SIEMENS

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

ST950 ICM Handbook

667/HE/46950/000

for

ST950

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	Prepared By	Checked and Released
Division/BU	Mobility, Intelligent Traffic Systems	Mobility, Intelligent Traffic Systems
Department	Engineering	Engineering
Name	C.Rabe & K.R.Napper	D.A.Martin
Function	Lead Engineer	Engineering Manager
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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
- 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.

Please note that the internal 24V DC supply should NOT be used for any equipment outside of the main controller cabinet.

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.

Controller Configuration

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.

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.

Contents

Change History

Version	Date	Change	Author
1	October 2013	Initial Draft	C. Rabe
2	January 2014	TS007325	C. Rabe
3	May 2014	TS007425	K.R.Napper
4	November 2018	TS008205	D.Martin
5	December 2018	TS009064	N.Atkinson

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 LV 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/46000/001	ST950 LV UK Power Circuit Diagram
ITS	667/GA/33900/ETC	General Assembly Schematic

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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On written request within three years from the date of product purchase and against payment of our expenses we will supply source code in line with the terms of the applicable license. For this, please contact us at:

Open Source Clearing
Product Development
Engineering Department
Siemens Mobility Intelligent Traffic Systems
Sopers Lane
Poole
Dorset
BH17 7ER
UK

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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

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- 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 ST950 Controller family is the latest in a long line of highly integrated traffic controllers.

The ST950 family of controllers can be supplied either in a single-door outer case with a 6U logic rack and equipment mounting frame or as a free-standing logic rack housing the power supply, CPU Card and Lamp Switch 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 of both incandescent and LED signals.
- 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 248 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 ST900 and the new ST950 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.

Lamp Switch Card(s)

The Lamp Switch cards provide 8 phase dedicated RAG switched outputs. The cards and are located within the Logic Rack and use wiring looms to interface with terminal blocks that terminate the street cables. Very large intersections may have additional I/O and Intelligent Detector Backplane cards located in an adjacent cabinet for ease of installation and maintenance.

Power Supplies

The Mains Distribution Unit (MDU) module distributes the mains lamp supply from the incoming supply and incorporates the Dim/Bright, A and B relays. This module is mounted in the Logic Rack on the left hand side.

The MDU also provides logic supplies to the CPU Card and I/O cards.

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 ST950 CPU I/O card cannot be used in a standard ST950 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 separate detector supply.

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

Please note that the internal 24V DC supply should NOT be used for any equipment outside of the main controller cabinet.

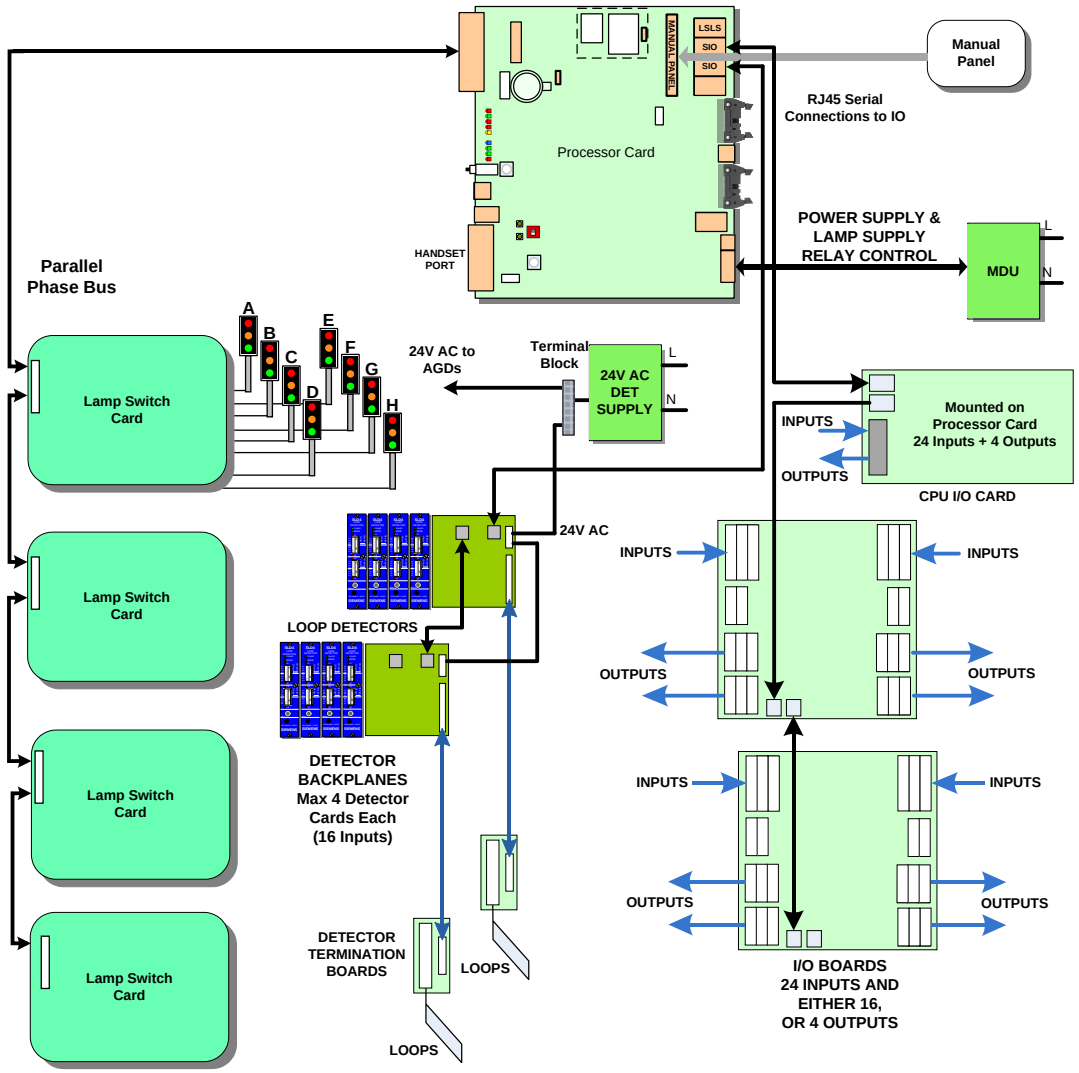


Figure 1 – System Overview

3 HARDWARE OVERVIEW

3.1 The Controller Cabinet

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

CET bars are installed in the base of the cabinet. The Master Switch Panel is installed on the right hand side panel of the cabinet. Up to three I/O cards, dimming transformer, termination blocks and cabling 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.

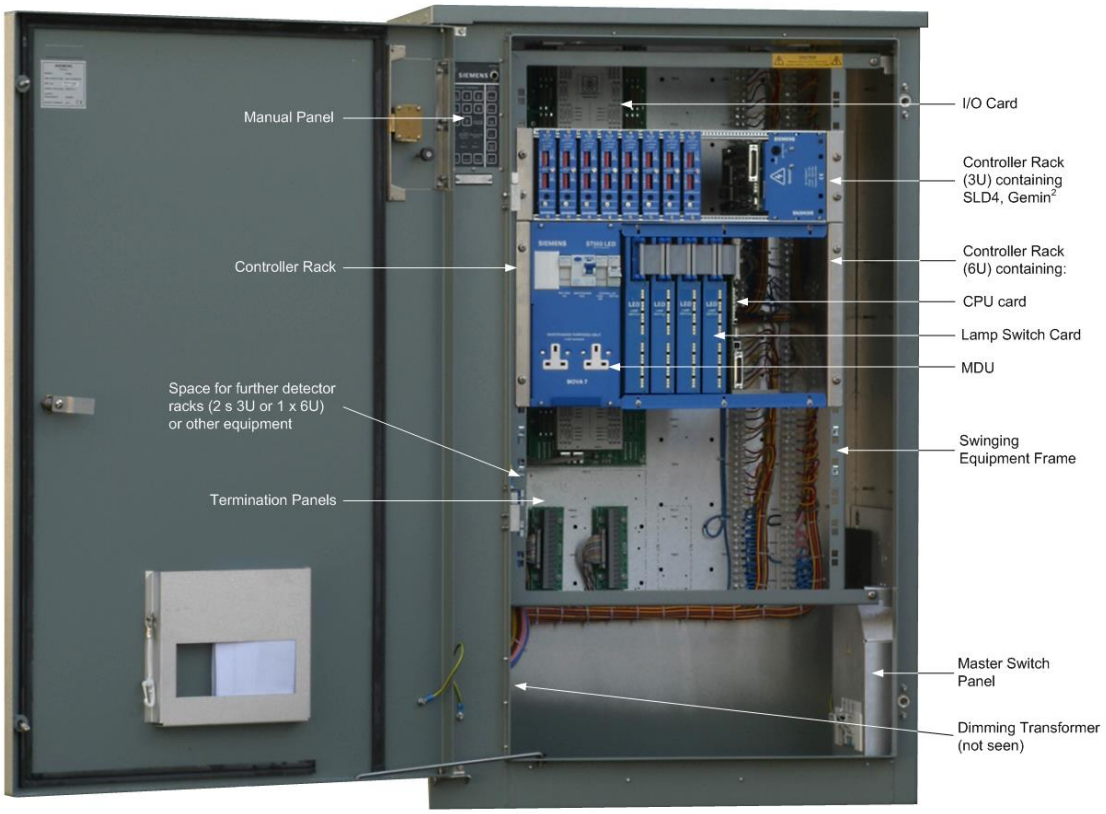


Figure 2 – ST950 Controller Cabinet

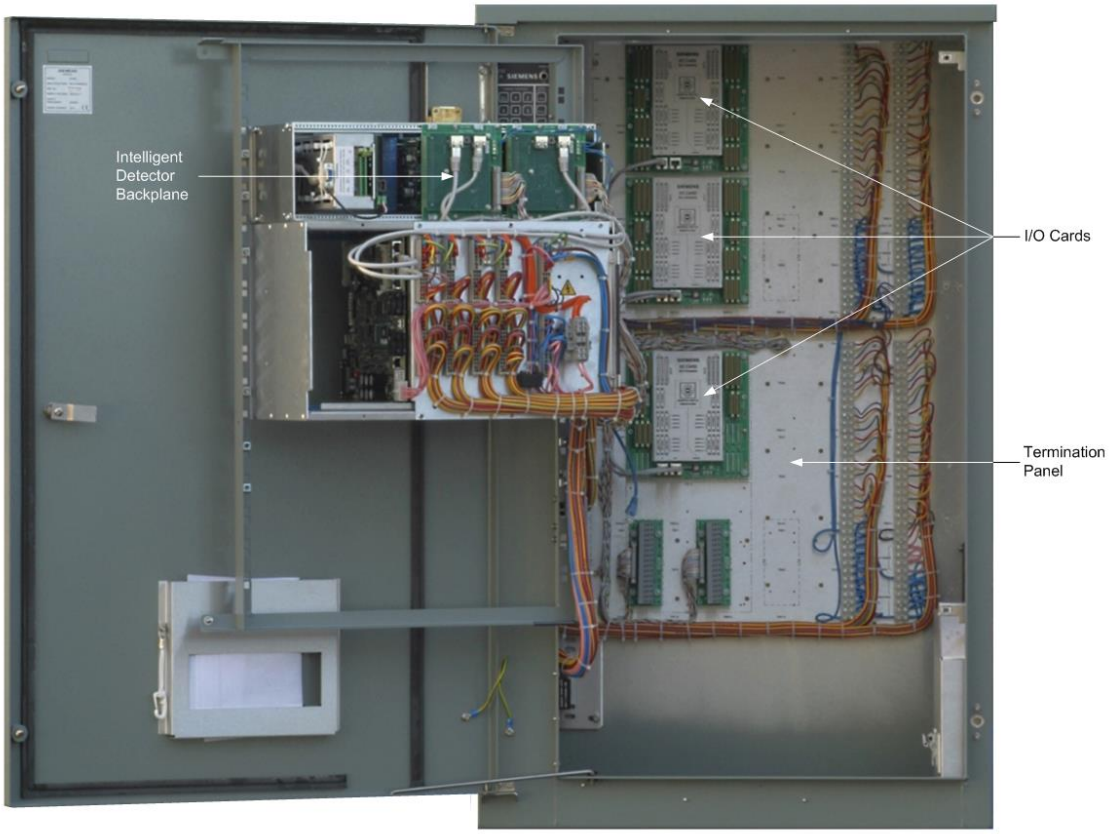


Figure 3 – Controller Cabinet showing new equipment

The Controller Rack

Figure 4 and **Error! Reference source not found.** show the ST950 controller in a 6U 19" rack.

