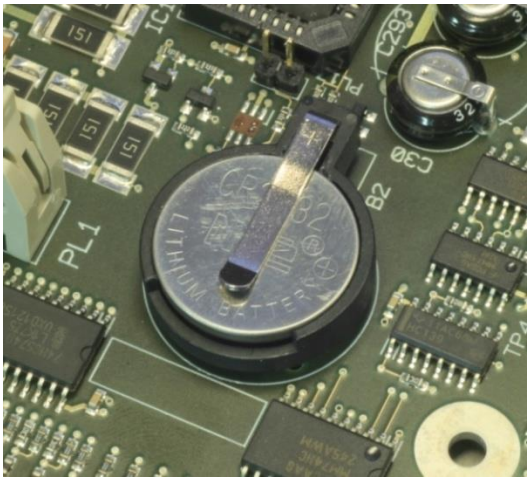


Empty holder

Slide the coin cell into the holder under the positive arm as shown below.

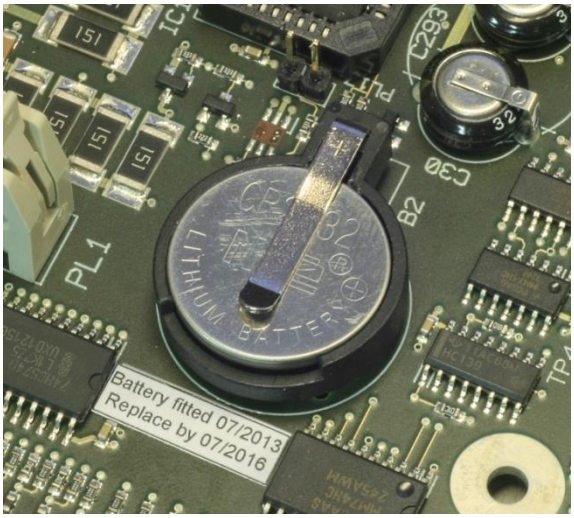


Cell partially in holder



Cell fully in holder

Affix the battery label in the space provided as shown below.



Cell and Label in fitted

Ensure that during commissioning that any battery isolation strip is removed.

Check the time reported by the controller after inserting new battery and correct if necessary.

Where the controller is connected to a network and configured to use NTP the clock will automatically be set when the controller synchronizes to the NTP server.

7.4.3 Loading IC4 Configuration

The ST950 controller requires an IC4 configuration to be loaded for correct operation. Configurations can be loaded in two ways:

- using the Status and Configuration → Controller → IC4 Config → Import Config web page
- using a USB memory stick and WIZ interface.

Full details on how to load an IC4 configuration can be found in the ST950 User Interface Handbook 667/HU/46000/000.

After loading an IC4 configuration which is significantly different from that previously in use, it will be necessary to own the Heart. This can be performed in either of the following ways:

- using the Status and Configuration → Controller → Heart → Ownership web page
- using the WIZ interface

Full details of this process are given in the ST950 User Interface Handbook 667/HU/46000/000.

7.4.4 Loading Licences

The ST950 requires licences to be fitted before certain facilities can be used. The facilities which are currently licensed are listed below.

Part Number	Licence Description
667/1/47560/000	LIGHTWEIGHT TUNNEL
667/1/47561/000	REMOTE ACCESS
667/1/47562/000	MOVA 7 STRMS 1 AND 2
667/1/47563/000	MOVA 7 STRMS 3 AND 4
667/1/47564/000	UTMC OTU
667/1/47565/000	SERIAL HANDSET
667/1/47566/000	UTMC OTU, MOVA 7 STRMS 1,2
667/1/47567/000	UTMC OTU, MOVA 7 STRMS 1,2,3,4

Each facility is licensed individually and some licences enable more than one facility. For example the UTMC OTU and MOVA7 licences each enable the Remote Access facility as this is required to make full use of the licensed feature.

By default, the controller has no licences fitted and those required must be ordered and installed on the controller.

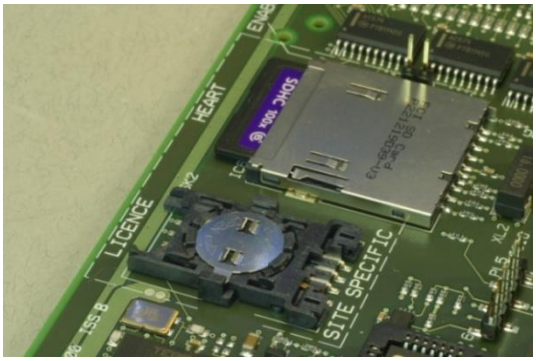
Distribution and Storage of Licences

Licences are distributed and held on the ST950 in Smart Cards. For distribution either a full size (credit card size) or SIM size Smart Card can be used. For storage on the ST950, a SIM size Smart Card is used and is fitted in the Smart Card holder on the CPU Card.

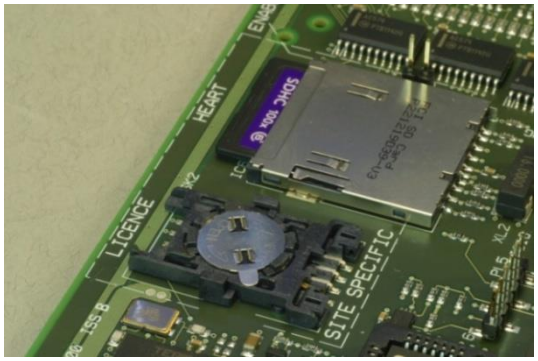
Installing Licences on the Controller

If no Licence Smart Card is fitted in the controller, the following procedure should be followed to fit the Smart Card:

- Power down the controller.
- Unplug connectors and slide the card free of the rack so that the top edge of the card can be accessed.
- Rotate the locking ring as shown below to unlock the container.

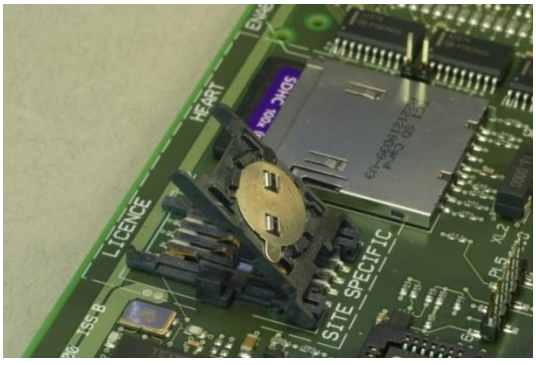


No Card – Locked



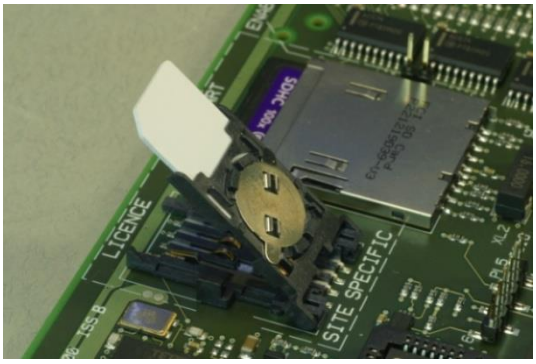
No card - Unlocked

- Carefully lift the end of the container as shown below.

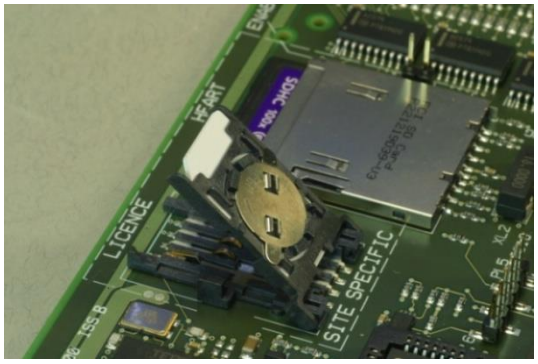


No Card, container Open

- Slide the licence card with the contacts facing the PCB into the raised section of the holder noting the card orientated shown below – ensure that the card is fully inserted.

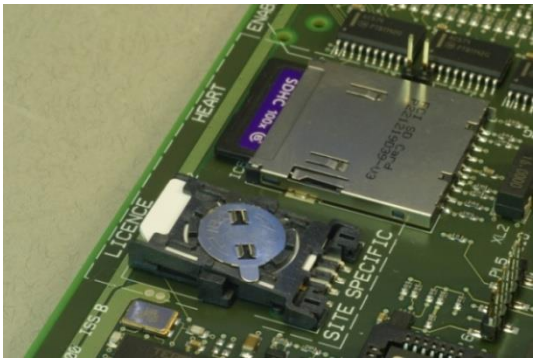


Card partially in container

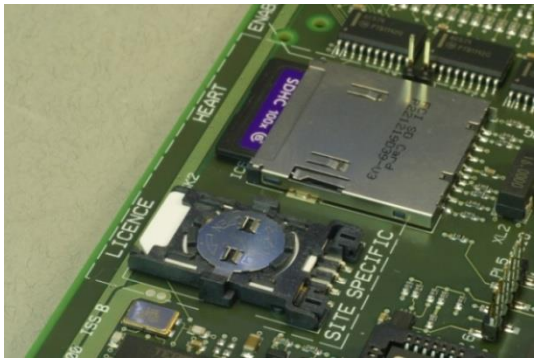


Card fully in container

- Close the container and rotate locking ring. The fitted card should appear as shown below.



× Card in container – unlocked



✓ Card in container - locked

- Re-connect connectors and power up the controller.

If a Licence Smart Card is already fitted to the controller then the licence is installed using the Licence Manager to transfer the licence from the Smart Card used for distribution to the Smart Card fitted to the controller.

Licence Manager

The Licence Manager can be used to:

- View licences installed on the controller
- Transfer a licence to the controller
- Transfer a licence off the controller

The Licence Manager is found on the web page:

Status and Configuration → System → Settings → Licence System → Manager

To view the licence information, press the 'Read Licences' button.

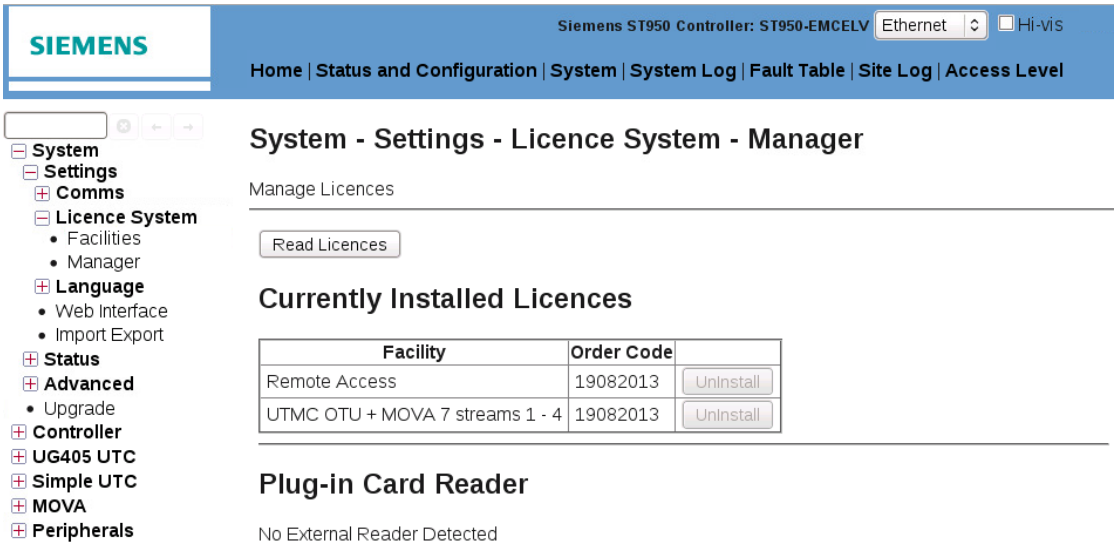


Figure 51 - Licence Manager web page with no external reader fitted

Transferring Licences to and from the Controller

To transfer a licence:

- Ensure a Licence Smart Card is fitted to the controller.
- Fit a Licence Smart Card into a USB Smart Card reader.
- Connect the USB Smart Card reader to the USB port on the front of the controller CPU Card.
- View the Licence Manager web page.
- Press the 'Read Licences' button.

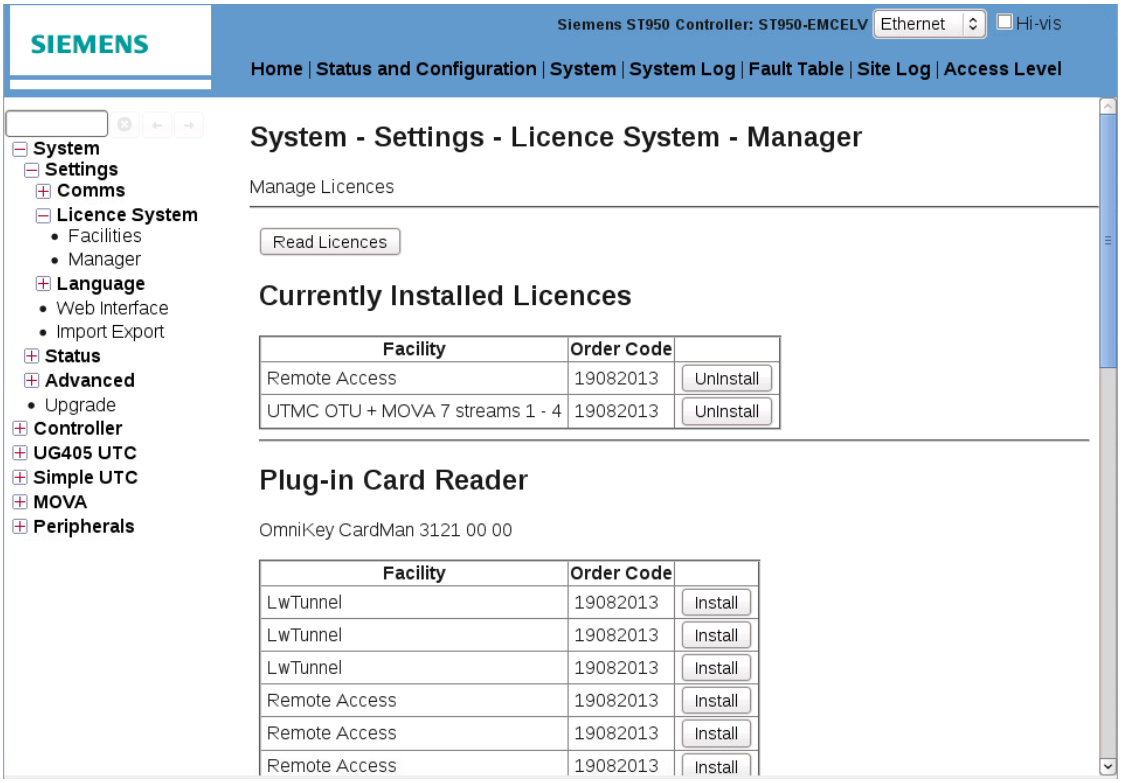


Figure 52 - Licence Manager web page with external reader fitted

The *Currently Installed Licences* table shows the licences currently installed in the controller (contained in the Licence Smart Card fitted to the controller CPU Card). The example above shows that the controller currently has two licences installed: Remote Access and a combined OTU & MOVA licence. Each installed licence has an associated 'Uninstall' button which can be used to transfer the licence from the controller to the Licence Smart Card in the external USB Smart Card reader. Pressing this button results in the licence being removed from the *Currently Installed Licences* table and added to the *Plug-in Card Reader* table and the facility becoming unlicensed.