The left-hand part of the rack contains the mains distribution unit (MDU) that contains the logic power supply, the lamp supply relays, the maintenance sockets and the controller's power off/on switch.

Situated in the middle are the four Lamp Switch cards, connected to each other, and to the CPU Card, by the phase bus ribbon cable connectors across the front. Connectors on the back of the rack provide the mains connections to the Lamp Switch cards. Each Lamp Switch card can control up to eight phases, giving a total capability of 32 phases, with the first card being the one closest to the Main Processor (i.e. on the right), with phase A at the top.

There is space above and below the controller rack for further equipment racks to be fitted, as shown in Figure 2. These can accommodate loop detector cards and Gemini^2 equipment.

For some cabinets additional kits of parts are available. These are listed on the ST950 Family Tree (667/DZ/46950/000). 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 listed in the ST950 Family Tree. Refer to Siemens Poole for the latest copy.

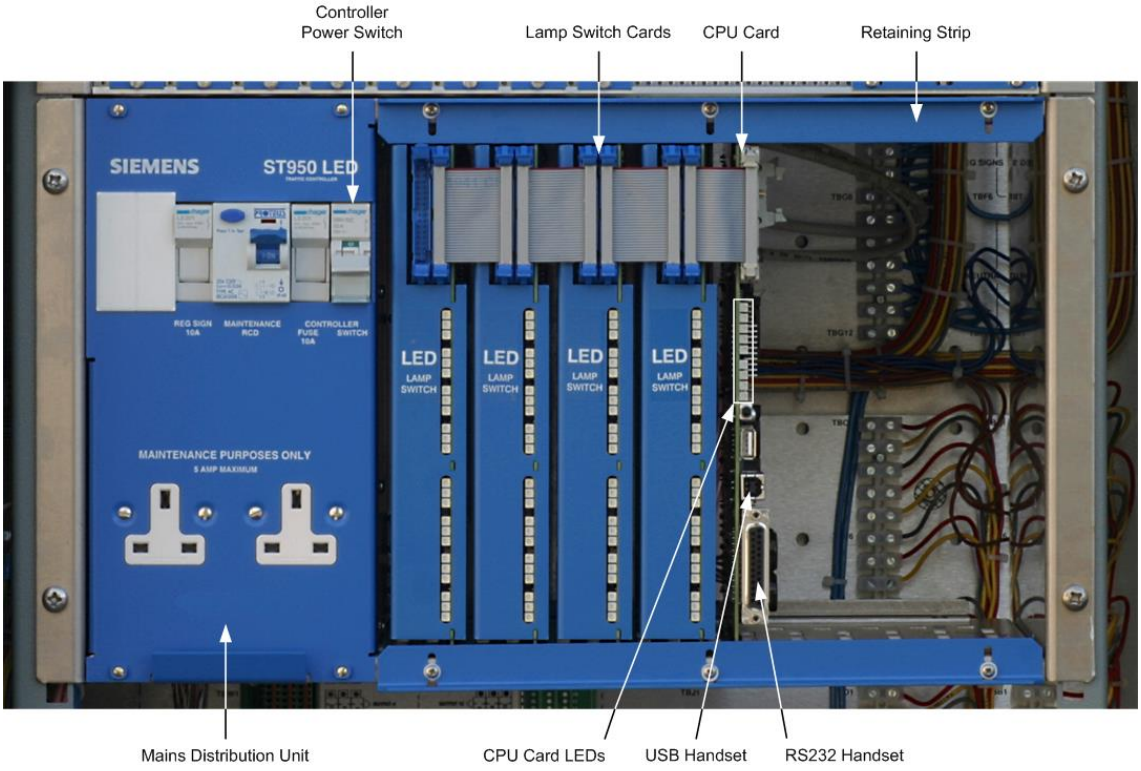


Figure 4 – ST950 19” Rack - Front

Note that a LED UK MDU is shown.

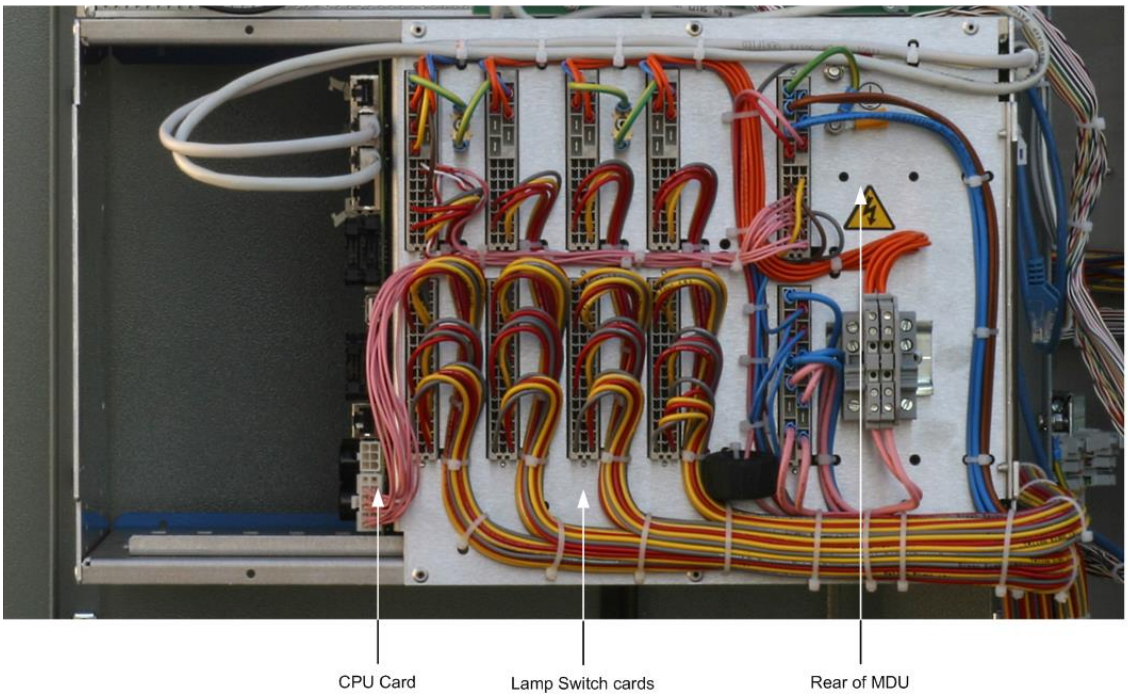


Figure 5 – ST950 19" Rack - Rear

3.2 ST950 Non UK Controller Racks

The ST950 Non UK variants provide a self contained controller providing all of the power supply and control functions located within a single rack.

The rack variants contain the following:

- MDU containing all controller mains distribution, fusing and switching
- CPU Card with integrated I/O card (16 input / 4 output) (Additional I/O cards can be plugged in and located outside of the rack assembly)
- 11" rack with Lamp Switch card(s) providing up to 16 phases (2 LSCs)
- 19" rack with Lamp Switch card(s) providing up to 32 phases (4 LSCs)
- Lamp Switch card variants for 4 & 8 phases per card (4 Phase halogen only)
- Lamp Switch cards for Halogen or LED loads

3.2.1 Rack Wiring

Mains Supply Filtering for Export Rack Configurations

The ST950 export rack is supplied without a mains input filter or Lightning Protection. We strongly recommend that a mains filter and/or Lightning Protection components are fitted to ensure maximum immunity to mains borne interference. This is especially important in areas that suffer with poor mains quality or frequent thunderstorms.

Siemens offer several kits to suit particular controller configurations:

667/1/46965/000 – Filter kit for ST950 or 40A ST950ELV controller

422/4/09906/010 – Filter for 20A ST950ELV controllers

667/1/27118/000 – Mains Surge Arrestor Kit for either LV or ELV controllers

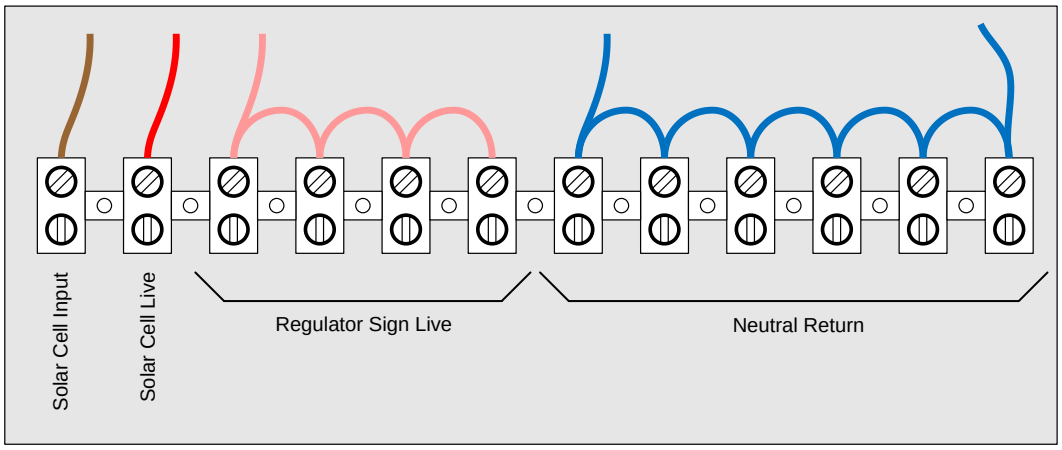
667/1/45972/001 – Ethernet Lightning protection kit

The ST950 Export Rack wiring information is described below:

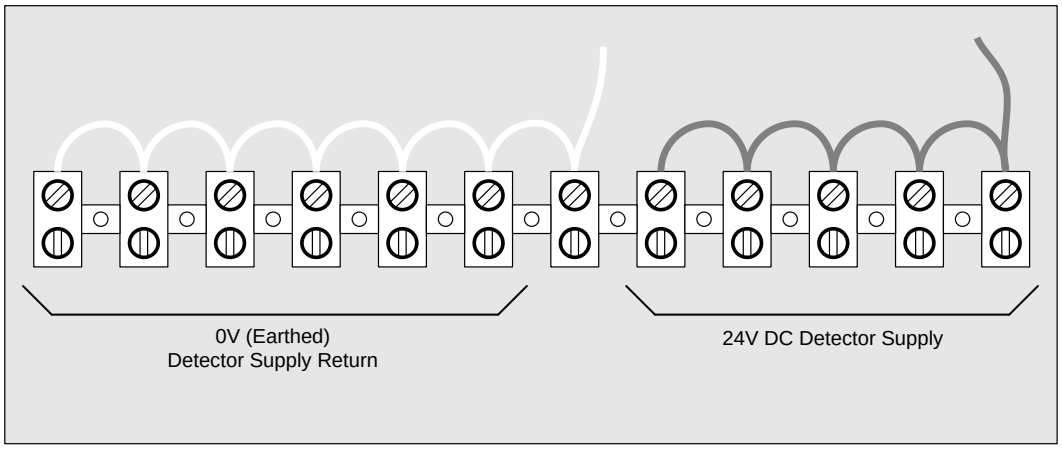
Mains supply wiring:

Colour	Function
Brown	2 wires – Live Supply Input from controller master switch
Blue	2 wires – Neutral Supply Input
Green/Yellow	Rack Earth

Aux Supplies:



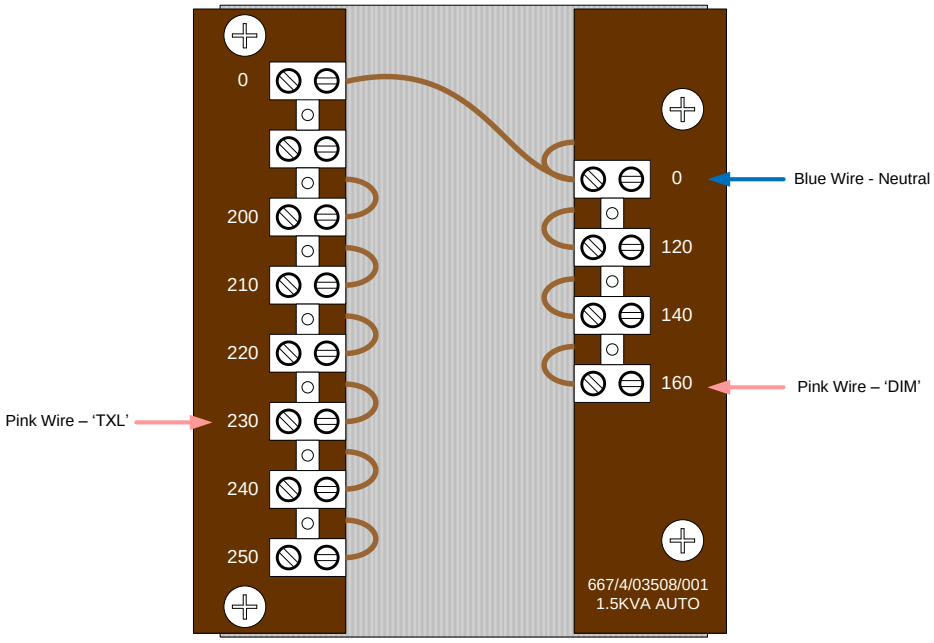
Detector Supply:



Dimming Transformer:

Where the dimming transformer option has been ordered, the transformer wiring is identified as follows:

Colour	Wire Ident	Function
Pink	DIM	Dimmed Supply Takeoff from Transformer
Pink	TXL	Mains Supply Live Feed to Transformer
Blue		Dim Transformer Neutral Connection



- Wire the Pink 'TXL' mains supply feed into the terminal that best matches the local mains supply voltage.

- Wire the Pink ‘DIM’ Takeoff wire to the required dim voltage for the site
- Wire the Blue Neutral Connection to the ‘0’ Terminal as shown above

4 ST950 System Components

This section introduces the main components of the ST950 system.

4.1 Mains Distribution Unit

The MDU is not used to power the Loop Detector cards.

MDU ConnectionsFigure 5 shows the rear of the MDU and details the connections on the connectors.

PL1	z		d	
32	EARTH IN			
			LIVE INPUT	30
28	LIVE INPUT			
			NEUTRAL INPUT	26
24	NEUTRAL INPUT			
			REG. SIGN.	22
20	SOLAR SUPPLY			
16	SPARE	N/C	SPARE	16
14	ZXO-N	N/C	ZXO-L	14
12	0V	0V	0V	12
10	0V	5V(CPU)	5V(CPU)	10
8	12V	24V	SSR	8
6	P/FAIL	5V(ESB)	5V(ESB)	6
4	REL-B	REL-DIM	24V(CPU)	4
2	REL-A	LSupp+	LSupp-	2

PL2	z	b	d	
32	DIM COMMON			
			NEUTRAL RETURNS	30
28	NEUTRAL RETURNS			
			NEUTRAL RETURNS	26
24	NEUTRAL RETURNS			
			NEUTRAL RETURNS	22
20	NEUTRAL RETURNS			
			DIM-LIVE (240V)	18
16	DIM-LIVE (240V)			
			DIM-LIVE (160V)	14
12	R/A SUPPLY			
			R/A SUPPLY	10
8	GREEN SUPPLY			
			GREEN SUPPLY	6
4	50-0-50V SUPPLY			

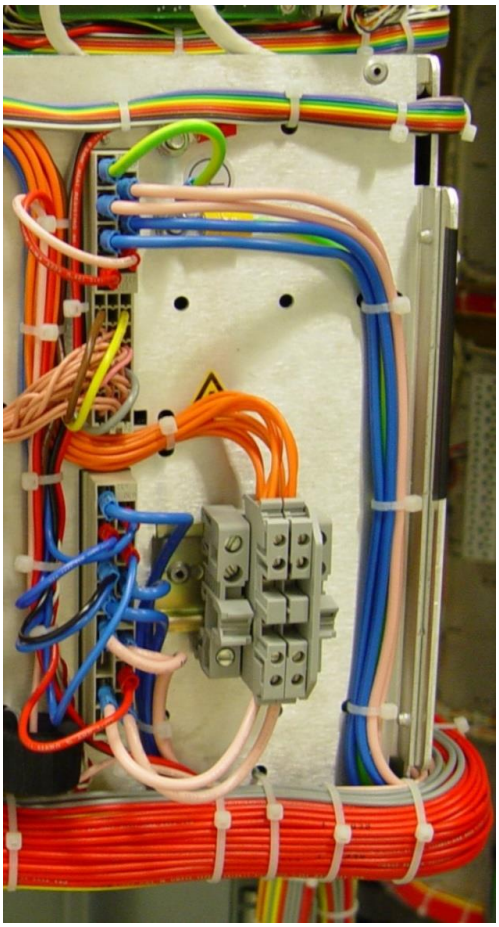


Figure 5 – MDU Connections & Rack View

4.1.1 Regulatory Signs Monitoring

The controller comes equipped and wired with a lamp monitoring sensor as standard that can monitor up to seven fluorescent tube regulatory signs. If the junction contains more than seven signs in total, additional current monitoring sensors must be fitted and the feeds to the signs split so that not more than seven signs are monitored through one sensor. (Note that at present the controller cannot monitor LED regulatory signs.)

The red wire from the sensors should be connected to the 'Sens' inputs at the rear of the first Lamp Switch card (see Figure 16), Sens33 is the first monitoring channel, Sens34 is the second etc. If more than 28 signs are present, additional sensors may be added to the second Lamp Switch card (if fitted).

The white wires should be joined together and connected to the 'COMMON' input (pin b16 of the connector).

4.2 Dimming Transformer

The Dimming Transformer is an 'auto' transformer and 'scales' the mains supply down to a lower voltage in order to dim the traffic signals.

There are a number of connection options (taps) on the transformer. The input tap (left) should be connected to the nominal supply voltage; the default is 230V. The output tap (right) selects the required dimming voltage; the default is 160V.

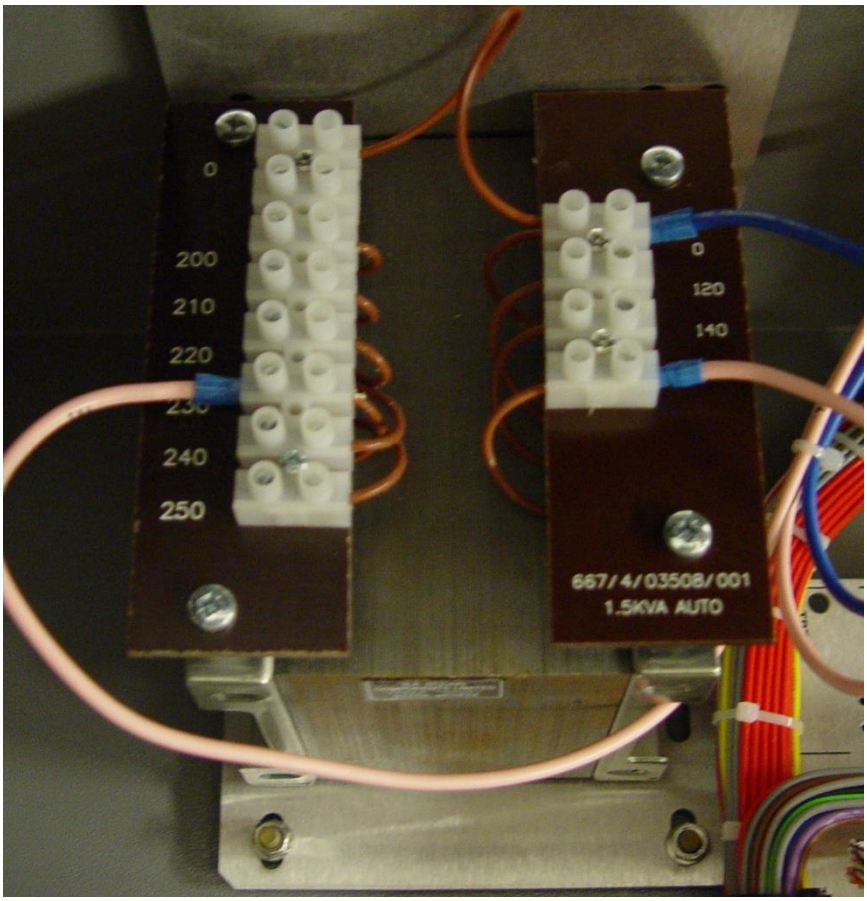


Figure 6 – Dimming Transformer Connections

Note: The ST950 LED controller only has one Dim output tap of 154V

4.3 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 **Error! Reference source not found.**). See 667/SU/46000/000 for full compatibility information.

General

The CPU Card holds the controller configuration and performs the function of configuration, control and management. The primary external data interfaces of the main CPU Card are the parallel phase bus to the Lamp Switch Cards, the Manual Panel interface and a front-panel User interfaces – RS232 serial interface to handset or Gemini^2 and USB device for a PC.

Two GSPI bus connectors are available on separate RJ45 sockets on the rear of the CPU Card. The first RJ45 socket is for LSLS connections within an ELV controller and the fourth is reserved for a future GSPI Manual Panel is blanked off and should not be used.

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.

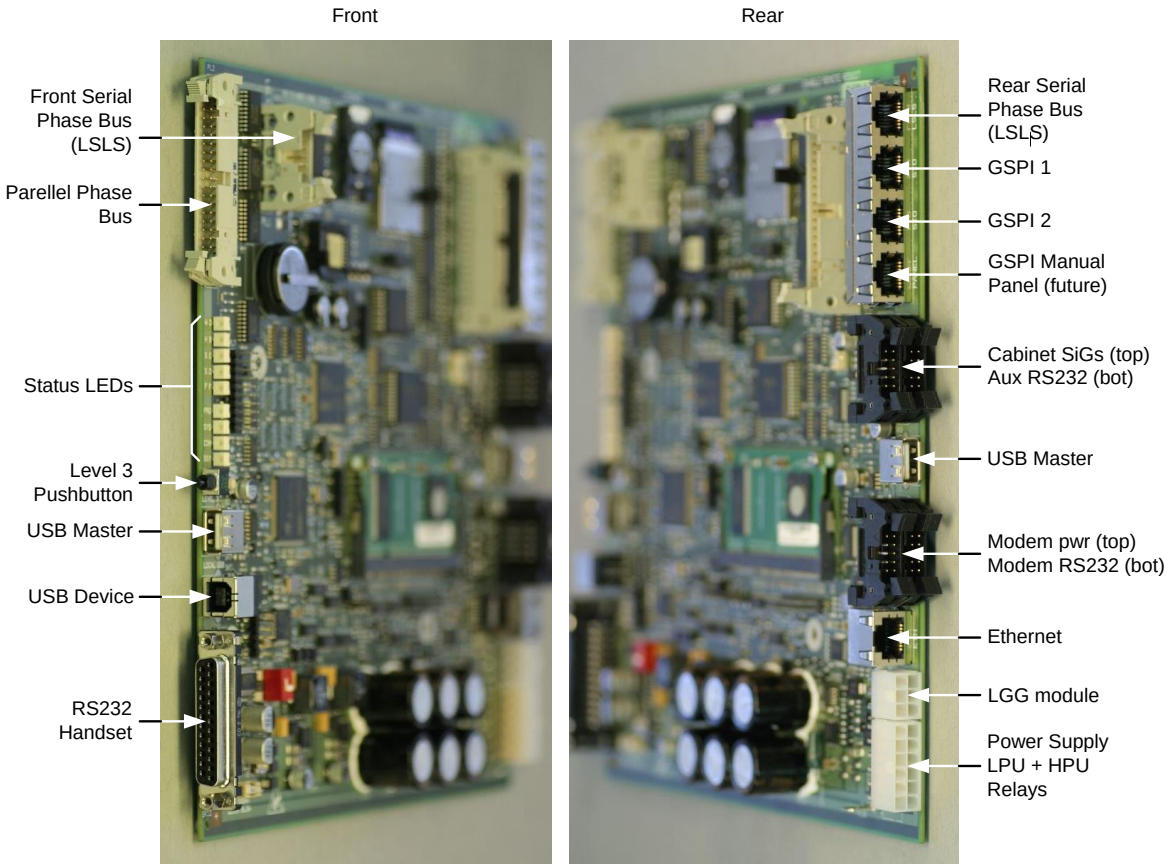


Figure 7 – ST950 CPU Card (front and rear views)

Figure 7 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 8 below and detailed in Table 1.