The *Plug-In Card Reader* table shows the licences contained in the Licence Smart Card fitted in the external USB Smart Card Reader. This Licence Smart Card holds a number of licences. Any of these can be transferred to the controller by pressing the *Install* button associated with the licence. As the controller already has a Remote Access licence fitted, transferring this licence to the controller would not enable any additional facilities (it would just end up with two of the same licence). Transferring a LwTunnel licence to the controller would activate the lightweight tunnel facility.

When a licence is installed, it is removed from the list of licences held on the Licence Smart Card in the external USB Smart Card reader and added to the list of currently installed licences. Once a licence has been installed, the associated facility can be operated without restriction.

7.4.5 Network Connection

The configuration required depends upon the network in which the controller resides. Two straightforward cases are described below each corresponding to the controller being connected to a single system: Stratos (section 7.4.6) & a non-Stratos system e.g. UTC (section 7.4.7). Where the controller is to be connected to more than one system, the network will have to be designed and the controller configured accordingly using a combination of the two methods as appropriate.

7.4.6 Connection to Stratos

CPU Hardware

CPU card 667/1/46010/101 is required to support Stratos profile (see below) and so connect to Stratos. CPU card 667/1/46010/001 does not support Stratos profile.

Network Configuration

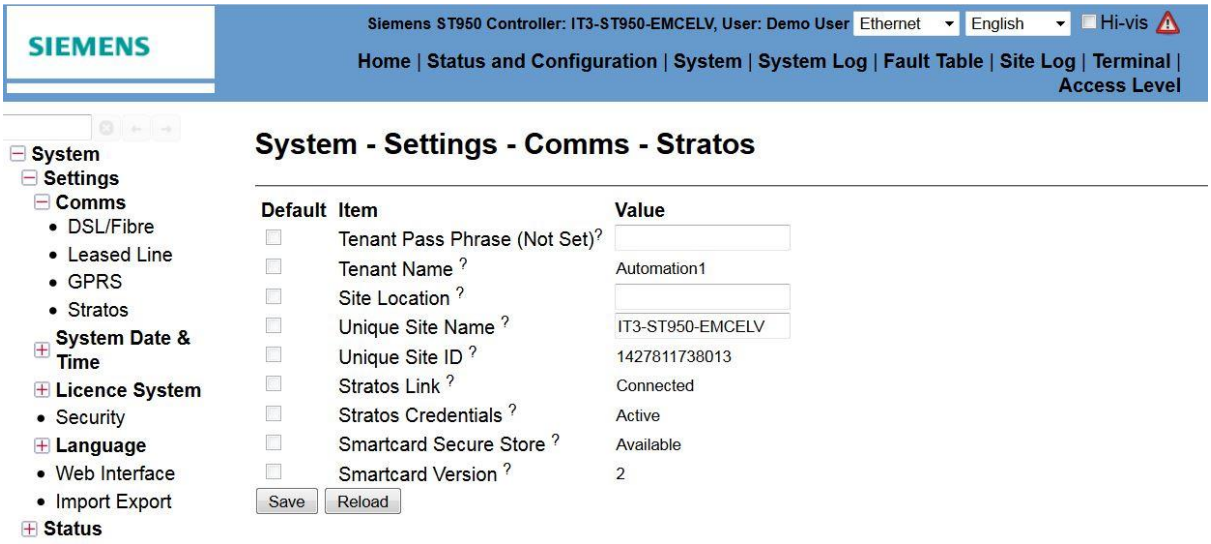
In order to connect to Stratos, the following internet services must be accessible to the equipment:

- DHCP (UDP 67 & 68)
- DNS (UDP 53)
- NTP (UDP 123)
    - pool.ntp.org
- HTTPS (TCP 443)
    - www.stratostraffic.com (TLS trusted time)
    - www.stratosemerge.com (CRLs)
    - ovpn1.stratostraffic.com (OpenVPN)
- HTTP or HTTPS (TCP 80 or 443)
    - OCSP authenticator for stratosemerge HTTPS certificate (OCSP)

Other applications and features of the equipment may require access to additional services either on the internet or on a local network. The documentation for these applications and features record these requirements.

Licence Card

A Licence Smartcard version 2 is required to support connections to Stratos. The version of the Licence Smartcard fitted can be checked on the System – Settings – Comms – Stratos configuration web page.



The UTMC OTU licence controls whether or not connection to Stratos is supported – see section 7.4.4.

Ethernet Configuration

Ethernet can be fully configured manually if required but configuration can be minimised by using DHCP.

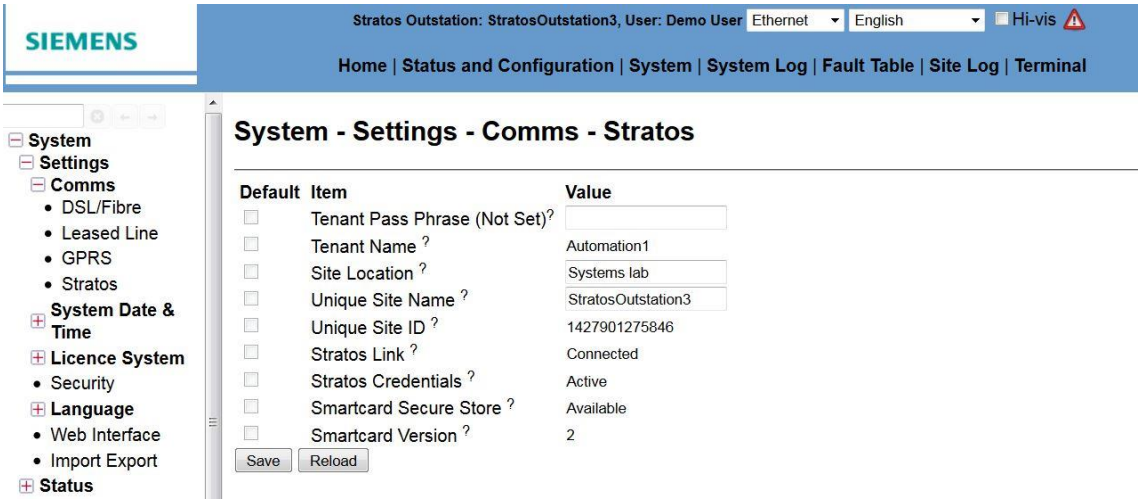
To connect the equipment to Stratos perform the following:

1. Set the date and time (*System - Settings - System Date & Time - Set System Date & Time* web page).
2. On the *System - Settings - Comms – Stratos* web page:
    - Set the Tenant Pass Phrase.
    - Set the Site Location.
    - Set the Site Name.
3. Set the profile to Stratos (*System – Settings* web page).
4. Check that Ethernet is suitably configured (*System - Settings - Comms - DSL/Fibre* web page). Using the Stratos profile sets this to DHCP. If this not suitable then configure as required.
5. Connect the Ethernet port to a network which has connectivity to the services described above.

Setting the Site Name, Site Location & Tenant Pass Phrase

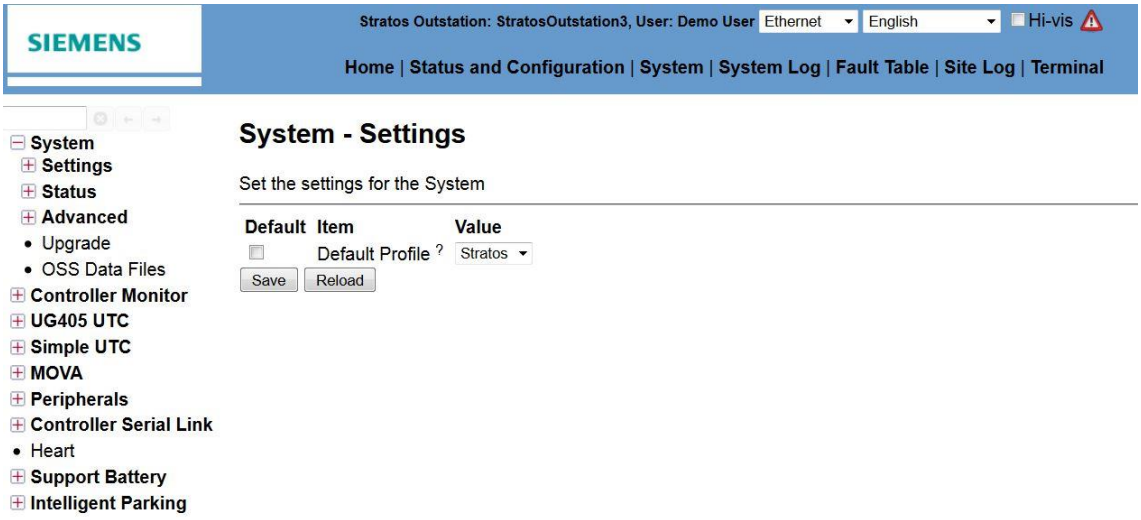
These items are set on the System – Settings – Comms – Stratos configuration web page.

Specifying a Tenant Pass Phrase prior to initial connection allows the equipment to be automatically allocated to the specified tenant on initial connection to Stratos. If the Tenant Pass Phrase is not specified at the time of initial connection then the equipment will be allocated to the Siemens Support team who can then make the allocation when required based on the outstation name, unique site id and destination tenant. This item has no effect after initial connection to Stratos.



Setting the profile to Stratos

Equipment is supplied configured for use in non-Stratos systems. To configure it for use with Stratos, visit the System – Settings configuration web page and set the *Profile* to *Stratos*.



7.4.7 Connection to Systems Other than Stratos

Security

When set to the Stratos profile and connected to Stratos only, the unit provides suitable security to allow it to be connected to the Internet. If either of these conditions is not met (i.e. the Stratos profile isn't selected and / or the unit is connected to systems other than Stratos e.g. UTC systems) then a suitable analysis should be performed to ensure that there are no security vulnerabilities in the network configuration and / or equipment used. The details of this will depend on the networks and connections involved and is outside the scope of this codument but the following are examples of what should be considered:

- General:
  - Has the system (including all equipment and interconnections) been reviewed for vulnerability / susceptibility weakness appropriate to the environment in which it is used?
  - Has a plan been drawn up to ensure that the findings of this analysis are implemented and maintained?
- Configuration:
  - Is configuration of equipment suitably protected?
  - Are only the services & features which are necessary enabled?
  - Is encryption used where privacy is required?
  - Is authentication used where trust is required?
  - Are firewalls in place to ensure traffic only flows as expected?
- Maintenance:
  - Is there a plan and means to apply security fixes to firmware used in all elements of the system?
  - Are secrets (e.g. passwords, encryption / authentication keys) held securely?
  - Is there a plan and means to update secrets as required (e.g. password update & strength)?
- Disposal:
  - Is equipment which is replaced or no longer required disposed of in a way which does not compromise the system (e.g. through leakage of secrets, configuration, etc.)?

Note that this consideration applies to all types of networks including those considered “private”. Often “private” networks will have external connections to some services and may also have some internal threats. These need to be identified and considered in order to ensure that the system is secure.

Connection

When connecting to systems other than Stratos it is important to set the network configuration before connecting the controller to a network using the Ethernet port on the CPU card. This is because the CPU card may be a spare which has been configured for and used on another controller site. It could therefore contain network configuration which would interfere with the site currently being installed.

The network can be configured in the following ways:

- using the Status and Configuration → System → Comms → DSL / Fibre web page
- using the WIZ command

Full details on how to configure then network interface can be found in the ST950 User Interface Handbook 667/HU/46000/000.

7.4.8 Setting the Date and Time

There are two clocks within the system:

- System - used for non controller applications

- Controller - used by the controller application

These clocks can run independently or be joined together to match the way in which the ST950 is being used. This relationship between the clocks is called the Time Mode. There are three options for Time Mode, used as follows:

- System Time - controller clock is synchronised to system clock. Use this mode where NTP or GPS is providing the source of time to the whole ST950 system and synchronisation to other controllers (e.g. mains synchronisation for CLF) is not required.
- Controller Time - system clock is synchronised to the controller clock. Use this mode where there is no NTP or GPS time source and the system is to maintain its own time (usually mains synchronised).
- Dual Time - system and controller clocks keep independent time. Use this mode where the system clock must be synchronised to NTP or GPS but the controller clock needs to be synchronised to neighbouring controllers e.g. to support mains synchronised CLF.

If the controller is installed outside of the UK, ensure that the time-zone and daylight saving settings have been configured correctly before attempting to set the time.

The time mode, date and time can be set from the web page:

Status and Configuration → Controller → Clocks

The user should configure the controller clocks as required - refer to the Time section in the ST950 Facilities Handbook 667/HB/46000/001 and then set the time and date as follows:

- Enter the current date in the 'Set Date' box using one of the accepted formats
- Enter the time to be set in the 'Set System Time' and / or 'Set Controller Time' (depending on the clock system required) in one of the accepted formats
- Press the 'Save' button at the precise time set.

It is not necessary to set the System time when the profile is set to *Stratos*.

If NTP is used, the time may not be the actual time but that used by the system (instation time)

If CLF plans are to be used it is important that the clock be set accurately to ensure that the plans operate as expected.

The Handset can also be used to set the Real Time Clock using Level 3 access and the 'TOD=' command, for example:

'TOD=21AUG13' to set the Date and

'TOD=10:36:00' to set the time

7.4.9 Lamp Testing

The ability to test individual lamps is an important facility that allows faults to be identified easily and rectified. The inbuilt self-test facility can be used to illuminate each aspect in turn or the lamp test facility that allows individual aspects to be illuminated is provided via the web page:

Status and Configuration → Controller → Phases → Lamp Test

To use this facility level 3 access is required and the signals on/off switch MUST be in the OFF position.

Use with Care!
All aspects under test must be covered

The aspect to be tested is identified and the following information entered into the web page:

- Phase
- Aspect Colour
- Duration of Test in seconds
- Once this information has been entered, press the 'Submit' and 'Confirm' buttons to start the test. The remaining time for the test is displayed against 'Progress'.
- The RS232 Handset 'LMP' command can also be used for lamp testing.

7.4.10 Learning Lamp Loads

When a new configuration is loaded or lamp loads are added or removed the lamp monitoring system will need to learn the connected loads. This can be achieved through Level 3 access and the web page:

Status and Configuration → Controller → LMU → Reset

If red lamp faults have extinguished phases, always attempt a 'Red Lamp Fail Reset Request' before attempting a 'Full Lamp Monitor Reset Request'.

Select the appropriate action and select 'reset' and then press the 'Submit' then 'Confirm' buttons.

To help with the learning sequence, artificial demands can be inserted along with a forced Dim/Bright change to ensure that all loads are learnt.

Use with Care!
Dim signals may be difficult for road users to see during daylight hours
Inserting artificial demands may confuse road users

The 'Learning Assist' feature can be enabled from the web page:

Status and Configuration → Controller → LMU → Reset/Learning

During the learning sequence, the percentage complete status for each signal can be monitored on the web page:

Status and Configuration → Controller → LMU → Readings

The RS232 handset can also be used to learn the lamp loads using the handset commands 'KRD' and 'KLR'.

7.4.11 Solar Cell Testing

For this test to be performed the ambient light conditions must be sufficient to set the bright condition on the controller.

Correct operation of the solar cell can be checked by covering the solar cell for at least one minute and checking that the controller (suitably configured to allow dimming) dims the signals. Remove the cover and check that the signals return to the bright condition.

Use with Care!
Dim signals may be difficult for road users to see during daylight hours

7.4.12 Junction System Testing

Using the detect lights on the above ground detectors, ensure that all above ground detectors (Kerbside and On-Crossing) are functional and have the required zone of detection.

Using the web page:

Status and Configuration → Controller → I/O → Lines

Or the Handset command “IOP”, check that all road detector loops, Above Ground Detector demand pushbuttons etc are correctly connected.

Clear all faults in the log and allow the junction to run normally. Periodically check the fault table / system log and ensure that no faults are raised. Verify that the controller has the correct date and time and is keeping correct time.

7.4.13 Lamp Supply Transformer

Measure the incoming mains voltage and wire the transformer.

7.4.14 Site Information Export (PI dump)

Various configuration and status information can be exported from the controller to be reviewed and stored using the 'Export Site Information' button on the System web page. This can be used to collect information as part of a periodic inspection (sometimes referred to as a 'PI dump').

Press the 'Export Site Information' button to download a zip file containing all of the site information. The filename generated is based on the following:

'Unique Site Name' that can be set on the web page:

Status and Configuration → System → Settings → Comms → DSL/Fibre

followed by '_dateTtime_siteinfo.zip' where date and time are the exported date and time.

Once downloaded the zip file can be unzipped into a folder. The user can navigate the downloaded file set by opening index.html in a web browser.

7.4.15 Loading New Firmware

If new firmware is required refer to the ST950 User Interface Handbook 667/HU/46000/000 for how to load new firmware.

7.5 Customer Acceptance

Run through the commissioning with the customer. The Controller Data page of the site information export contains important controller settings which the customer should review and accept as part of the acceptance procedure.

Sign the Site Acceptance Test report.

8 LEAVING SITE

Before leaving site:

- Check the current plan. If CLF is configured, use the user interface to verify that the correct plan is in operation bearing in mind the time of day.
- CLF and timetable can be re-synchronised with the real time clock using the user interface.
- Reset any data that has been set up for testing, e.g. permanent demands or extensions.
- If all inputs can be reset to normal operation, i.e. none have been set to provide permanent signals due to faulty inputs, then use the user interface to reset all inputs to normal operation.
- Select ‘Normal’ on the Manual Panel (unless there is a valid reason to leave it in ‘Fixed Time’, for example).
- Should manual control be enabled, use the user interface to enable or disable manual.
- If all faults have been investigated the fault log may be cleared using the user interface.
- If MOVA or UTC are enabled, ensure that they are functioning as expected.
- Ensure the visit is accurately recorded in the controller's `visit log book'. It should contain reason for visit, action taken (i.e. card changed etc.) and any follow up action required or details of what actions are required should the fault re-occur.
- Place the Junction Plan, the IC4 Printout and the Site Logbook into the pocket inside the door of the controller.
- Lock the Manual Panel door, ensure that the main controller door is locked and return the keys to the customer.

The key lock should not be operated unless the screw locks are tight, i.e. Unlock the case before undoing the screw lock and only lock the case after tightening the screw locks.

9 ROUTINE MAINTENANCE PROCEDURES

This section contains a list of checks that must be performed at an ST950ELV installation on a regular basis (normally annually).

These instructions override any others that may exist. If a Site PI exists for the specific site, it may contain instructions that should be carried out in addition to those detailed below.

All power to the controller must be disconnected before any attempt is made to remove the internal components of the controller.

Any change of lamp monitoring data will trigger an automatic relearn. After such a change all relevant safety checks (all lamps working and so correctly learnt, etc.) needs to be performed.

9.1 Routine Inspection of Signal Equipment

- Check all signal heads/aspects for damage and take any necessary corrective action.
- Check all signal heads for correct alignment with their respective approaches.
- Check all pole top cable connections; ensure that they are sound, secure and not seriously corroded.
- Check that all top caps are fitted and are not damaged.
- Check that all poles are secure in the ground and are not leaning or damaged.

9.2 Routine Inspection and Electrical Testing of Controller

It is suggested that these procedures be performed in the order listed.

Examine the outer case for serious damage. The outer case would normally only be replaced if it has been damaged to the extent that its security has been breached or that water or dirt is entering.

Open the main door and the Manual Panel door, check that the screw-locks, lock and hinges operate freely. Inspect the door and lock, and check the lock and catch-plate for security. Replace or tighten as necessary. Lubricate as necessary with good quality penetrating type oil.

The key lock should not be operated unless the screw locks are tight, i.e. Unlock the case before undoing the screw lock and only lock the case after tightening the screw locks.

Inspect the main door seal and Manual Panel gasket, ensuring they are intact and in the correct position. Replace as necessary ensuring that the surface is clean before fitting.

Check the Manual Panel for any damage and replace if necessary. Check that all functions operate correctly. Press the lamp test keypad and check that all LEDs are operational.

Check the termination panel(s) and master switch panel within the controller and ensure that there are no loose fixings, or damage to these panels. Tighten any loose fixings and carry out any repairs that are necessary.

Check the logic rack(s) and other assemblies within the controller are securely fixed. Retighten loose fixings as necessary.

Ensure that no fault indications are showing..

The following tests will result in the signals extinguishing.

Test the 300mA RCD (if fitted) by pressing the test button. The breaker should operate immediately.

Check that all fuses are secure in their holders. It is strongly recommended that the controller supply is isolated before any fuses are checked.

Check for damage all wiring, cables and cable forms, particularly any of the more vulnerable small gauge, single insulation wires and cables, such as ribbon cables. Repair or replace if necessary.

If fitted, the RTC battery backup cell on the CPU Card must be replaced if it has passed the replace by date on the label below the coin cell holder. The date label supplied with the replacement kit should be fitted over the existing label. Having done this, the controller records should be updated accordingly.

The following tests require the controller to be powered and running normally.

Check that all inputs used are operating correctly using the user interface.

Test the maintenance socket RCD by pressing the test button. The breaker should operate immediately.

The following checks should be carried out before leaving the site.

Check the cabinet door seals are intact and in the correct positions. Replace as necessary ensuring the surface is clean before fitting.

Inspect the cabinet base seal. If damaged, the affected area should be filled with sand and re-sealed. For details see the Controller Site Installation Handbook.

9.3 Routine Setup Check

Check that the real time clock is set correctly.

A true measurement of the accuracy of the real time clock can only be gained if the clock with which it is compared has been accurately set up.

It is essential that the time be compared with an adjacent controller using a clock that has been synchronised to that controller within the last 30 minutes.

9.4 Other Maintenance Operations

The following maintenance procedures may also be required and are described elsewhere in this document.

- RTC battery replacement - see section 7.4.2
- Addition & removal of licences - see section 7.4.4
- Loading new IC4 configuration - see section 7.4.3
- Update of firmware - see section 7.4.15
- Export of site information - see section 7.4.14

10 FAULT FINDING

This section contains information to assist in location and diagnosis of faults.

10.1 Site Visits

This section provides a reminder of considerations to be made before visiting a site, and actions to be taken on site and before leaving.

For the tools and essential spares required when making a site visit, see sections 1.4.2 and Appendix 0.

10.1.1 On Receipt of a Fault Report

When a fault report is received it is recommended that the following are checked:

a) Is the fault a repeat one; i.e. is the fault and its cause known from previous visit. Why was the controller left faulty? Can it now be cleared? I.e. are the resources now available to clear it; if so go to site. If not, make an appropriate note in the fault recording system, or on your fault report.

b) If the report is DFM, i.e. detector fault, check to see if a fault is known to exist on the site, especially if the fault is reported by an OMU as it may be a repeat alarm for a reported fault. Because, unlike the controller, most OMUs cannot be made to ignore faulty loops which have already been reported and, therefore, continue to raise the alarm.

c) If the controller is under UTC control, check with UTC centre to ensure that the fault report is not a result of any problem with the UTC, e.g. OTU may be out of action or faulty.

d) If the Signal State is reported as being All Out, All Red or not giving right-of-way to one approach try and check with the local authority/police as to whether they know of a requirement for the signals to be in this state.

e) Check that after clearance of the fault the controller may be re-commissioned and switched on again; in some cases the local authority may require the signals left off.

10.1.2 Before Going to a Site

Before leaving for a site visit, it is recommended that the following be checked:

a) Check that you have the correct equipment and sufficient spares to do the job you are going out to do. See the spares list in section 0.

b) Check that all your spares are good; i.e. check that the replacement cards have labels with test and inspection stamps on them. Ensure that none of the cards have labels on them that would indicate they are suspect or have been removed from a faulty site.

10.1.3 On Arrival at the Site

If the visit is to install additional equipment or perform an annual inspection then proceed with the installation or inspection procedure.

If the visit is to investigate a reported fault then on arrival at the site proceed as follows: Check all signal heads to see what signals are being shown to the road users, if any. Open the controller door. Make a visual inspection of all of the wiring and cards.

Check the controller log book to see if any previous visits/faults are similar, as previous actions may have a bearing on this visit.

Use the user interface to check for any entries in the Controller fault log.

Now proceed with the fault diagnosis.

10.2 Fault Finding Starting From the Fault Indications

The following is a list of indicators in the ST950ELV controller that assist in the location and diagnosis of a fault. The state of each of these indicators should be noted on arrival at a site before doing anything else.

10.2.1 Cabinet Alarm Indicator

The LED (behind the manual access door) is normally lit when the controller has identified a detector fault, and flashes when the Controller has detected a red lamp fault.

In some installations, the Cabinet Alarm may also be lit for other reasons - refer to the Works Specification.

10.2.2 Master Switch

This removes the mains supply from the entire controller when opened, i.e. switched off. Depending on cabinet installation this is normally mounted on a panel at the bottom of the controller.

10.2.3 Controller Switch

This is normally included in the Master Switch panel and removes power from the equipment rack and equipment powered from it. This is a single pole switch so does not provide safety isolation. Also note that the maintenance socket is still powered when the controller switch is off.

10.2.4 Main CPU Card LEDs

When the controller is initially powered up, it performs various internal checks before starting normal operation. While these checks are being performed, the green heartbeat LED flickers and the red system error LED remains illuminated on the CPU Card.

If these tests fail, it would point to a serious fault on the CPU Card and it should be replaced. The error message is repeatedly written to the handset display at 1200 baud, and no other handset operations can take place. See the ST950 Family Handset Handbook for full details.

If the SE (System Error) light is on, then the processor will have shut the system down and logged a fault – check the fault log.

10.2.5 LSLS Card LEDs

Refer to Table 10 on page 59.

Each LSLS card is equipped with 32 multicolour LEDs indicating the state of each output.

It should be remembered that for pedestrian phases, the amber channel is used for the pedestrian wait indicator, and hence may be lit for relatively long periods giving the false impression of being stuck red and amber.

10.2.6 I/O card LEDs

If a major fault is indicated, check that the GSPI comms cable is correctly fitted and the card address is set correctly. If this does not solve the problem, replace the card.

If all of the LEDs on the card are out, then check that the GSPI comms cable is correctly fitted.

Also check other I/O cards in the system and the Intelligent Detector Backplanes.

If all lights are off to all IDBs and I/O cards then suspect the +24V DC supply from the LPU has failed.

Check the +24V DC output from the LPU. If it is not present, remove the power plug into the CPU Card and re-test – if it is then present, then suspect a short-circuit between the LPU and the I/O cards.

Remove the high-speed serial cables in the controller to isolate the short-circuit.

If there is no +24V DC available at the LPU, the check the AC mains input to the LPU. If present, replace the LPU and re-test.

If the lights are out on only one I/O card then the power supply on that card may have failed – replace the card and re-test.

10.2.7 Intelligent Backplane Controller

If all LEDs on the card are out, then follow the same checking as for the I/O card.

10.2.8 Audible Driver Module – Single Output type

The green PP LED on the Audible Driver Module will only illuminate when the audible indicators are being driven. This will only occur when the LSLS output is on (i.e. -48V DC) AND the inhibit+ and inhibit– connections on the module are shorted together AND the output is not short-circuited.

If the green PP led is ON but the audibles are not sounding, check the polarity of the audible connections to the module and re-test. Measure across the “Audible +” and “Audible –” connections of the module - the module will present 12V DC when driving the audibles. If this is present, then suspect the connection between the module and the audibles and check that the audibles are not faulty by substituting a known working audible.

Remove all audible connections to the module. If the PP LED on the module illuminates when the audibles should sound, check for a short-circuit on one of the

audible connections either inside or outside the cabinet. Reconnect each audible one at a time to find the faulty one. The module is protected indefinitely against short-circuits on the output and will not be damaged.