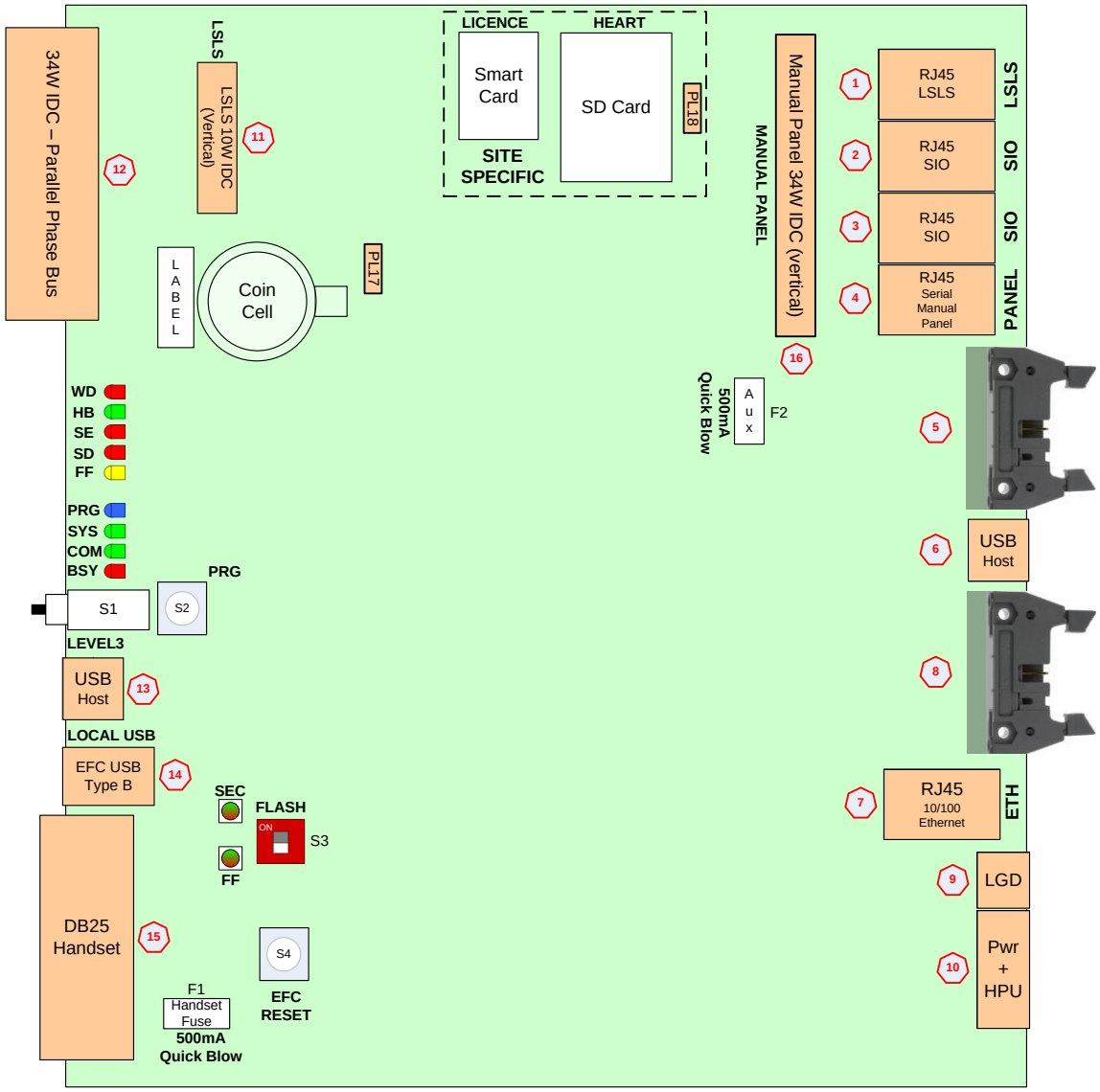


Figure 8 - Main CPU Card Layout

ID	Description	Connector
1	Serial Phase bus to LSLS cards (ELV Controller)	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

ID	Description	Connector
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 (ELV Controller)	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 1 – Connector Functions and Types

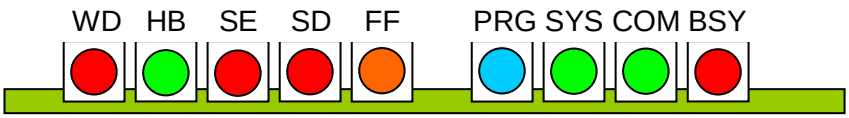
4.3.1 Processor Status LEDs

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; too many restarts so no applications loaded.

COM – Communications (green)

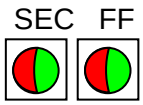
On	Under UTC control, pulses off indicate receipt of messages
Off	Not under UTC control, pulses on indicate receipt of messages

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

4.3.2 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).

8 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
	3	Modem 0V DC output (+5V return)
	4	Connected to pin 3
	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 9 below:

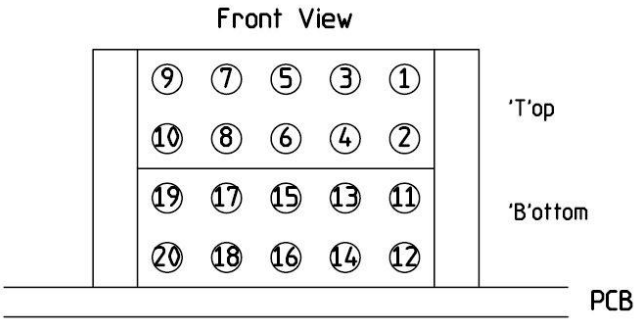


Figure 9 – Double stacked connector pin numbering

4.3.3 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 are shown in Figure 8.

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.

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.

4.4 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:

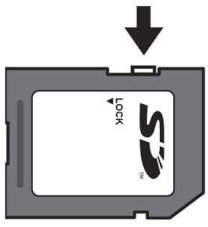
Power down the controller.

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

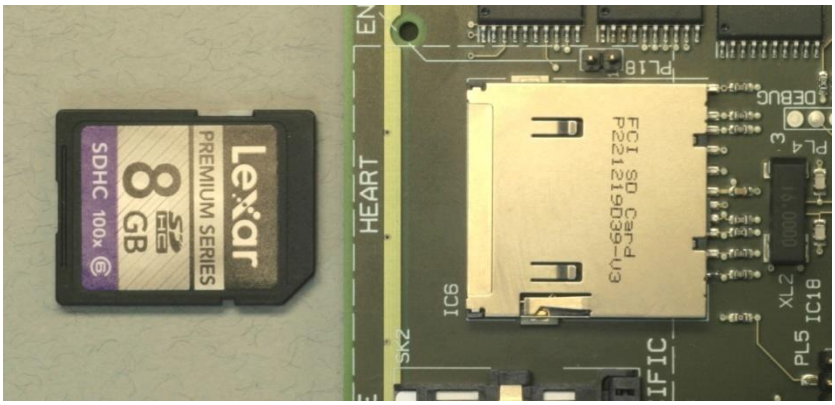
Push the card into the socket slightly until it ‘clicks’ then release pressure. The card can now be pulled from the socket.

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:

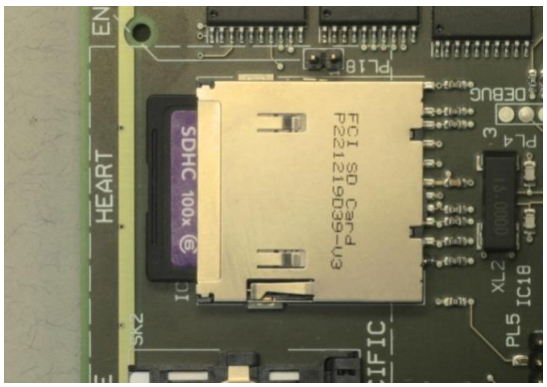


SD card Write Enable switch position



SD Card Orientation

× SD card partially inserted – incorrect



✓ SD card fully inserted – correct

4.5 Gemini2

For information regarding the Gemini^2 equipment, see:

667/HB/32600/000 - Gemini^2 Traffic Outstation Handbook

4.6 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.

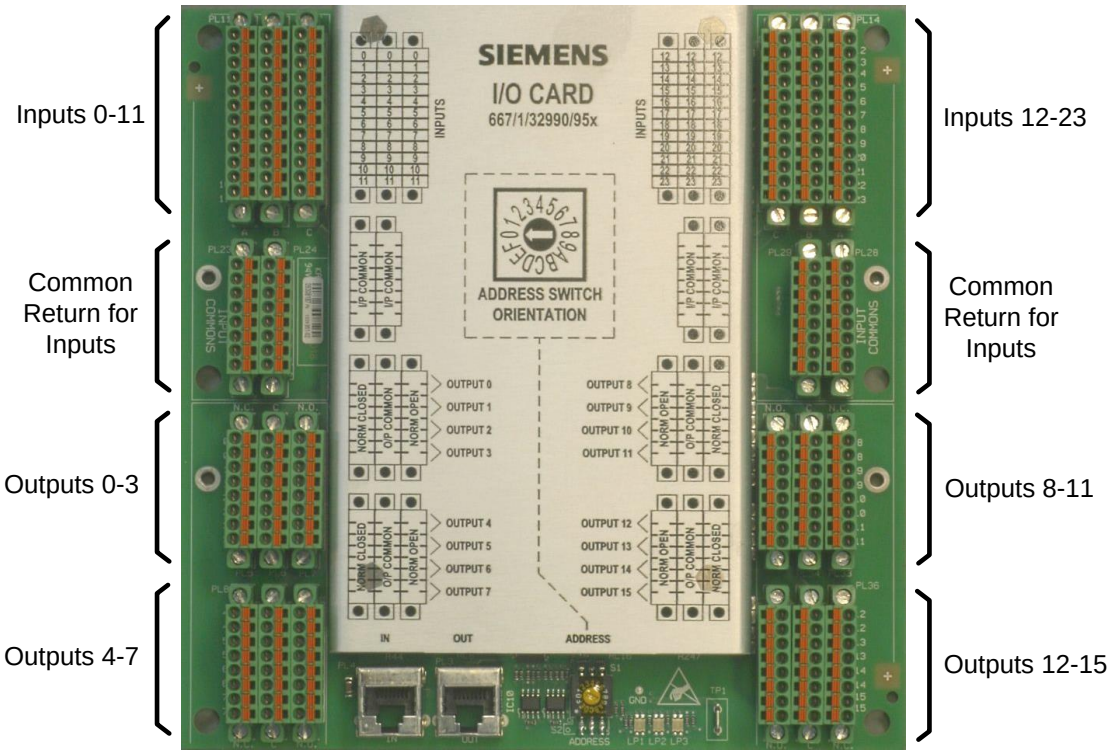
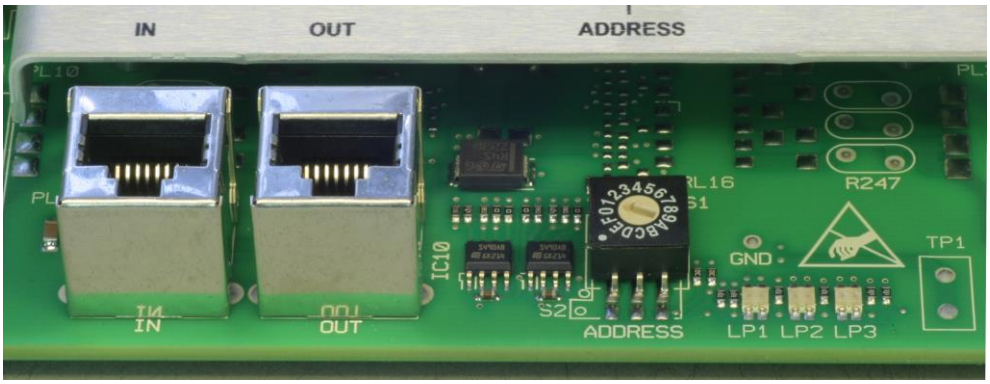


Figure 10 – I/O Card (Showing 16-output variant)



GSPI comms input from Processor Card or Previous IO card

GSPI comms output to next IO card

Address switch

Status LEDs

Figure 11 – I/O Card Address Switch and LEDs

4.6.1 I/O Card Status LEDs

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

Figure 11, 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 4 – I/O Card LEDs

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

4.6.2 I/O Card Rotary Address Switch

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

Figure 11 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.

4.7 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.