Short INH+ to INH- with wire. If the PP LED illuminates (and audibles sound) when the LSLS output is on, suspect a faulty connection between the audible module and the I/O card or a faulty controller configuration causing the I/O card to inhibit the audible module or a faulty I/O card.

If the PP LED on the module does not illuminate and the audibles do not sound with INH+ and INH- shorted together, then measure the voltage across the “LSLS OP” and “LSLS RET” pins of the connector. This should be at lamp supply potential (-48V DC or -27.5V DC) when the module is being driven. If not, then suspect the connection between LSLS and the module or the controller configuration or faulty LSLS output.

Finally, having shown that the module is getting power from the LSLS output AND that the inhibit is shorted to enable operation AND that there isn’t a short-circuit on the audible output, replace the module and re-test.

10.2.9 Audible Driver Module – Dual Output type

The green PP LED on the Audible Driver Module will only illuminate when the audible indicators are being driven. This will only occur when the LSLS output is on (i.e. -48V DC) AND the EN+ and EN COM connections on the module are shorted together AND the output is not short-circuited. If link R40 is fitted, both Loud and Quiet PP LEDs will illuminate, but if link R40 is cut, only one LED should light. This would be the Loud PP LED if LQ+ is open circuit, or Quiet if LQ+ is shorted to LQ COM.

If link R40 is cut and a single green PP led is ON but the audibles are not sounding, check that audibles are connected to the correct outputs – loud or Quiet. If this is correct, or link R40 is still fitted, check the polarity of the audible connections to the module and re-test. Measure across the “O/P +” and “Audible COM” connections of the module - the module will present approximately 12V DC when driving the audibles. If this is present, then suspect the connection between the module and the audibles and check that the audibles are not faulty by substituting a known working audible.

Note that when the Special Condition code for audible monitoring is included, the monitoring function must be enabled (typically using CFE6=1) in order to enable the audible output. If monitoring is not enabled, there will be no audible output and the green PP LEDs will not light.

With monitoring enabled, faults in the circuit such as output short circuit will trigger a system error, which will extinguish all the signals (with fault ‘SCF1’ in the fault log). If this occurs, before conducting the fault tests described below, it would be necessary to temporarily short ‘EN+ to ‘EN COM’ with a wire link. Audible monitoring would then need to be disabled for the duration of the fault-finding tests below (e.g. CFE6=0).

If the PP LED on the module fails to illuminate when the audibles should sound, short EN+ to EN COM with wire. If a PP LED illuminates (and audibles sound) when the LSLS output is on, suspect a faulty connection between the audible module and the I/O card or a faulty controller configuration causing the I/O card to inhibit the audible module or a faulty I/O card.

If the PP LED on the module still did not illuminate with EN+ shorted to EN COM, remove all audible connections to the module. If the PP LED on the module now illuminates when the audibles should sound, check for a short-circuit on one of the audible connections either inside or outside the cabinet. Reconnect each audible one at a time to find the faulty one. The module is protected indefinitely against short-circuits on the output and will not be damaged.

If the PP LED on the module still does not illuminate with EN+ shorted to EN COM and audible connections removed, then measure the voltage across the “LSLS I/P” and “LSLS RET” pins of the connector. This should be at lamp supply potential (-48V DC or -27.5V DC) when the module is being driven. If not, then suspect the connection between LSLS and the module or the controller configuration or faulty LSLS output.

If link R40 is cut and the wrong PP LED lights, check whether the LQ+ input is open circuit or shorted to LQ COM. Open circuit should cause the Loud PP LED to light, and short circuit should cause the Quiet PP LED to light. If the module functions correctly (using a local wire link for this test if necessary) then suspect a faulty connection between the audible module and the I/O card or a faulty controller configuration causing the I/O card to request the wrong state or a faulty I/O card.

Finally, having shown that the module is getting power from the LSLS output AND that the Enable input is shorted to enable operation AND that there isn’t a short-circuit on the audible output AND the loud/quiet input is driven correctly, replace the Audible Driver module and re-test.

10.2.10 Intermittent Faults/Problem Sites

If a site has an intermittent fault or a fault which keeps repeating then first the appropriate procedure for the fault should be followed as most paths have more than one suggested area to check for the fault.

If the fault is still intermittent, do the following:

- Gently - try and move/flex each card whilst in situ to check for any intermittent connections.
- If any intermittent connections are found, replace appropriate card.
- Gently move cables and wiring looms to check for any intermittent connections.
- Switch controller ‘off’ and withdraw all cards. Check security of any ICs mounted in sockets on the CPU Card.
- Re-fit cards and re-check operation of controller.

10.2.11 Faults with Handset

If the handset does not operate correctly when plugged into the handset port on Main CPU Card, do the following:

- Check that the Handset +5V supply fuse (F1) on the CPU Card is intact.
- Check that there is a +5V supply on pins 9 and 10 of the handset socket (0V is on pins 1, 7, 18 and 19). With the handset plugged in check the ripple voltage on 5V supply.
- (This supply powers those handsets that do not have their own supplies.)
- To fully investigate, this supply may require the use of an oscilloscope.
- Switch off controller and withdraw Main CPU Card. Check security of ICs mounted in sockets of the above card. If no loose ICs are found, replace Main CPU Card.
- Replace Main CPU Card and re-check to see if handset now operates correctly.

10.3 Replacement of Cards

This section covers removal and fitting of cards in the ST950 ELV cabinet. Also described are procedures to ensure that the card functions correctly when fitted.

10.3.1 Safety Requirements

Before replacing any fuses, cards etc., IT IS ESSENTIAL THAT THE POWER TO THE CONTROLLER IS ISOLATED. See the Safety Warning on page 2 for details.

Failure to isolate the supply before changing parts may result in damage to the Controller.

10.3.2 General Requirements

When replacing cards, the original card should be inspected and the following points checked:

- Check the connectors on the card. Are any pins bent, broken or damaged in any way? If there are, make a note of the card and pin number in the Controller Visit Logbook as the backplane may have been damaged.
- Check any ICs that are mounted in sockets and ensure they are securely fitted.
- A problem with a loose fitting IC or use of an incorrect one can usually be rectified easily without having to fit a replacement card.
- Do not forget to record the replacement in the Controller Visit Logbook.
- Complete a fault label and return the faulty card for repair.

10.3.3 Access to Cards in ST950 ELV 19” Controller Rack

Most cards in the rack have connectors at their rear edge linked to various parts of the system. In order to gain access to the rear of the cards, first swing out the ST950 Rack Assembly. Release this by undoing the two screws at the right hand

edge of the frame. Having done this there is room to reach the back of the cards to deal with the ribbon cables.

The cards are held in the rack by retaining strips at the front, which must be moved clear after first loosening the strip clamping screws.

Exercise care when withdrawing cards so as not to damage the ribbon cables as they pass across the rear edge of the rack.

I/O cards are located on the back panel of the controller. The swing frame should be swung out of the way first, then the I/O card(s) can be reached.

Intelligent Detector Backplane cards are fitted to the rear of the separate 3U detector rack.

10.3.4 Replacement of HPU

See the Safety Information on pages 2-4 before proceeding.

When an HPU card needs to be replaced, remove the HPU card, metal brackets and heat transfer pad. Handle the heat transfer pad with care, as it can be damaged by sharp blows. Fit the new heat transfer pad to the side panel, as shown on 667/GA/33040/ETC. Align the HPU and metal brackets to the panel, and screw the brackets to the panel, gradually compressing the heat transfer pad.

10.3.5 Replacement of LPU

The LPU is removed by unscrewing the 4 retaining screws at the front of the LPU and pulling the LPU forward. The replacement LPU is fitted in the reverse order, taking care to align the LPU into the card guides when inserting,

10.3.6 Replacement of CPU Card

In case of failure, the CPU Card should be replaced. The Licence card and Heart of the controller (SD card) should be moved to the new card to preserve the junction configuration and facilities.

Only replace a CPU card with a compatible variant:

- 667/1/46010/001 can be replaced with either 667/1/46010/001 or 667/1/46010/101
- 667/1/46010/101 must only be replaced with 667/1/46010/101

Ensure the before re-connecting the Ethernet connector that the new CPU card has the IP configuration set correctly. Failure to do this may result in network disruption that can affect other network devices.

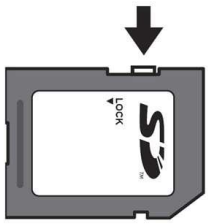
When replacing a CPU card it is possible to clone the system running on the CPU card being replaced onto the new CPU card using the Heart of the Controller. The steps to perform this are described in this section.

When restoration from Heart is being performed to clone a system onto a replacement CPU card then it is important that the Ethernet cable (if used) is not connected to the replacement CPU card until the restore from Heart operation is complete. This is because if the replacement CPU card has been previously used it might have network configuration remaining within it which conflicts with the network being connected to.

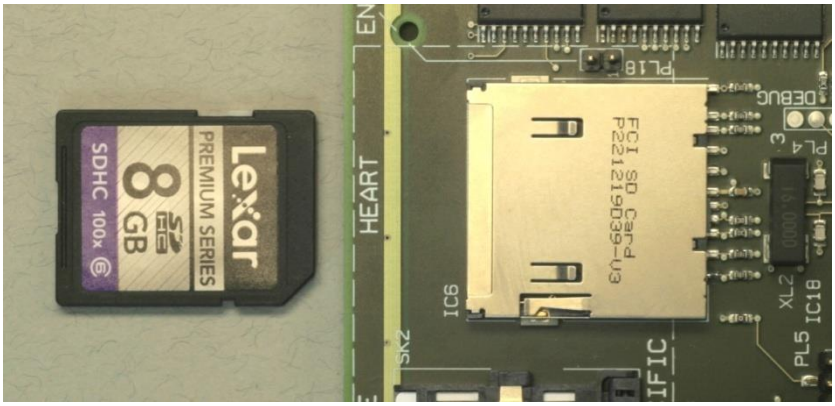
Move Heart to new CPU card

Take the CPU card being replaced and remove the SD card from the slot marked "HEART". Insert this SD card into the replacement CPU card. To insert a card, align it with the socket with the contacts facing PCB and closest to the socket, slide it into the socket and apply slight pressure until it ‘clicks’. The card is now located correctly. The photos below show the correct orientation for the card.

Note: It is important that the card is not write protected. The ‘lock’ switch must be in the position shown in the diagram below:

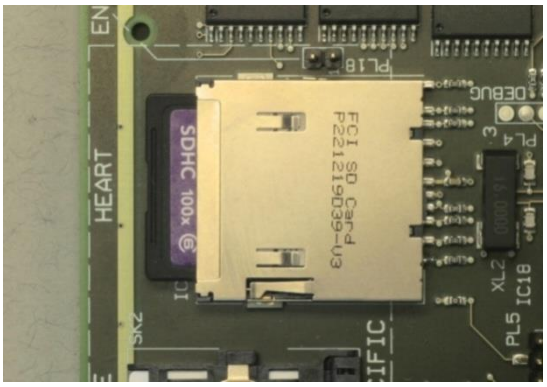


SD card Write Enable switch position



SD Card Orientation

✗ SD card partially inserted – incorrect



✓ SD card fully inserted – this is correct

Restore from Heart

Install the replacement CPU card into the controller connecting up all cables as required. Turn on the controller. The restore from Heart operation can be performed using either web pages or WIZ.

Restoring from the Heart Using Web Pages

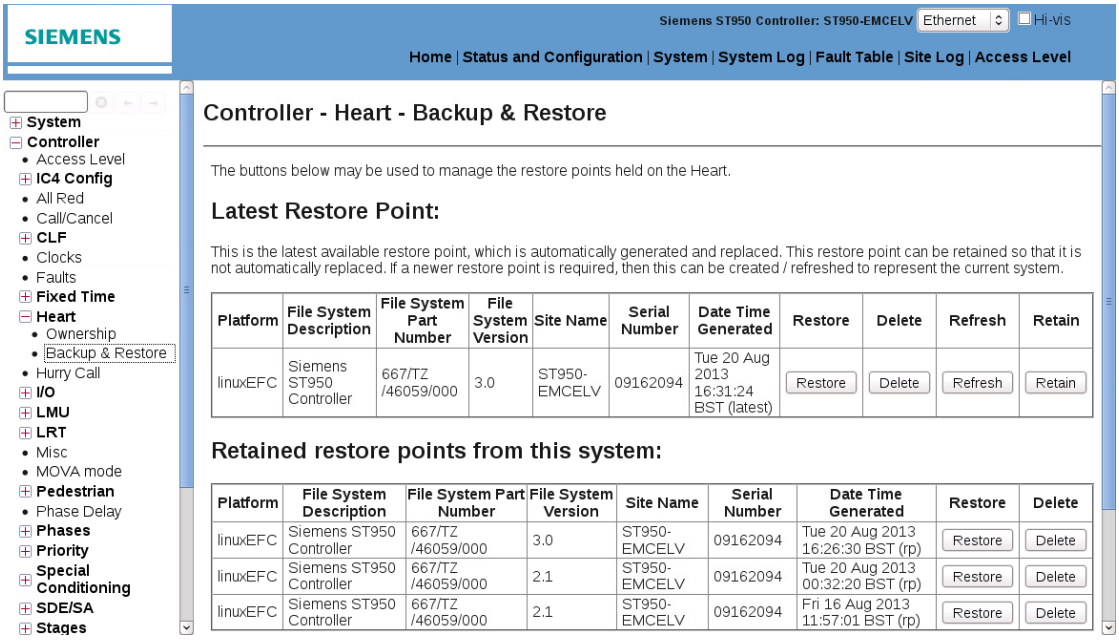


Figure 53 - Restore Points available for use

The system backups held on the Heart are known as Restore Points. The Restore Points available are shown on the Controller - Heart - Backup & Restore web page. Restoration to one of the listed Restore Points is initiated by:

Turning off the signals

Pressing the *Restore* button associated with the Restore Point.

- Pressing the Program Button on the Processor Card within 30 seconds of the previous step.

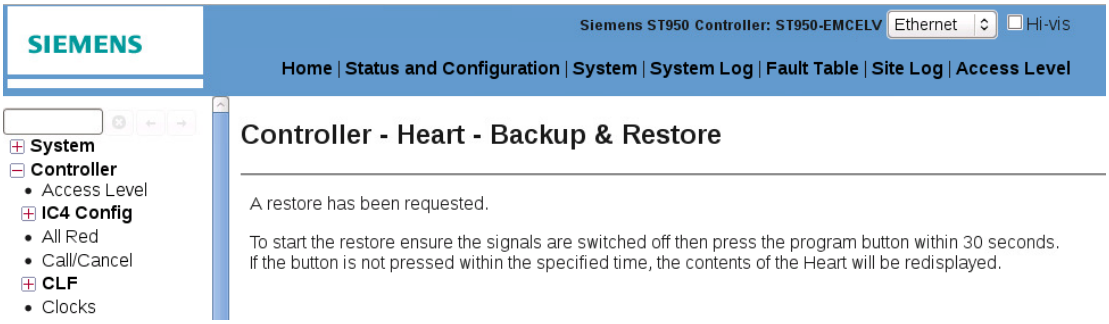


Figure 54 - Restoration instruction screen

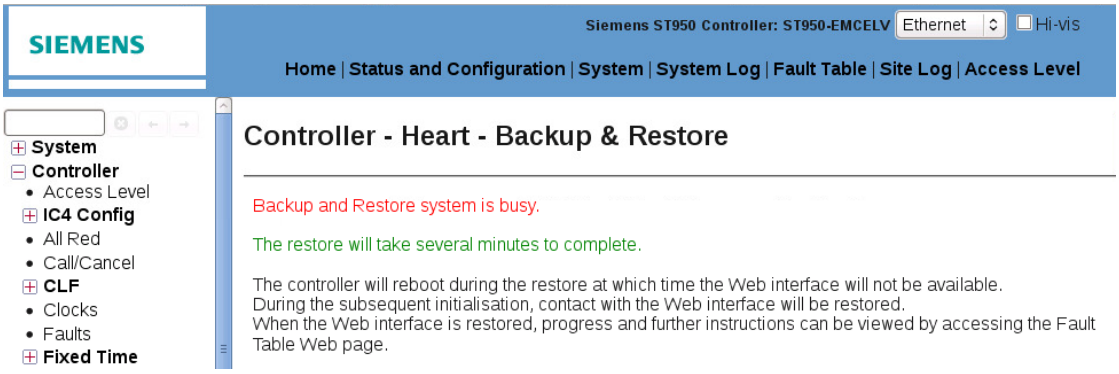


Figure 55 - Restoration progress screen

The EFC now reboots, performs the restoration then programs the Primary, SEC and Fail Flash processors in order to restore their state to that requested. The operation is completed by turning the power to the controller off then on.

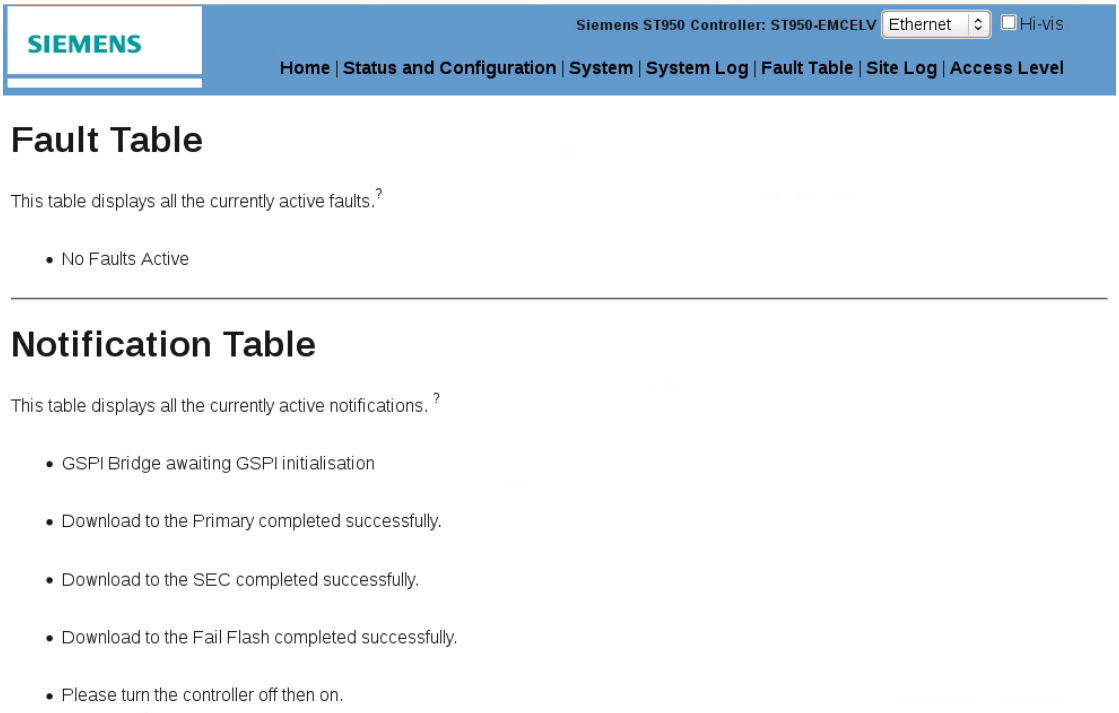


Figure 56 - Fault Table on completion of restoration from Heart

Restoring from the Heart Using WIZ

It is only possible to restore the most recent Restore Point when using WIZ. To start the operation, invoke WIZ from the handset command line and select the *Heart* menu item from the top level WIZ menu.

The user is presented with a sub-menu containing the following two options.

```
1> Own Heart
2> Restore
```

Select option 2.

The controller reads the available restore points from the Heart and outputs the following. NOTE : The restore point name shown below is representative of a typical restore point.

```
Restore from:
ST950-LV32B
Y/N?
```

Selecting “N” will display the following.

```
Restore not
started.
Press any key
```

Pressing any key returns to the original sub-menu. If no key is pressed, the user is automatically returned to the sub-menu after a few seconds.

Selecting “Y” will display the following.

```
Switch signals off
and press the PRG
button.
```

Press any key

The blue LED on the front of the Processor Card starts pulsing in a heartbeat fashion for 30 seconds. The user has this period in which to ensure the signals switch is turned OFF and to press the program button on the front of the Processor Card. If the program button is pressed whilst the signals switch is ON or after the blue LED has extinguished, the restore operation is not started.

The original WIZ menu is displayed irrespective of whether the user presses any key.

The restore operation takes several minutes to complete during which time the controller reboots. Contact via the handset is not possible whilst the restore is in progress. Completion is indicated by the blue LED remaining permanently lit (on but not flashing).

The process is completed by turning the controller off then on.

10.3.7 Heart Replacement

It may become necessary to replace the Heart fitted to a CPU card, if it becomes faulty for example (this will be reported in the Fault Table). The steps to perform this are described in this section.

Fit New Heart

Take the CPU card and remove the SD card from the slot marked "HEART". Insert the new SD card into the slot following the guidelines in section 0,

Own Heart

Before using a new SD as a Heart it must be owned. This operation can be carried out either using the web pages or using WIZ.

Owning the Heart Using Web Pages

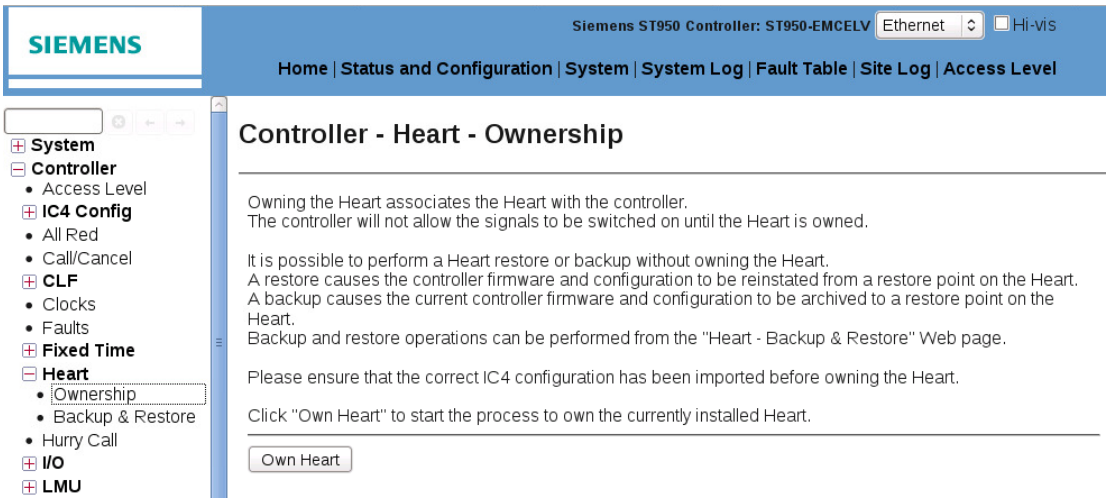


Figure 57 - Web page used to own the Heart

The Heart is owned using the Controller - Heart - Ownership web page. To start the process, press the *Own Heart* button. It is important to confirm that the operation is being performed on site (to ensure that the Heart / Processor combination has been reviewed and the correct decision been made) so it is necessary to press the Level 3 button as instructed.

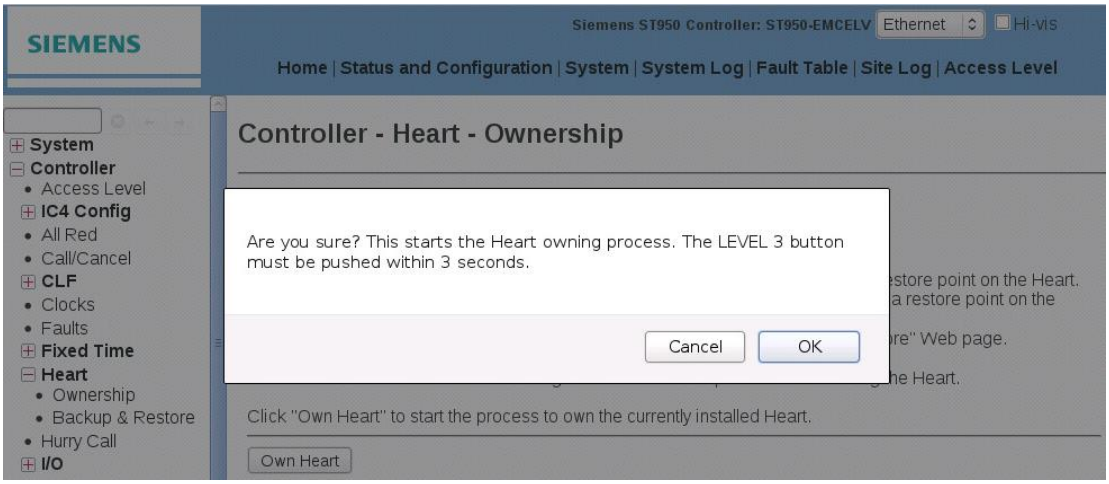


Figure 58 - Request to press Level 3 button during Heart ownership sequence

The ownership sequence is completed by turning the controller off and then on. This is reported in the Fault Table.

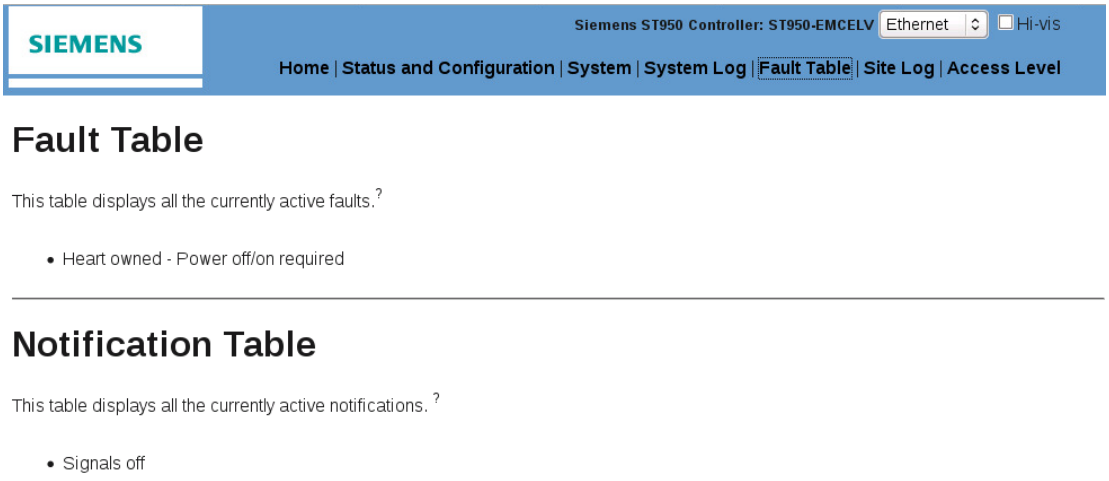


Figure 59 - Fault Table indication that the controller must be turned off then on to complete the Heart ownership

Owning the Heart using WIZ

In WIZ there are two options within the Heart menu:

```
1> Own Heart
```

```
2> Restore
```

Select the first of these for this operation and the following will be displayed:

```
Signals are not
controlled unless
Heart is owned
Press any key.
```

Press any key and the following is displayed:

```
To own Heart press
any key, then the
LEVEL 3 button
within 3 seconds.
```

Follow the instructions and the following is displayed:

```
Success:
Power off/on
required.
Press any key
```

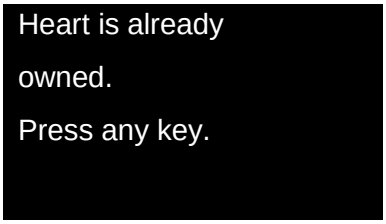
Power the controller off then on and the controller will start normally and allow the signals to be turned on.

Other Possible Routes

If the controller is shutdown then the following is displayed.

```
Cannot own Heart
while controller
is shutdown.
Press any key.
```

If the Heart is already owned then the following is displayed.



10.3.8 Replacement of LSLS Card

Pull the spring clip under the LSLS card and pull the card part way towards you using the front handle. Tilt the top of the card away from the side of the cabinet, lining up a notch on the card with the projection on the card holder, then pull the card right out.

Replace with the new LSLS card by reversing the above procedure.

Note that LSLS 3 is reverse orientation; the spring clip is on top.

10.3.9 Replacement of I/O Card

The controller should be powered down before disconnecting any RJ45 connector.

I/O cards are situated on the back panel of the controller cabinet. Disconnect the cables which are held in place with two screws each, then the serial cables and the six mounting screws. Remove the card and replace with the new one. Reverse the procedure to connect the new card.

10.3.10 Replacement of Intelligent Detector Backplane Card

The controller should be powered down before disconnecting any RJ45 connector.

The Detector Backplane card(s) is/are situated at the rear of the rack.