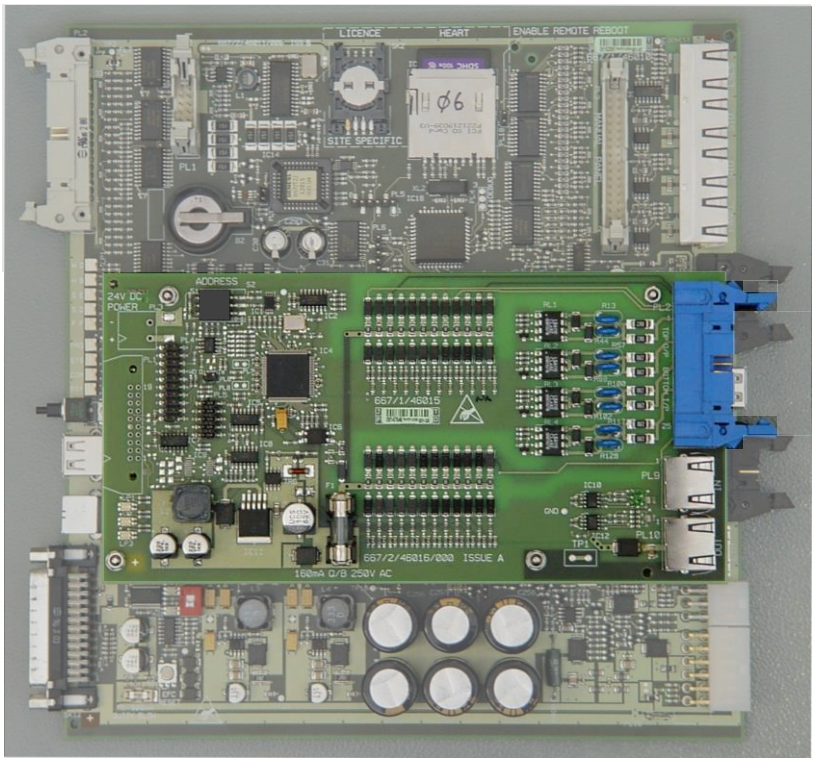


Figure 12 – CPU I/O Card

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 5 - CPU IO Card Connector Pin Out

4.8 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.

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.

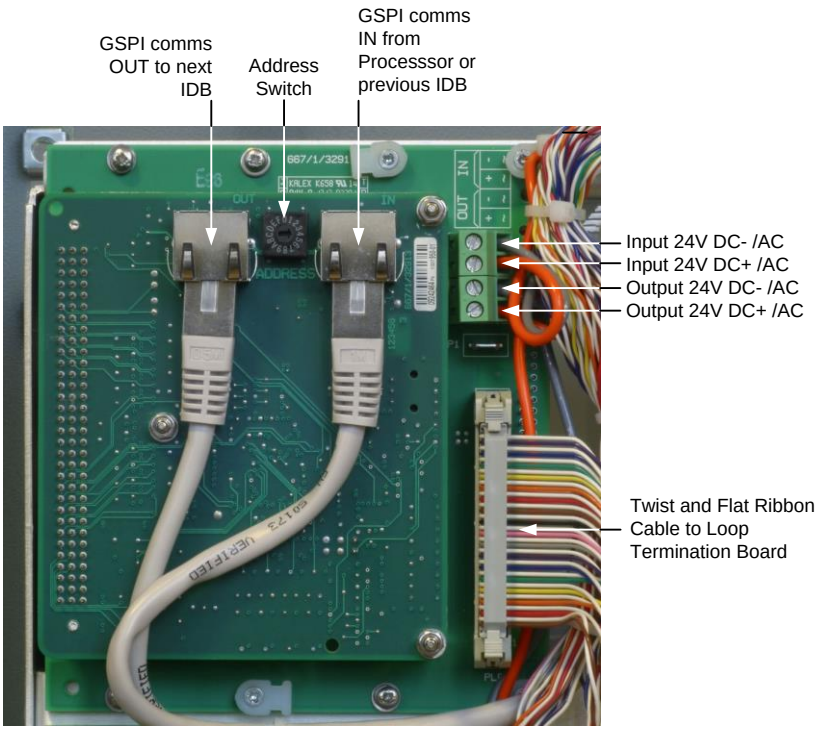


Figure 13 – Intelligent Detector Backplane (rear view)

4.8.1 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 0 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
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 6 – Intelligent Detector Backplane Card LEDs

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

4.8.2 Intelligent Detector Backplane Card Rotary Address Switch

This screwdriver-adjustable switch is located on the Intelligent Detector Backplane card(s) as shown in Figure 13 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.

4.8.3 Loop Detector Power

The Loop Detector cards derive their power directly from the Intelligent Detector Backplane that they are plugged into.

The Loop Detector cards are powered from the 2A or 6A 24V AC transformer. They are not powered from 24V DC from the MDU.

The maximum number of each type of each type of detector which can be supported by each type of transformer is given in the ST950 General Handbook.

4.9 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

4.10 Lamp Switch Cards

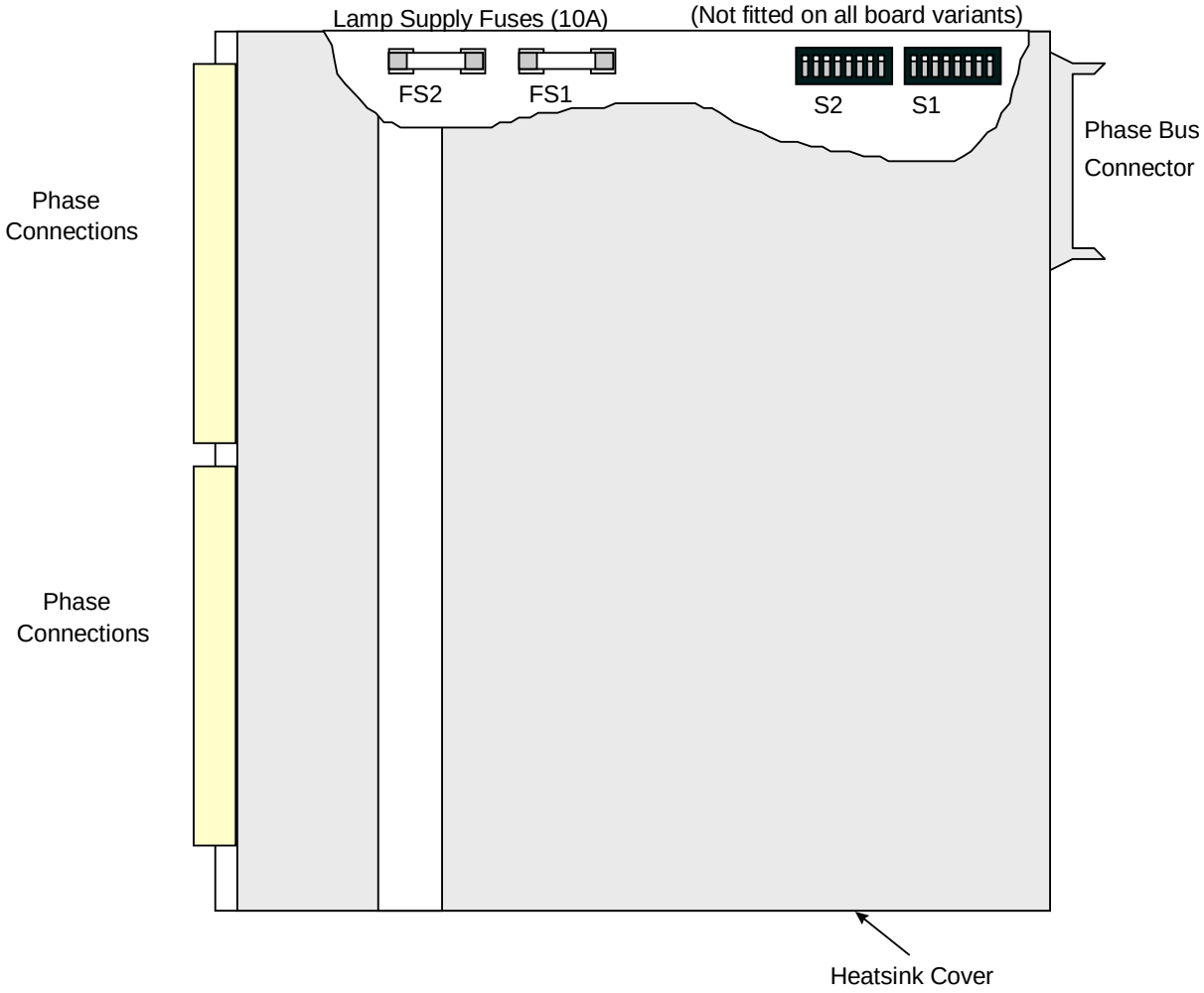


Figure 14 - Lamp Switch Card

If Fail flash is enabled the choice of Red or Amber aspects to be flashed for each phase is set on the Lamp Switch cards

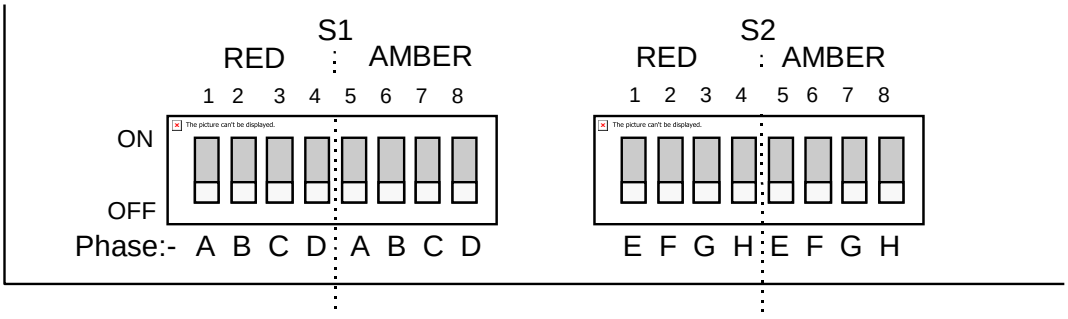


Figure 15 - Lamp Switch Card Switch Settings

There are a number of different variants of the Lamp Switch Card. In particular there are the original incandescent lamps LSC and the LED LSC, clearly labelled 'LED Lamp Switch'. It is not possible to mix standard and LED Lams Switch Cards in one controller; the controller reports an ADC Test Failure (FLF 2:10) if cards are mixed.

Lamp Switch Card ConnectionsFigure 16 details the connections on the back of one of the Lamp Switch cards. The back of all the Lamp Switch cards are identical except, it should be noted, that the ZXO wires, the output from the lamp supply monitoring transformer (LSupp) and the Solar Cell input must be connected to the first Lamp Switch card.

PLB	z	b	d	
32	EARTH			
			NEUTRAL	30
28	GREEN SUPPLY			
			R/A SUPPLY	26
24	ZXO-N (240V)			
			ZXO-N (110V)	22
20	ZXO-LIVE			
16	Sen34+	COMMON	LSupp-	16
14	Sen35+	Sen33+	LSupp+	14
12	Sen36+			12
10			SOLAR	10
8	1R		1G	8
6	-		-	6
4	2R		1A	4
2	-		2A	2

PLA	z	b	d	
32	3A		3R	32
30	-		2G	30
28	-		3G	28
26	-		4A	26
24	4R		5A	24
22	-		-	22
20	-		4G	20
18	-		5R	18
16	-		5G	16
14	-		6G	14
12	6R		6A	12
10	-		7G	10
8	-		7A	8
6	-		7R	6
4	-		8A	4
2	8G		8R	2

Figure 16 – Lamp Switch Card Connections

4.11 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 8.

The full intersection manual panel is shown in Figure 17 below.