Generally speaking, only the Intelligent Detector Backplane card will need replacing, although the replacement kit includes the passive Detector Backplane. They are supplied together to protect delicate components and connections.

Remove the three nuts holding the card in place and pull away from the passive backplane. Replace with the new card and tighten the nuts.

Reassemble and return the kit including the defective card to Siemens Poole.

10.3.11 Replacement of the Manual Panel Card

First unplug the cable connecting the panel to the CPU Card.

The panel is retained by a number of screws to the main cabinet assembly. (Mounting methods may vary in different cabinets).

After removal of these screws the panel may remain stuck in place by the gasket. Ease the panel away from the housing, gradually working from one corner taking care not to scratch or otherwise damage it.

The replacement panel should be mounted with a new gasket to prevent water ingress. After fitting, reconnect the cable to the CPU Card.

An Internal Manual panel (where fitted) can be removed directly by removal of the screws holding it to the 19 inch panel; it may be easier to remove the 19" panel from the rack first. As there is no gasket on an internal Manual Panel, no sealing is required on refitting.

10.4 Replacing Components Other Than Cards

When replacing any components (including cards) only approved spares may be used. Use of any other components may invalidate the Type Approval of the equipment. See Appendix for details of approved spares.

10.5 Logging/Recording Faults and Visits

Controller Visit Log Book

Every controller should have a log book. It should be a small book that is usually stored in the document pocket affixed to the controller door. On every visit the visiting Engineer should write down in the log book the date, his name, reason for visit and actions taken. For example, the reasons for the visit may be a fault report, routine inspection, fitting of new equipment, adjustment of timings, etc. The actions taken may be PCB or unit replaced, timing adjusted, new equipment fitted, etc. This information is essential for the next Engineer who may visit the site so that he can see what has happened previously and helps to reduce duplication of effort.

The requirement to fill in the visit log book also applies to Local Authority Staff. The maintenance organisation cannot be held responsible for any problems arising from neglect of this responsibility.

If desired the site log facility within the controller can be used as an alternative to the physical log book. Please see the ST950 User Interface Handbook (667/HU/46000/000) for further details.

11 THE SELF-TEST FACILITY

11.1 Introduction

The Self-Test facility can be used to check the hardware fitted to the controller with or without a configuration loaded. It has been designed for use in the depot and on the street by installation / maintenance engineers. A subset of the tests can also be initiated and monitored from the Tester web page, without the need to cycle the controller power off/on to start the full Self-Test facility.

The full controller Self-Test is initiated by holding down the level 3 access button while switching the controller's power on. The button should be released once the green heartbeat LED starts to flash.

The green heartbeat LED continues to flash during the Self-Test unless a fault is detected, when the red system error LED illuminates.

A 20 character by 4 line handset or other terminal connection (e.g. PC, Android) displays information about the checks it is performing, such as the firmware issue and the lamp supply voltage, both dim and bright, and details any faults found.

In previous controllers, LEDs on a lamp switch card were used to indicate the presence of up to three IO cards. The ST950 does not do this.

Self-Test performs the checks detailed on the following pages and reports the error messages shown if faults have been detected.

11.2 Structure of Self Test

Self Test comprises several parts:

1. Test with lamp supply turned off. Only run when self test initiated by powering up the controller with the level 3 access button pressed.
    - check the integrity of the communications between the processors on the CPU Card
    - determine how many lamp switch cards are fitted and checks their type
    - pass control to the EFC CPU so it can start step 3 and display further inventory information (see section 46.6)
    - check and displays the mains supply frequency
    - check the lamp supply is off and the voltage monitors on all the lamp switch card outputs indicate that all the outputs are off
2. Test with lamp supply turned on. Only run when self test initiated by powering up the controller with the level 3 access button pressed.
    - Switch on the lamp supply and check the voltage
    - Check that all the lamp switch card outputs (V/Mons) remain off
    - Check the dim/bright relay and display the dimmed lamp supply value
    - Check the fail to hardware fail flashing arrangement and display whether hardware fail flashing is available and selected

- Check all the lamp switch card outputs by pulsing each one ON in turn. This can also detect short-circuits between outputs in the cabling to the signals.
- Check that each lamp supply relay can switch off the lamp supply

3. Test of non traffic signal aspects of the system. Run when self test initiated by powering up the controller with the level 3 access button pressed and tests can also be run at other times using the Tester web page. The tests run are selected determined by the scenario selected on the Tester web page. Full details on scenarios are given in the ST950 Facilities Handbook (667/HB/46000/001) but the scenarios most appropriate to installation and commissioning are *ST950 System Test* (the default which is used if no other choice is made) and *ST950 System Test (no licence).*

ST950 System Test Scenario

This scenario does not require any special connections and is suitable for running on most controllers. This is the default scenario.

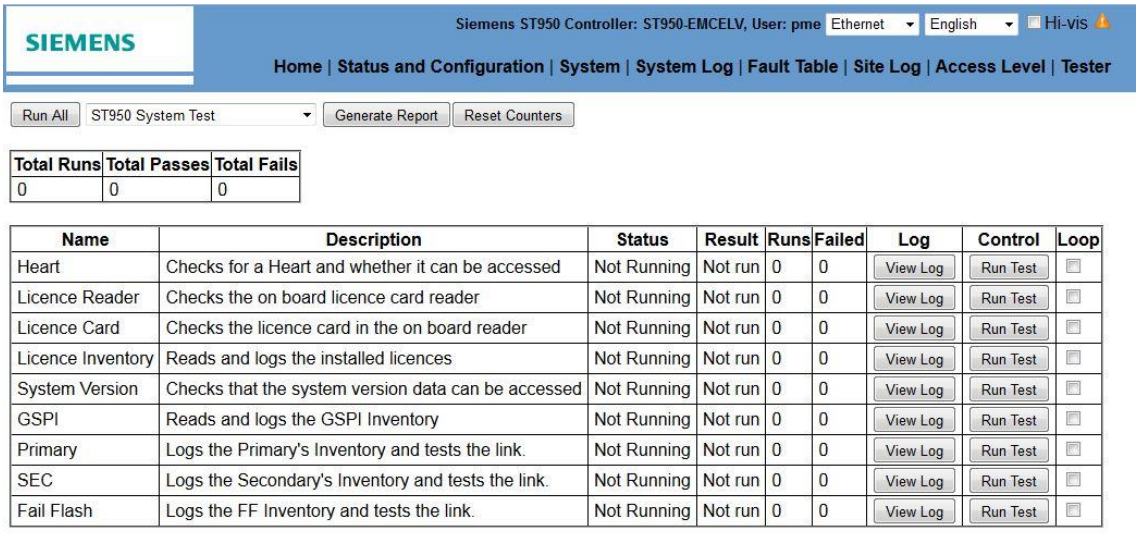


Figure 60 - ST950 System Test Scenario

ST950 System Test (no licence) Scenario

This scenario is similar to ST950 System Test but it does not include testing of the licence card so won't report failures when run on controllers without a licence card fitted.

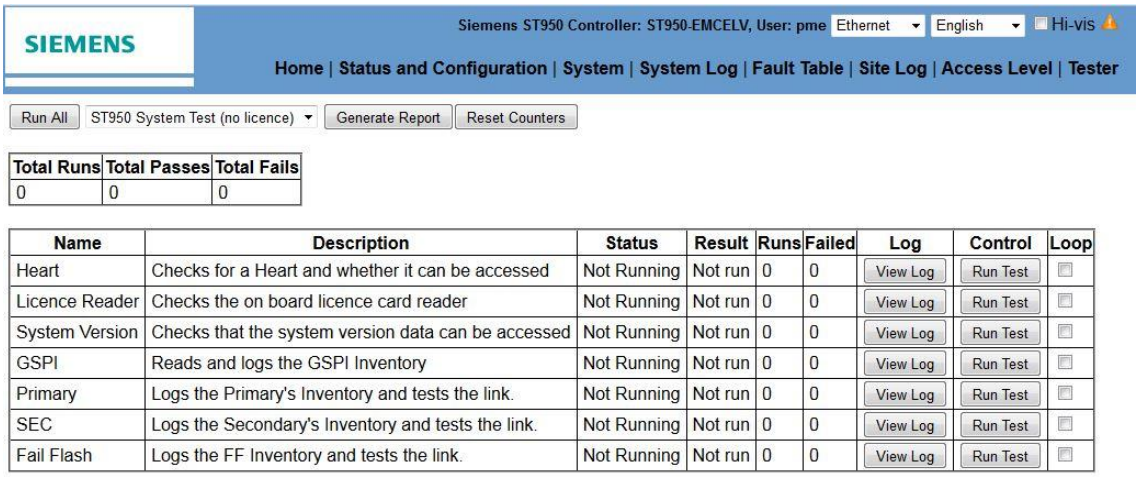


Figure 61 - ST950 System Test (no licence) Scenario

When self test is initiated by powering up the controller with the level 3 access button pressed, steps 2 and 3 are repeated to form a soak test.

11.3 Manual Panel Checks

While the full controller Self-Test is running, the Manual Panel can be checked. Pressing each button on the panel should illuminate the associated LED. To distinguish this from normal operation, the LED flashes at a fast rate while the button is pressed. Note that the 'Lamp Test' button flashes all the LEDs on the Manual Panel.

To test the signals On/Off switch and the cabinet alarm LED, switching the switch to the signals 'ON' position flashes the cabinet alarm LED. Switching it to the 'off' position extinguishes the cabinet alarm indicator. The Signals On/Off Switch does not affect the Self-Test in any other way.

11.4 Self-Test Handset Output Prior to Lamp Supply On

The following shows typical information output by a fully functional controller during the initial part of Self Test and summarizes the tests it performs. Exact output will depend on the scenario selected.

Test Area	Test	Self Test Output Examples
	The first test stage is undertaken without power being applied to the Lamp Switch cards.	

Introduction		`Controller SelfTest` `==========`
Pause output question		`Q: Pause Display` `After 4 Lines? [YN]`
Primary control of self test		
Primary Firmware	Identifies the Primary processor firmware and package issue	`PRI:46020 1.0`
SEC CPU	Checks that the SEC processor is running	`SEC CPU......Active`
Lamp switch card identification	Searches for LSLS cards This example shows two LSLS cards	`LSLS Cards...----21`

	Details LSLS cards found:
	Firmware number and version
	Hardware number
	Hardware Issue
	Date of manufacture
	If no inventory information is found:
	'No Inventory Data' is displayed
		`2 LSLS Cards`
		`VLS 1:32941 7`
		`HW: 667/1/32943/001`
		`ISS 20`
		`DOM 2013/07/11`
		`VLS 2:32941 ISS 7`
		`No Inventory Data`
		`VLS3:-`
		`VLS4:-`
		`VLS5:-`
		`VLS6:-`

PHP CPU	Checks to see if the PHP processor is running. Will not be running on an ELV controller	`PHP CPU......None`
Controller	Type Confirmation	`Ok, ELV Controller`

EFC control of self test		`Waiting for EFC...`
		`EFC started...`
		`EFC in control...`

	Primary Inventory tests finished	`PRI INV done`
	EFC Inventory tests start here	`EFC INV start`
Test ID	System	`TEST: System version:`

File system firmware	Identifies the file system firmware and version	`File system`
		`667/TZ/46059/000`
		`Siemens ST950`
		`Controller`
		`Vers: 1.0`

Platform hardware and firmware	Identifies the platform hardware, firmware and version	`linuxEFC Hardware 667/TZ46010/001,C,2012/09/12,ST950 CPU Card SN: xxxxxxxx`
Ethernet	Identifies the programmed MAC address	`Mac Address: xx:xx:xx:xx:xx:xx`
Test Status		`Pass: System Version`
Test ID	Primary CPU	`Test: Primary`
Primary firmware	Identifies the Primary CPU firmware and version	`Primary: Primary 667/TZ/46020/000 Version 1.0`
Primary comms	Tests communications between EFC & Primary	`Comms ok`
Test Status		`Pass: Primary`
Test ID	SEC CPU	`Test: SEC`
SEC firmware	Identifies the SEC CPU firmware and version	`SEC: SEC 667/TZ/46040/000 Version 1.0`
SEC comms	Tests communications between EFC & SEC	`Comms ok`
Test Status		`Pass: SEC`
Test ID	Fail Flash CPU	`Test: Fail Flash`
Fail Flash firmware	Identifies the Fail Flash CPU firmware and version	`Fail Flash: Fail Flash 667/TZ/46041/000 Version 1.0`
SEC comms	Tests communications between EFC & Fail Flash	`Comms ok`
Test Status		`Pass: Fail Flash`
Test ID	GSPI Peripherals	`Test: GSPI`

Peripherals	Identify all connected GSPI peripherals and reports card types, firmware & versions.
	
	This example shows two cards connected:
	1 - 24/16 I/O Card
	2 - Intelligent Detector Backplane
	
	Checks communications with each peripheral
	If cards do not have inventory information programmed some fields are omitted or identified as 'unknown'
		`GSPI Inventory`
		
		`GSPI:1 HW:`
		`Prt:667/1/32990/951`
		`Iss:02`
		`Serial:xxxxxxxx`
		`GSPI:1 FW:`
		`Prt: 32998`
		`Iss:0.1.3.4`
		`GSPI:1 HWID: 193`
		`24in 16out`
		`link ok`
		
		`GSPI:2 HW:`
		`Prt:`
		`667/1/46090/000`
		`Iss:01`
		`Serial:xxxxxxxx`
		`Intelligent Det`
		`Backplane`
		`GSPI:2 FW:`
		`Prt: 32998`
		`Iss:0.1.3.4`
		`GSPI:1 HWID: 194`
		`16in`
		`link ok`

Test Status		`Pass: GSPI`
Test ID	Ethernet	`Test: Ethernet Ping`

Ethernet	Ping test over Ethernet interface.The IP address used is gateway address For use in manufacturing the controller uses an IP address stored in an XML file on a USB memory stick that is plugged into the controller.	`Ping:`
		`i/f OK`
		`xxx.xxx.xxx.xxx OK`

Test Status		`Pass: Ethernet Ping`
Test ID	USB Device	`Test: PcPing`
USB Device	Ping test over USB device interface. IP address is hardwired to 172.29.100.10 which is the address adopted by the connected PC.	`USB PC:` `172.29.100.10 OK`
Test Status		`Pass: PcPing`

Test ID	License Reader	`Test: License Rdr`

License Reader	Tests the license card reader and reports licenses stored on the inserted card (facilities)	`License Card: 72S8010C serial 00 00`
		`facility: x`
		`facility: y`
		`facility: z`

Test Status		`Pass: License Rdr`
Test ID	License Card	`Test: License Card`

License Card	Tests the license card and reports licenses stored on the inserted card (facilities)	`License Card: 72S8010C serial 00 00`
		`facility: x`
		`facility: y`
		`facility: z`

Test Status		`Pass: License Card`
Test ID	USB Card Reader	`Test: USB Card Reader`
USB Card Reader	Tests connection with USB card reader	`USB Card Readers: No USB Card Readers`
Test Status		`Fail: USB Card Reader`
Test ID	Heart	`Test: Heart`

Heart	Test read & write access to the SD card	`Heart:`
		`data write OK`
		`data read OK`

Test Status		`Pass: Heart`
Test ID	USB Drive	`Test: USB Drive`

	Tests read & write access to a USB memory device	`USB Drive:`
		`data write OK`
		`data read OK`

Test Status		`Pass: USB Drive`
Test ID	Modem	`Test: Modem`

RS232 Modem	Tests the RS232 modem connection using a loopback connector. Where no loopback is detected 'not conn' is displayed for each failed connection: TXD-RXD DTR-CTS DTR-RI RTS-DSR	`Modem: loopback:`
Test Status		`Pass: Modem`
Test ID	Aux3	`Test: Aux3`
Auxiliary RS232	Tests the Auxiliary RS232 connection using a loopback connector. Where no loopback is detected 'not conn' is displayed for each failed connection: TXD-RXD DTR-CTS RTS-DSR	`Aux3: Loopback:`
Test Status		`Pass: Aux3`
EFC Tests Complete	EFC passes control of self test back to Primary CPU – EFC Inventory tests complete	`EFC INV done`
Primary control of self test	Primary Driver tests begin; checks that the Phase Bus system can be started but does not yet switch on the lamp supply	
Waits for ZXO synchronization and checks the mains frequency	Source of ZXO detected and reported. If the Processor cannot synchronize to the mains zero cross-over signal, then Self-Test waits indefinitely at this point with the red system error LED illuminated. Check/replace the connection between LSLS#1 and the CPU Card. Then try replacing LSLS#1 or the CPU Card	`ZXO from.....SEC`
Mains Supply	Mains frequency measured and reported	`Mains Freq...50.0Hz`

SEC	Checks communications with the SEC CPU	`SEC CPU......Active`
Phase Bus	Phase bus system initialization LSLS cards found and configured. Once initialized, the Phase Bus Processor and LSLS Cards perform more thorough checks and may detect faults. This could result in some of the general error message (as shown in section 11.7) being displayed.	`P/Bus Init...Ok`
Lamp Supply	Checks that the measured Lamp Supply is 0V with the Lamp Supply Switched off	`L/Supply Off=0V`
LSLS voltage monitoring	Checks that the LSLS voltage monitors are reporting that all outputs are switched off	`V/Mons Off...Passed`

	Primary Driver tests complete
	EFC Driver tests – place holder for possible future tests.
		`PRI DRV done`
		`EFC DRV start`
		`EFC DRV done`

At this point, the Self-Test has successfully checked-out the logic side of all the LSLS cards that it has found. It then displays a scrolling pattern on the amber LEDs on these LSLS cards to prove that it can address all the cards correctly and to show that the first part of the Self-Test is complete.

11.4.1 Test Failures

If test fail during the 1st part of self test the handset output will provide details of the failure. The section below details the output and describes what possible causes there are.

```
No LSC or LSLS!
```

No lamp switch cards were detected; check the connections from the CPU Card to each LSLS and that all the LSLS Cards appear powered (i.e. their status LEDs are flashing).

```
Missing LSLS?
```

If it appears that an LSLS Card is missing, e.g. if the first and third cards are detected, but not the second, then the error message “Missing LSLS?” is displayed. It should be clear from the information displayed prior to this error message (shown above in grey) as to which card or cards appear missing. Check the connections from the CPU Card to each LSLS and that all the LSLS Cards appeared powered (i.e. their status LEDs are flashing).

Note: If the last fitted card is not found, the Self-Test will not detect the problem at this point. For example, it will continue if LSLS#1 and LSLS#2 are found, but LSLS#3 is not powered. It is therefore essential that the user checks (at the start of

Part Two, see section **Error! Reference source not found.**) that all the LSLS C ards have been correctly identified.

```
EFC Failed
```

Displayed if the Primary has seen SelfTest start in the EFC, but the EFC appears to have stopped

```
Mains Freq Error
```

Reported if the mains frequency measurement is more than 5% out from either 50Hz or 60Hz

```
P/Bus init...Failed
P/Bus Fault
```

The phase bus system has failed to initialise correctly

```
L/Supply Off=48V
L/Supply Stuck On
```

If a lamp supply is being detected, then this implies that the lamp supply relays are all switched ON or are being by-passed by a wiring fault for example.

```
V/Mons Off...Failed
180000000  4--------
200000001  5--------
300000000  6--------
```

If any of the voltage monitors appear to be detecting a voltage, even though the lamp supply is switched off, then this implies a problem with the hardware on one or more of the LSLS cards. See section 10.4 for details of this format of error message.

11.5 Self-Test Handset Output After Lamp Supply On

It is essential that the correct number of LSLS cards have been detected at this point as, following this, the Self-Test starts applying the lamp supply to the LSLS Cards.

Therefore, check that the pattern illuminates the correct number of LEDs on the card for that card's address, e.g. the pattern will just contain one illuminated LED on LSLS#1, but will contain two illuminated LEDs on LSLS #2. Also check that the scrolling pattern illuminates all the amber LEDs in turn on all the LSLS cards fitted.

After the level 3 button is pressed or "Y" entered and confirmed, Self-Test switches ON the lamp supply and will test each LSLS output and monitor circuit by switching each one ON in turn for just two mains cycles (40ms). This may visible on the traffic signals as a bright flash, particularly with LED Signals. Therefore:

All LED Signal Heads should be covered before proceeding any further with the Self-Test.

The following shows typical information output by a fully functional controller during Self Test during Part Two, and summarizes the tests it performs:

Test Area	Test	Self Test Output Examples
LSLS addressing	Sequences the phase amber LED's on each fitted lamp switch card. This allows the operator to confirm that the controller has recognised all Lamp switch cards that are fitted and that each is being addressed correctly.	`All Cards Working?`
	If satisfied that the controller has correctly recognised the Lamp Switch cards the operator initiates the second stage of the test by pressing the level 3 push button again. The tests now continue with Lamp Supply switched on.	`**** IMPORTANT **** All LED Signals to Be covered before Continuing...`
	Cyclic self test starts	`Starting Pass 0001`
	**The second test stage is undertaken with power applied to the Lamp Switch cards.** **No mains supplies are present on the Lamp switch cards (LSLS)**	
LSLS voltage monitoring	Lamp supply is now applied to the lamp switch cards and checks that no outputs switch on. Should return 0V	`V/Mons off...Passed`
Lamp Supply switching – Relays & FETs	Measure lamp supply and report value	`Lamp Supply..48V`
LSLS	Monitor Validation test – Checks that the monitor validation is working as expected	`M/V Test.....Passed`
Lamp Supply	Measures and reports the dim lamp supply	`Dim L/Supply=28V`
HPU Supply Arrangement and relay tests	Lamp Supply relay tests. Checks that each relay on the HPU can switch off the lamp supply. From the HPU relay test, determines how the controller is configured to provide lamp supply	`HPU Relays switch off LSLS cards: A:All LSLS Off B:All LSLS Off Controller Set-Up: 'Fail To Black-Out'`

	If hardware fail flashing is available	HPU Relays switch off LSLS cards: A:LSLS 1 On B:LSLS 1 On FailFlash Available But Not Selected.
LSLS	Switches each LSLS output on in turn (Amber LED moves across all LSLS cards) to check that all outputs are working.	LSLS Outputs:1-xx
HPU	Relay A Control by Primary CPU Test	Relay A-PRI..Ok
LSLS	LSLS output test continues	LSLS Outputs:11-xx
HPU	Relay B Control by SEC CPU Test	Relay B-SEC..Ok
LSLS	LSLS output test continues	LSLS Outputs:21-xx LSLS Outputs:Passed
SEC	SEC CPU still running	SEC Working
	1st pass of self test complete. After a short period the second stage of the test is repeated indefinitely to allow the controller to be soak tested if required.	========== Pass 0001 Complete ==========

11.5.1 Test Failures

If test fail during the 1st part of self test the handset output will provide details of the failure. The section below details the output and describes what possible causes there are.

```
M/V Test.....Failed
Mon Val Failed
```

The monitor validation signal is generated by the CPU Card and travels down the phase bus cables to each of the LSLS cards, so a failure is probably due to a faulty LSLS Card or interconnecting cable. If two lamp supply transforms are used, check the live-neutral connections to those are correct and consistent. If, after checking and/or replacing these items, the problem persists, there is the possibility that the logic supply phasing may be incorrect – contact Siemens Engineering in Poole for further information.

```
V/Mons Off...Failed
100000000  4--------
200000001  5--------
3--------  6--------
```

If any of the voltage monitors appear to be detecting voltages, it would imply that those LSLS Outputs are stuck ON (short circuit) and thus that LSLS card should be replaced. See section 11.6 for details of this format of error message.

In the above example, LSLS #2 should be replaced because the eight digits after the card number are not all zeroes; one or more outputs ON. LSLS #1 appears ok because the eight digits are all zeroes; all outputs OFF.

```
L/Supply Failure
LSLS not on..----21
```

No lamp supply has been detected on the LSLS Cards identified. Check the lamp supply circuit's relays, fuses, etc., in and around the HPU.

```
Relay A Fault
Relay B Fault
```

Failure of any of the relay tests implies that the relay is not switching off, i.e. that it is either stuck closed or the control signals from the CPU Card are stuck active.

```
Relay A HFF Fault
```

This fault indicates a problem with the Hardware Fail Flash set-up of the controller:

Only one LSLS Card has been found, but the link on the HPU appears to be set-up for HFF, i.e. Relay A did not switch off the lamp supply to LSLS#1.

More than one LSLS Card has been found and the link of the HPU appeared to be set-up for HFF, but Relay A has switched off the lamp supply to LSLS#1.

```
Dim L/Supply=48V
Dimming Fault
```

A fault is only detected with the dimming relay if the dim lamp supply is more than 75% of the normal lamp supply, i.e. that the dimming relay seems to have no effect on the lamp supply. If dimming is not required, then the dim and bright lamp supplies must not be connected together. If dimming is configured as not present, i.e. KDP is set to zero, then the controller simply never attempts to switch to dim.

Note that this test does not fail if there is no dim lamp supply. Therefore, the dim voltage should be checked manually.

```
Relay A Fault or
HPU2 selects HFF
(only select HFF
On HPU1, not HPU2)
```

Two LSLS cards remained powered.

```
Relay A Fault:
LSLS 3 not
Switched off
```

Three or more LSLS cards remained powered.

```
Only 1 LSLS but
HPU link set for
'Fail to
Flashing'!
```

Only one LSLS card fitted.

```
Only LSLS #1
Should
Be connected to
The fail flash lamp
Supply!
```

The LSLS card set-up for HFF is not the first card.

```
HPU link set
For ST900 HFF
Not ST950 HFF
Or Relay A Fault
```

Only one LSLS; with Relay A it appears to be connected to HFF, with Relay B it appears to switched off, i.e. ST900 HPU or Relay A stuck.

```
ST900 HPU fitted
Or HPU link set
For ST900 HFF
Not ST950 HFF.
```

Relay A indicated HFF but Relay B does not; this is probably ST900-style HFF connections.

```
Unexpected result
From HPU Relay
Checks.
```

Implies a relay fault.

11.6 LSLS Card Faults

Resolving problems with LSLS Cards and LSLS Outputs:

When various tests fail, the handset may display information such as shown below:

If only one LSLS Card is fitted:

```
1/05:Extra Sigs On        ← identifies the test which has failed
32:1000000000000000       ← LSLS outputs 32 through to 17
16:0000000000010000       ← LSLS outputs 16 through to 1
   ........87654321       ← (Helpful information)
```

The display shows the status of all 32 LSLS Outputs on that card. The display is in 'binary', with each digit / bit showing '1' to identify that output as faulty. The status of the 32 LSLS Outputs (1-32) is shown on the second and third lines.

The first line identifies the test that has failed (see section **Error! Reference source not found.**). The second line shows the status of LSLS Outputs 17 to 32, starting

with 32 on the left, just after the text “32:”. The third line shows the status of LSLS Outputs 1 to 16, starting with 16 on the left, just after the text “16:” and finishes with LSLS Output 1 on the right. The fourth line is added to clarify the position of the digits / bits for LSLS Outputs 8 through to 1. In this example, the LSLS Outputs 5 and 32 appear to be ON.

If more than one LSLS Card is fitted:

```
No Voltages On...
180000000 4--------
200000000 5--------
3-------- 6--------
```

← identifies the test which has failed

← outputs on LSLS#1 and LSLS#4

← outputs on LSLS#2 and LSLS#5

← outputs on LSLS#3 and LSLS#6

The numbers are in hexadecimal notation with each of the eight digits encoding four LSLS outputs, so the status of the 32 LSLS Output numbered 1-32 (from right to left) is shown by the eight digits. Each possible combination of the LSLS outputs is encoded to a value as follows. In the above example, the voltage monitor for LSLS Output 32 is indicated as faulty, implying that the output switch (or the monitor) is faulty.