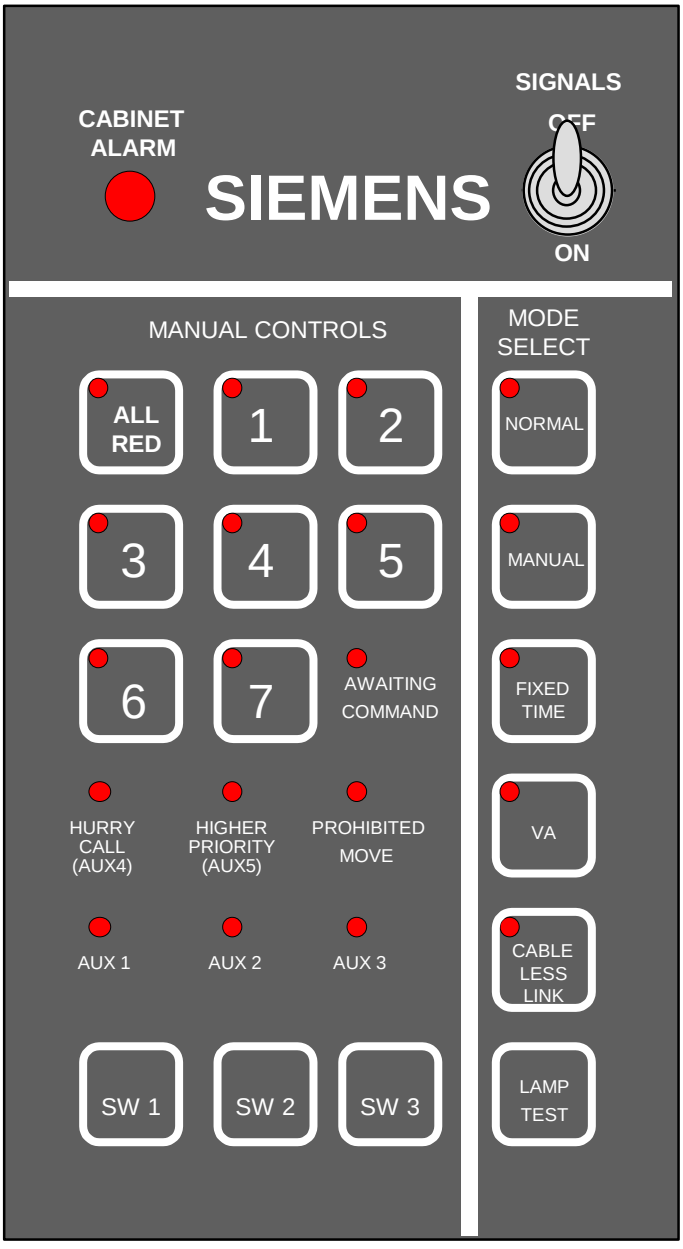


Figure 17 – Manual Panel

4.11.1 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.

4.11.2 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.

4.11.3 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.

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

With Manual mode selected (Manual LED lit), the buttons 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.

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

These buttons 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).

4.12 Pedestrian Audible/Tactile Indications

4.12.1 Non-Switched Audibles/Tactiles

The Audible power supplies on the ST950 are designed to provide a DC voltage between 10V and 24V, and typically provide 50mA at 18V DC. This is provided using the Audible Supply Kit. See the ST950 Installation, Commissioning and Maintenance Handbook for more details.

This kit also provides the controlling signal for 'Tactile Power Supplies'. The tactile power supply obtains its power directly from the pedestrian green drive. The controlling signal allows the controller to switch off the tactile while the green is flashing, for example.

Audible and tactile units used must operate correctly over the voltage range 10 to 24V DC. The audible units recommended and supplied by Siemens, which meet this requirement, are:

Audible: 667/4/04785/000

- Highland Electronics type SC628P*
- Roxborough type SPCI535A4
- Askari (Tone 22 – variable volume)
- (* was Sonalert Mallory SC628P)

Tactile: 667/7/17390/000 (mains driven pedestrian green signal)

- Radix RS252

667/7/17390/048 (48V nearside pedestrian green signal)

Options Available:

KOP for Signal Head mounted Audible/Tactile Drive	667/1/15799/000
KOP to add Audio Ind to Push Button Unit	667/1/15292/000, or
Adjustable Audio Kit	667/1/15292/001

Note: If the dimmed supply voltage is 120V, 140V or 160V, the Sonalert Mallory SC628P audible indicator can be used as specified above. An alternative used by other companies is the Bleeptone A.P. Bessom RS/1 18V, which can only be used at 160V dimming.

It is recommended that all units on one supply are the same type.

The items are connected as shown in the circuits in Figure 18 and Figure 19. The connections to the transformer are via single to dual Faston terminals.

It is a requirement in the U.K. that audible signals may only be used if the pedestrian phase appears at ROW with no vehicle phases also at ROW and is accompanied by the Red Lamp Monitoring facility.

4.12.2 Switched Audibles/Tactiles

(DRIVE CIRCUIT MUST BE MOUNTED INSIDE THE CONTROLLER)

This facility provides the power unit to supply one group of four Audible/Tactile Indicators during Pedestrian Green time using an I/O card output, see Figure 20 and Figure 21. This may be increased to 16 units if 3 more kits are added. The supply to the Audible/Tactile can be switched off while the pedestrian green is still illuminated, to terminate them before the end of the pedestrian green or during the flashing green clearance period for example, by utilising a Controller output.

Note that the 'Radix System RS250' Tactile Unit is used if the Tactiles are to be switched since this provides an input for a steady DC voltage. Unswitched Tactiles can use the 'RS251' Tactile Unit. The 'RS252' Tactile Unit can be used in either situation and is 'configured' by the use of a link.

4.12.3 Switched Mains Voltage Pedestrian Audibles (Non UK Only)

Items required:

Audio Switching Kit of Parts 667/1/21470/000 (Although this was designed for the T400 it may also be used for the ST950)

In certain non UK markets the Pedestrian Audible units are powered from mains voltage, namely the pedestrian phase green man supply and red man supply. When connected to the green and red man supplies the Audible units give high rate audible clicks as a signal during the green man and lower rate audible clicks as a signal during the red man. The supplies to these units may be taken via suitably rated relay contacts to allow the audio to be switched off at a certain time of day.

4.12.4 Dual Level Audibles

Items required:

Kit of Parts to add secondary buzzer 667/1/15292/000

The audible indication can be Dual Level. The audibles only change state during the vehicle green period, using Special Conditioning and two I/O card outputs.

Switching between the two levels is achieved using the event timetable

(See Figure 20 if the Audibles are to be switched on/off by the controller)

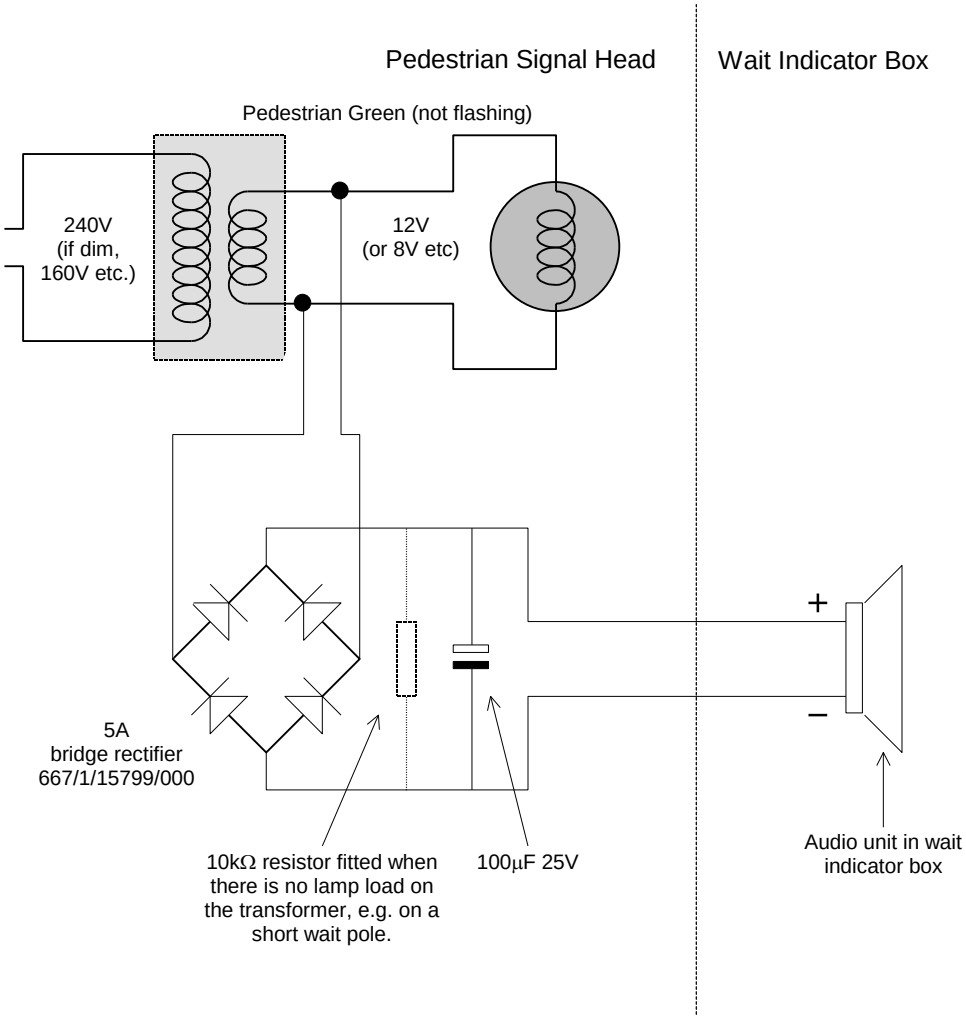


Figure 18 - Pedestrian Audible Indication (Signal Head Mounting)

(See Figure 21 if the Tactiles are to be switched on/off by the controller)

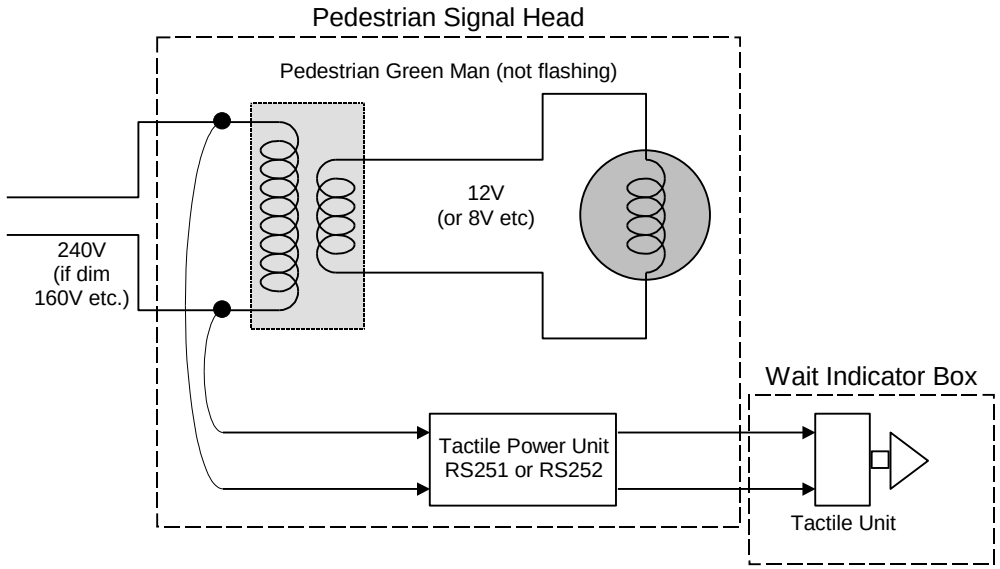


Figure 19 - Pedestrian Tactile Indication (Unswitched)

(See Figure 18 if the Audibles do not need to be switched on/off by the controller)

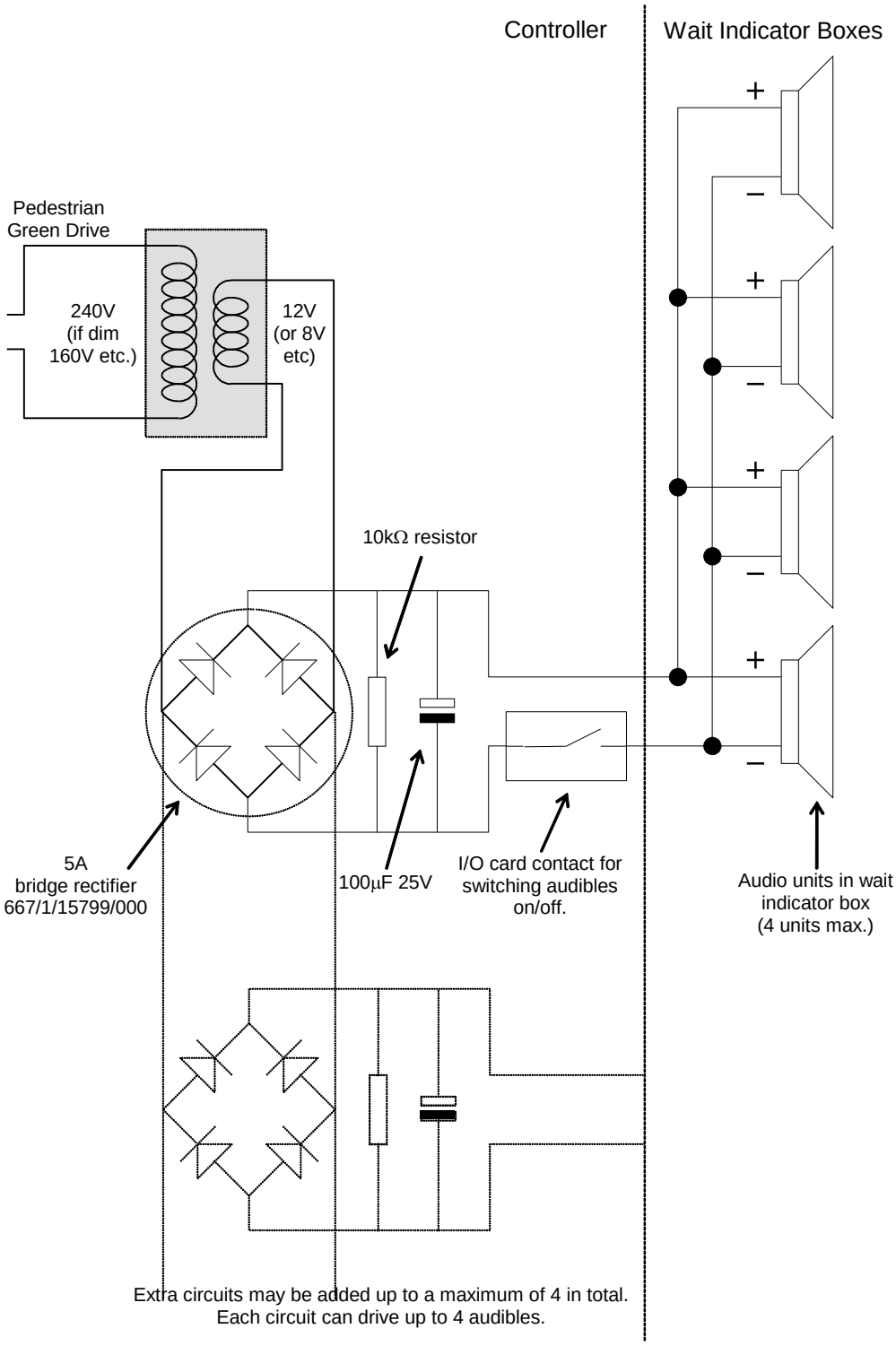


Figure 20 - Pedestrian Audible Indication (Controller Mounting)

Note that each of the circuits above can drive up to four Audible Units (as shown above in Figure 20) or control up to four Tactile Power Supplies (as shown in Figure 21) or a mixture of audibles and tactiles up to a total of four.

(See Figure 19 if the tactiles do not need to be switched on/off by the controller)

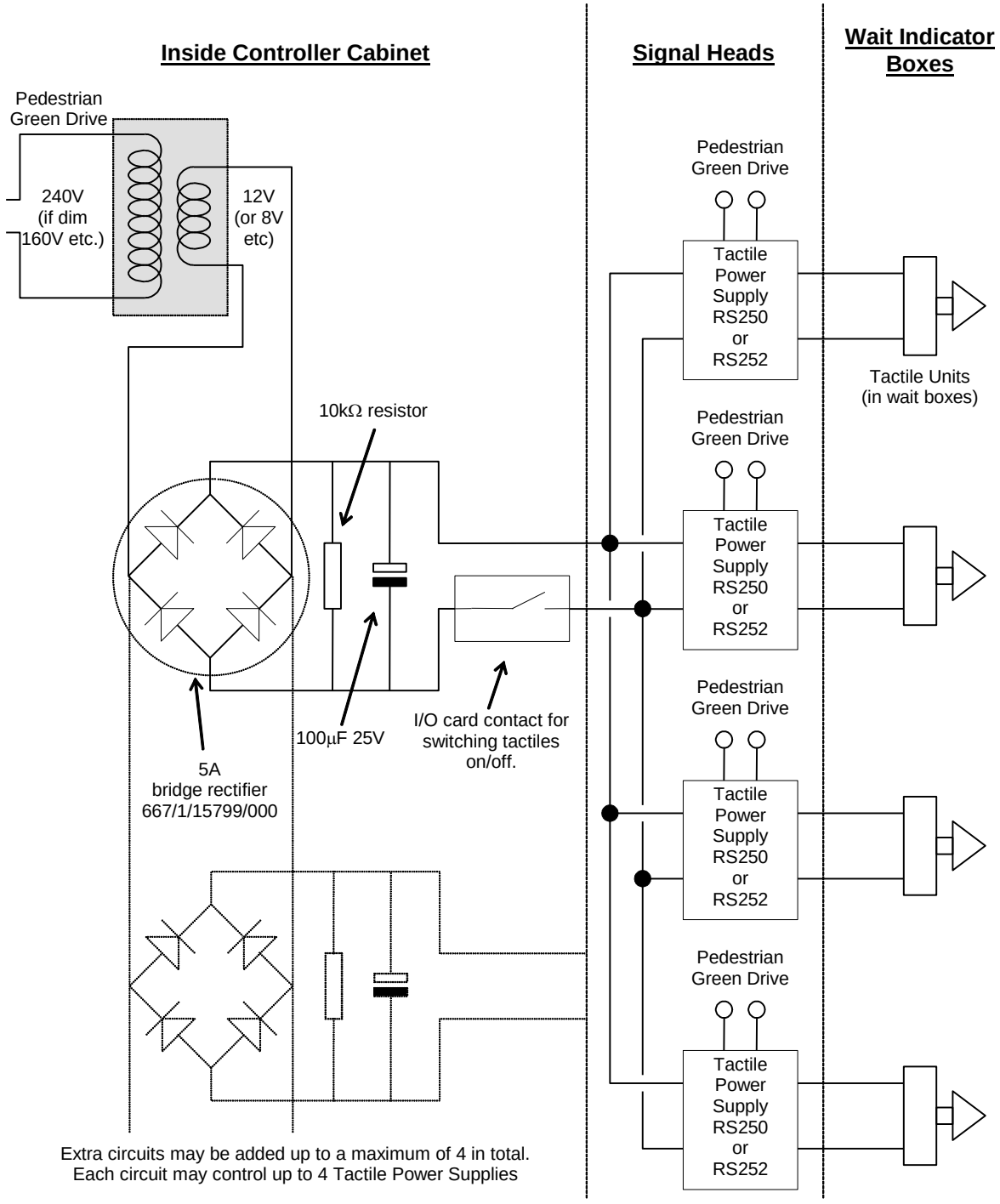


Figure 21 - Pedestrian Tactile Indication (Switched)

Note that each of the circuits above can control up to four Tactile Power Supplies (as shown in Figure 20 above) or drive up to four Audible Units directly (as shown in Figure 21) or a mixture of tactiles and audibles up to a total of four.

4.13 Above Ground Detectors

Above Ground Detectors provide detection for pedestrians and vehicles. The 24V AC power for the above ground detectors is taken from the same Detector Supply that supplies the Loop Detector cards.

The Above Ground Detector outputs connect directly to the I/O card inputs.

See the documentation relevant to the particular Above Ground Detector devices being used.

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

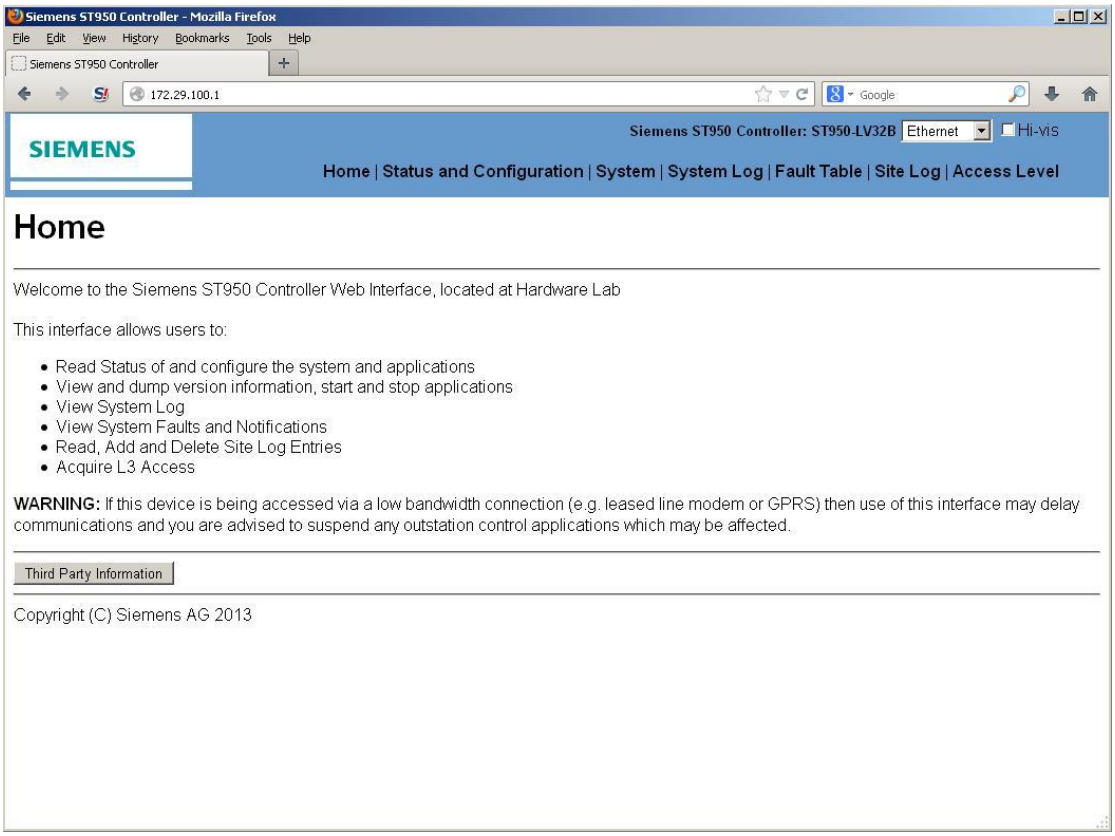
A driver needs to be installed in order to use the USB Handset port. A suitable driver for Windows is provided by the controller and can be installed on connection to the controller.

5.2 Types of User Interface

There are three styles of user interface.

5.2.1 Web Browser

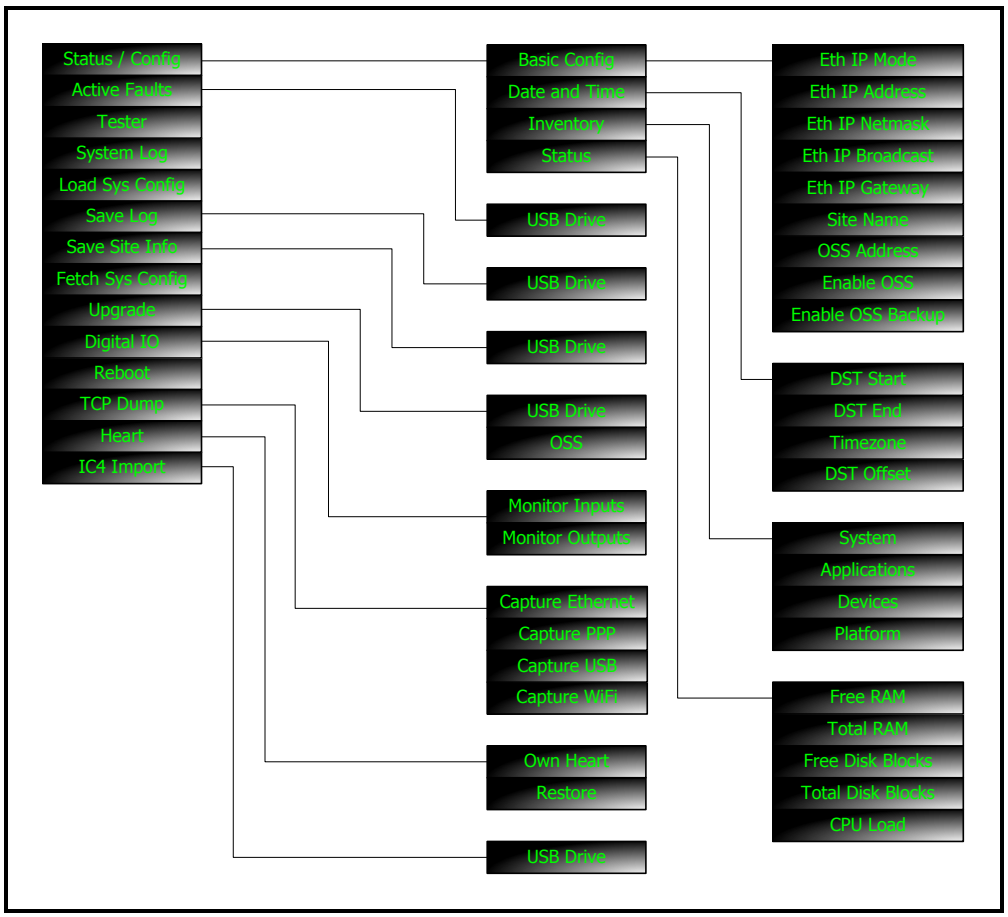
The controller web interface provides full control and monitoring of the controller. It is available over the USB handset and network connections.