	32 - 29 3 3 3 2 2 1 0 9		28 - 25 2 2 2 2 8 7 6 5		24 - 21 2 2 2 2 4 3 2 1		20 - 17 2 1 1 1 0 9 8 7		16 - 13 1 1 1 1 6 5 4 3		12 - 9 1 1 1 2 1 0 9		8 - 5 8 7 6 5		4 - 1 4 3 2 1
0=	- - - -	0=	- - - -	0=	- - - -	0=	- - - -	0=	- - - -	0=	- - - -	0=	- - - -	0=	- - - -
1=	- - - X	1=	- - - X	1=	- - - X	1=	- - - X	1=	- - - X	1=	- - - X	1=	- - - X	1=	- - - X
2=	- - X -	2=	- - X -	2=	- - X -	2=	- - X -	2=	- - X -	2=	- - X -	2=	- - X -	2=	- - X -
3=	- - X X	3=	- - X X	3=	- - X X	3=	- - X X	3=	- - X X	3=	- - X X	3=	- - X X	3=	- - X X
4=	- X - -	4=	- X - -	4=	- X - -	4=	- X - -	4=	- X - -	4=	- X - -	4=	- X - -	4=	- X - -
5=	- X - X	5=	- X - X	5=	- X - X	5=	- X - X	5=	- X - X	5=	- X - X	5=	- X - X	5=	- X - X
6=	- X X -	6=	- X X -	6=	- X X -	6=	- X X -	6=	- X X -	6=	- X X -	6=	- X X -	6=	- X X -
7=	- X X X	7=	- X X X	7=	- X X X	7=	- X X X	7=	- X X X	7=	- X X X	7=	- X X X	7=	- X X X
8=	X - - -	8=	X - - -	8=	X - - -	8=	X - - -	8=	X - - -	8=	X - - -	8=	X - - -	8=	X - - -
9=	X - - X	9=	X - - X	9=	X - - X	9=	X - - X	9=	X - - X	9=	X - - X	9=	X - - X	9=	X - - X
A=	X - X -	A=	X - X -	A=	X - X -	A=	X - X -	A=	X - X -	A=	X - X -	A=	X - X -	A=	X - X -
B=	X - X X	B=	X - X X	B=	X - X X	B=	X - X X	B=	X - X X	B=	X - X X	B=	X - X X	B=	X - X X
C=	X X - -	C=	X X - -	C=	X X - -	C=	X X - -	C=	X X - -	C=	X X - -	C=	X X - -	C=	X X - -
D=	X X - X	D=	X X - X	D=	X X - X	D=	X X - X	D=	X X - X	D=	X X - X	D=	X X - X	D=	X X - X
E=	X X X -	E=	X X X -	E=	X X X -	E=	X X X -	E=	X X X -	E=	X X X -	E=	X X X -	E=	X X X -
F=	X X X X	F=	X X X X	F=	X X X X	F=	X X X X	F=	X X X X	F=	X X X X	F=	X X X X	F=	X X X X
	8		0		0		0		0		0		0		0

11.7 Other Error Messages

The following error messages can be displayed at any time during the Self Test.

Other error messages not shown here may be displayed shortly after power-up and before Self-Test begins if there is a fundamental problem with the CPU Card. See the details of the start-up sequence in the Handset Handbook for details.

ZXO Synchronisation

If the Controller loses synchronisation with the zero-crossing points of the mains supply, the following error message will be displayed and Self-Test will abort.

```
ZXO Sync Lost
```

This fault is also displayed when the mains power to the controller is switched OFF or there has been a short interruption to the mains supply. If the problem persists and the mains supply is thought to be good, check the connections between LSLS#1 and the CPU Card. Then try replacing LSLS#1, CPU Card.

SEC CPU Faults

If communications between the Primary CPU and the SEC CPU fail, the following error messages can be displayed:

```
SEC Msg Timeout
```

```
SEC Stopped!
```

Replace the CPU Card if the problem persists.

```
SEC fault FLF2:N
```

The SEC has confirmed a serious fault and shutdown the controller; see the ST950 Handset Handbook for the meaning of the various values.

Unexpected Correspondence Faults

If the LSLS Cards indicate that signals appear ON at times when the Self-Test is not expecting any signals to be illuminated, then either of the following error messages will be displayed:

```
Unexp Corr Fault
```

If the fault occurs within a few seconds of the “P/Bus Init…” step in part one of the Self-Test (see section ?), then it implies that outputs appear to be ON even though the lamp supply is still OFF.

This can be caused by faulty voltage monitors on the LSLS Cards. Try removing all but LSLS#1 and repeating the Self-Test. If it still fails, then replace LSLS#1. If it passes, remove LSLS#1 and replace it with just one of the other LSLS Cards and repeat the test. Repeat this to test each LSLS Card in turn.

It can also be caused by stray voltages on the street cables. Carefully check all the street cables to ensure that no voltages are present from external sources.

Configuration Download Sequence

If the configuration download sequence to the LSLS Card fails, then one of the following error messages is displayed. The '*' will be replaced by the card address.

```
DL NOT STARTED
```

```
BAD REPLY TO SD MSG
```

```
LS* DOWNLOAD FAIL
```

Check the connections to the card and if the fault persists, replace the card.

LSLS Card Failures

If low power is confirmed by one or more LSLS Cards, then the following error message is displayed. The '*' will be replaced by the address of the first card to report it.

```
LSLS* POWER LOW
```

Carefully check the mains supply voltage to the Controller and the taps on the lamp supply transformer (which also provides the logic power to the LSLS Cards). If the fault persists, change the LSLS Card. Also see the description of "FLF 9:255 LSPF" in the handset handbook.

If communication to one or more LSLS cards has been lost, then the following error message is displayed. The '*' will be replaced by the address of the first card that disappears.

```
LSLS* COMMS FAIL
```

Check the cable connections between the Main CPU Card and that LSLS Card. Also see the description of "FLF 43:255 LSLS" in the handset handbook.

If a 'Major Fault' is reported by an LSLS Cards, then the following error message is displayed. The '*' will be replaced by the address of the LSLS Card.

```
LSLS* MAJOR FAULT
```

The LSLS Card will probably need to be replaced. For more information, see the description of "FLF 42:255 LSMF" in the handset handbook.

Appendix A Part Numbers and Spares List

Use of components other than those listed, or modifications or enhancements that have not been authorised by Siemens Traffic Controls may invalidate the warranty and/or safety of this product.

Part Numbers

Listed below are all the currently available main parts common to all ST950 ELV Controllers. Sections A.1 and A.2 give part numbers for those parts that are exclusive to either UK only or non-UK Controllers. For an up to date list see the ST950ELV Family Tree (667/DZ/45950/000).

Spares List

In addition to the spares listed below, many of the parts listed in section 0 and A.4 may be ordered as replacement items. Contact Siemens Poole for details.

Description	Part Number
ST950ELV Additional LSLS Rack Wiring kit	667/1/32945/000
20A Transformer kit	667/1/32980/020
ST950ELV Low Inrush Transformer kit (20A only)	667/1/32980/500
ELV Lamp Switch (32 channel LSLS) kit	667/1/32943/001
ELV Lamp Switch (LSLS) Backplane kit position 1	667/1/32960/000
ELV Lamp Switch (LSLS) Backplane kit positions 2 & 3	667/1/32960/001
ST950 CPU Card assembly (64M EFC)	667/1/46010/001
ST950 CPU Card assembly (128M EFC)	667/1/46010/101
ST950 I/O Card Kit (16 outputs)	667/1/46085/001
ST950 I/O Card Kit (4 outputs)	667/1/46085/002
Intelligent Detector Backplane kit	667/1/32910/950
ELV 24V DC Detector Supply kit (6.6A)	667/1/33074/000
ELV 24V DC Detector Supply kit (2A)	667/1/33075/000
Detector 6U Rack Expansion kit (Divider kit)	667/1/33002/000
Manual Panel RS232 kit	667/1/27110/000
ELV Audible Driver Kit (Dual Output type)	667/1/32955/000
300mA RCD kit	667/1/27117/000
40A Upgrade kit	667/1/32980/040
Regulatory Signs Expansion kit	667/1/33070/000
Cabinet Rear (Additional) Panel kit	667/1/33001/000
Mains Isolator Locking kit	667/1/33073/000
Cabinet mounted Cut-out Connection kit	667/1/33072/000
Expansion Cabinet kit - Grey	667/1/32900/000

Expansion Cabinet kit - Black	667/1/32900/001
Mounting Stool (Grey)	667/2/27096/000
CET Bar Kit	667/1/27063/000
Expansion Cabinet kit ELV Master Switch assembly	667/1/33080/000
LSLS Expansion Cabinet kit	667/1/33007/000
Screw Lock Key	667/2/20234/000
Manual Panel Assembly (Intersection Controller)	667/1/27056/001
DFM Lens kit	667/1/27104/000
ELV Solar Cell kit	667/1/10039/024
Tactile kit (ELV, non-switched; combined motor and drive unit)	667/7/17390/048
Tactile kit (ELV, switched; separate motor and drive unit)	667/7/17390/148
Tactile kit (ELV, switched; fault o/p; combined motor and drive unit)	667/7/17390/248

A.1 UK Standard Types

Description	Part Number
ST950ELV Controller Cabinet UK 20A Single LSLS Grey	667/1/45950/020
ST950ELV Controller Cabinet UK 40A Single LSLS Grey	667/1/45950/040
ST950ELV Controller Cabinet UK 20A Single LSLS Black	667/1/45950/021
ST950ELV Controller Cabinet UK 40A Single LSLS Black	667/1/45950/041
ST950ELV Controller Cab UK 20A Single LSLS Low Inrush Grey	667/1/45950/520
ST950ELV Controller Cab UK 20A Single LSLS Low Inrush Black	667/1/45950/521
NAL Cabinet Base Grey	667/7/46690/000
NAL Cabinet Base Black	667/7/46690/001

A.2 Non-UK Standard Types

Description	Part Number
ST950ELV Controller Cabinet Non UK 20A Single LSLS Grey	667/1/45950/120
ST950ELV Controller Cabinet Non UK 40A Single LSLS Grey	667/1/45950/140
ST950ELV 40/42V Controller Cabinet Non UK 20A Single LSLS Grey	667/1/32900/242
ST950ELV Logic Rack Kit with single LSLS	667/1/45950/951
Lightning Protection Kit – Mains Surge Arrester (Non UK)	667/1/27118/000
Lightning Protection Kit – Telephone (Non UK)	667/1/26271/000
Manual Panel Signals On/Off and DFM Assembly (Non UK)	667/1/27056/301
CPU I/O Kit (24 Input / 4 Output)	667/1/46014/000
CPU I/O Cable Form (24 Input / 4 Output)	667/1/45952/001

A.3 Optional Parts

Description	Part Number
RTC Backup Battery Kit	667/1/45970/000
GPS Module Kit	667/1/27014/950
USB Card Reader	667/1/45964/001
License Card Kit – Lightweight Tunnel	667/1/47560/000
License Card Kit – Remote Access	667/1/47561/000
License Card Kit – MOVA 7 Streams 1,2	667/1/47562/000
License Card Kit – MOVA 7 Streams 3,4	667/1/47563/000
License Card Kit – UTMC OTU	667/1/47564/000
License Card Kit – Serial Handset	667/1/47565/000
License Card Kit – UTMC OTU, MOVA 7 Streams 1,2	667/1/47566/000
License Card Kit – UTMC OTU, MOVA 7 Streams 1,2,3,4	667/1/47567/000
USB WiFi Dongle	667/1/45966/000
ST900ELV to ST950ELV Power Adaptor Cable Assy (White)	667/1/45961/000
Lightning Protection Kit – Ethernet	667/1/45972/001
Gemini2	667/1/32600/000

A.4 Other Spares

Description	Part Number
27C Yale Door Lock Kit	667/1/21384/000
Yale Lock Barrel Protector kit	667/1/21498/000
Mains Isolator Locking Kit	667/1/33073/000
Manual Panel Gasket	667/7/27129/000
Sealant strip self adhesive PVC 20mm x 6mm per m	667/4/04026/023
Base sealant - Robnorganic PX212ZF (or similar)	992/4/00216/000
HPU PCB Assy	667/1/33041/000
Intelligent Detector Backplane with Control PCB Assy	667/1/32910/950
Loop Detector Termination Board Assy	667/1/32915/000
IDB Ribbon Cable Assy (IDB to Loop Termination Board)	667/1/32917/000
CPU Card Power Cableform	667/1/45960/000
HPU – LSLS Power Cable Long (For LSLS 1)	667/1/33046/000
HPU – LSLS Power Cable Short (For LSLS 2 & 3)	667/1/33046/001
RJ45 cable for I/O card 0.2m length	998/4/88351/002
RJ45 cable for I/O card 0.5m length	998/4/88351/005
RJ45 cable for I/O card 1.0m length	998/4/88351/010

RJ45 cable for I/O card 2.0m length	998/4/88351/020
RJ45 cable for I/O card 3.0m length	998/4/88351/030
HPU to LSLS 1 Reg Sign Current Sensor Cable Assy	667/1/33047/000
HPU1 to HPU2 Link Cable Assy	667/1/33045/000
Manual Panel On/Off Only	667/1/27056/010
PB815 Firmware PHP PROM (Latest issue)	667/1/12815/000
Audible Indicator	667/4/04785/000
LPU Assembly	667/1/32970/951
HPU metal bracket (Single – two required to mount HPU)	667/2/33043/000
HPU heat transfer pad	667/7/33048/000
SLD4 Detector – Basic	667/1/45200/001
SLD4 Detector – Enhanced	667/1/45200/011
Heart of the Controller (SD Card)	421/4/97008/004
Sealant Stool to Case	996/4/22026/100

A.5 Controller Fuses

The following table lists the fuses fitted in the controller. Fuses should only be replaced with ones of similar rating and type.

Description	Part Number
Electricity Company Cut-out - Standard ST950ELV The Max size of this fuse should not exceed 100A (without reference to Siemens Poole). Maximum prospective short circuit current must not exceed 16,000A. Rating depends on application but 45A minimum is recommended up to 20A load	N/A
Electricity Company Cut-out - ST950ELV Low Inrush Max size and Maximum prospective short circuit current as above. Recommended rating 16A minimum up to 20A ELV load	N/A
Master Switch Fuse - Standard ST950ELV 30A HRC cartridge fuse to BS1361 on Master Switch panel (or 32A HRC cartridge fuse to BS88)	518/4/90637/001
Master Switch Fuse - ST950ELV Low Inrush 16A HRC cartridge fuse to BS1361 on Master Switch panel	518/4/90637/007
Regulatory Signs Fuse 5A SB 250V 5 x 20mm fuse marked ‘Reg Sign’ on the HPU (F1)	518/4/90302/020
Detector Supply Fuse 5A SB 250V 5 x 20mm fuse marked ‘Detector’ on the HPU (F2)	518/4/90302/020
Solar Cell Supply Fuse 500mA QB 5 x 20mm fuse marked ‘Solar’ on the HPU (F3)	518/4/90285/004

LSLS Supply Fuse 30A 80V blade type fuse marked 'LSLS' on the HPU (F4)	518/4/97079/001
Controller Switch Fuse 30A HRC cartridge fuse to BS1361 on the front of the distribution unit.	518/4/90638/005
CPU Card Handset protection fuse 500mA fuse on CPU Card to protect against short-circuit on 5V supply on handset socket (F1) and Aux RS232 Modem power supply output (F2)	518/4/97070/004