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* in 3 and earlier, *ssh* in later) 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 ST950 cabinet. In the UK the alternative cabinet must be one that has previously been approved to house a different controller. Some examples are Siemens T200, T400L, GEC3000, GEC25, GEC CX cabinets and all Microsense and Monitron cabinets.

The procedure for each type of controller depends largely on the type and condition of the existing equipment. For this reason it is not possible to define in detail exactly what needs to be done.

In a T400 or T200 large outercase, access to the rear connectors is available through the rear door. The cards are held in the rack by a retaining strip at their front edge. To release it, loosen the clamping screws and allow it to fall clear of the card guides.

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

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.

7 INSTALLATION AND COMMISSIONING PROCEDURE

Refer to the Handbook Supplement 667/HB/32921/007 if the controller is fitted with 'LED Lamp Switch' Cards and Helios CLS (NLM) LED Signals.

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 dimming transformer (if required) connections have been set to the correct voltages as per the Works Specification. (Section 3.2.1)
    - The Pink lead marked TXL always connects to the voltage tap appropriate to the supply voltage. This is stated in the Works Specification
    - The Pink lead marked DIM connects to the dim tapping as stated in the Works Specification.
    - The Blue lead not marked connects to the neutral connection on the transformer
- The connections between the Dimming Transformer (if fitted) and the MDU are correct and are secure.
- The MDU, LSC's and Master switch panel are all of the correct variant for the type of ST950 in the Works specification LED or 20A.
- 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.

If the IC4 Configuration is available at this stage:

- 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/20664/000 - Traffic Signal Junction Cabling & Design & Certification

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 detector supplies 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 outer case 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 22 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 outer case 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 22. Adjustment may be required to ensure that the outer case 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.

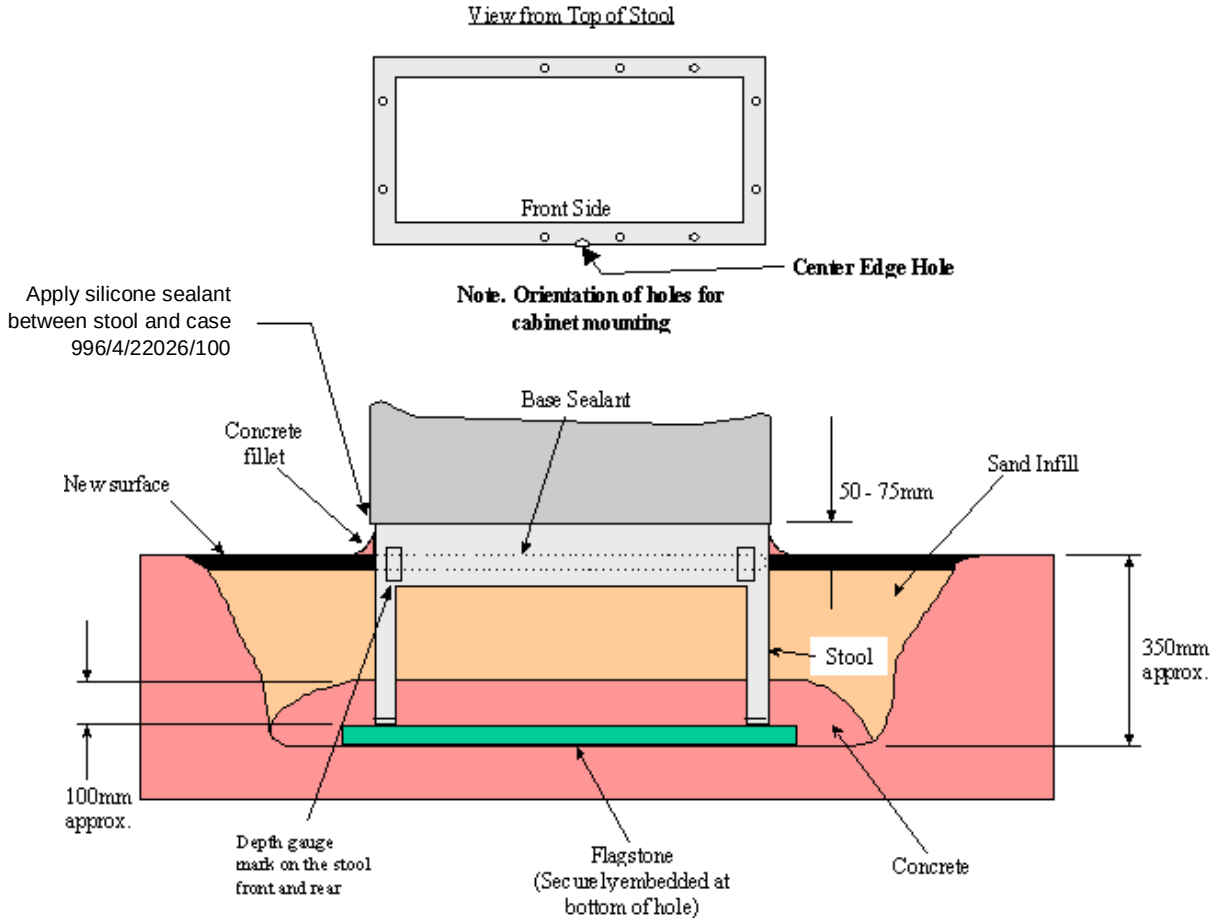


Figure 22 - Stool Installation

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 23 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)

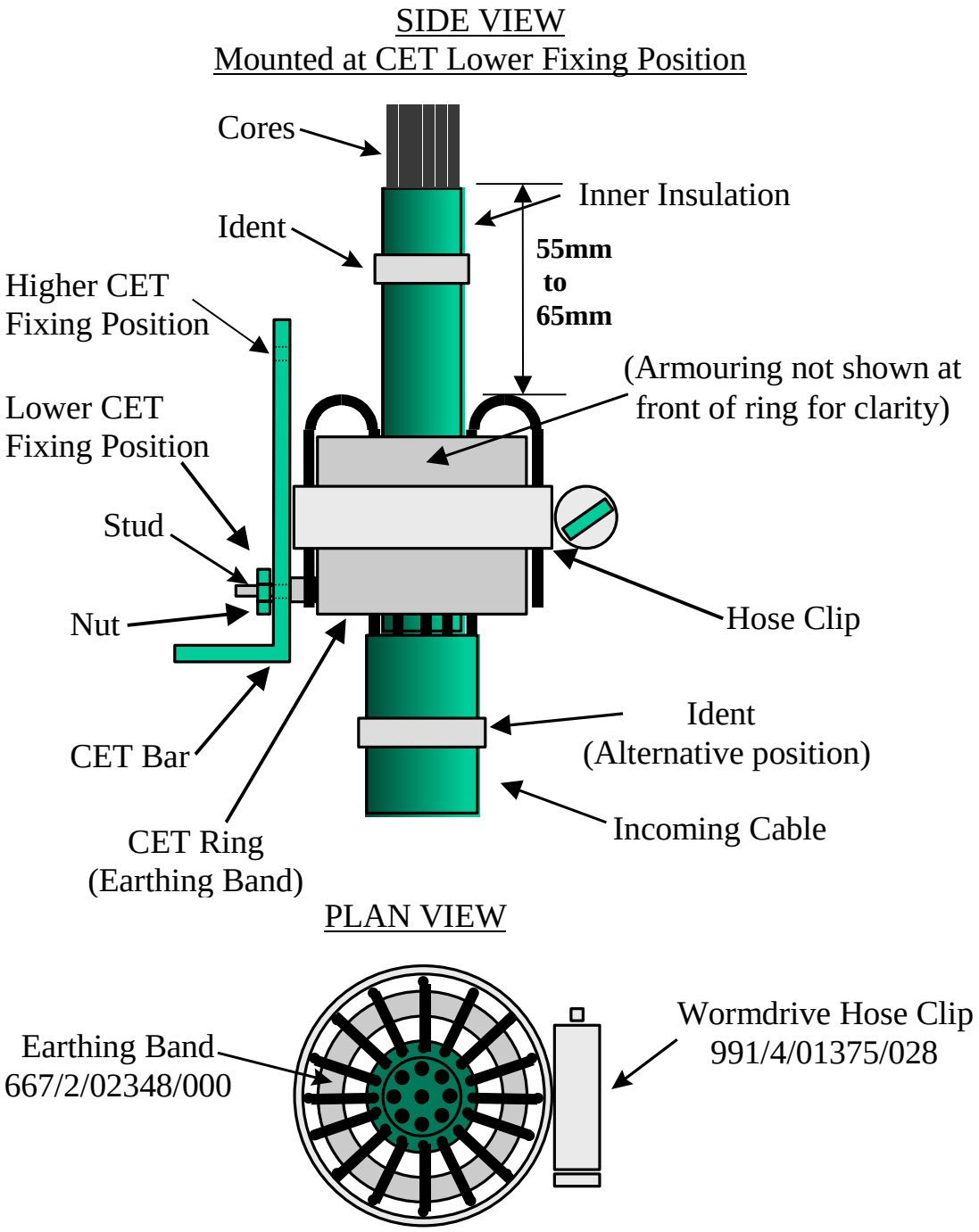


Figure 23 - Termination of Armoured Cable to CET bar

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.

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.

NOTE: -

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 Dimming transformer have been set to the correct voltage
- 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 On Site Testing

Once delivered to site and with reference to the Works Specification, check that:

- The cabinet is free from external physical damage
- All cards are seated correctly in their sockets
- The connections between the Dimming Transformer and the MDU 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.
- 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 Lamp Switch Cards, MDU, I/O card or Loop Termination Card connectors.

7.5 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.

7.5.1 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 7.5.2).
- Load the IC4 configuration (section 7.5.3)
- Add the required Licence(s) (section 7.5.4)
- If required, configure the communications systems (e.g. IP data) (section 7.5.5)
- 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 monitor and report controller status to Stratos
- Set the controller date and time (section 7.5.8)
- Calibrate the lamp supply voltage reading (section 7.5.9)
- If LED signals are being used, check the dim lamp supply voltage (section 7.5.10)
- Bag all signal heads
- Perform Lamp tests to ensure correct wiring (section 7.5.11)
- Learn the lamp loads (section 7.5.12)
- Perform Solar Cell testing (section 7.5.13)
- Perform Junction Testing (section 7.5.14)
- Extract site information for review with customer (section 7.5.15)
- 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.

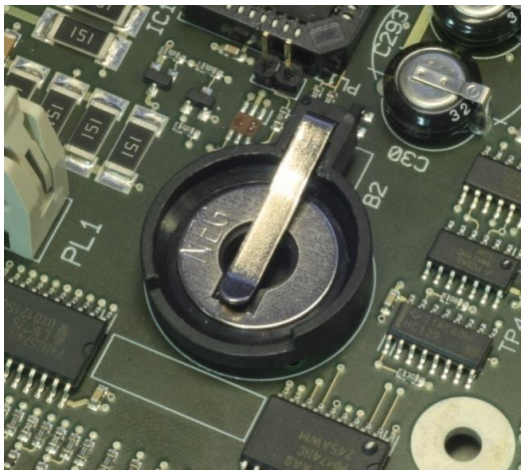
If commissioning an ST950SE controller it will be installed in an 11” rack. The procedure is largely as described for the standard ST950 controller. Cabinet specific instructions depend on the cabinet into which it is to be installed.

7.5.2 RTC battery backup kit

The optional battery backup kit for the RTC is provided with a lithium coin cell (CR2032 or equivalent) 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:

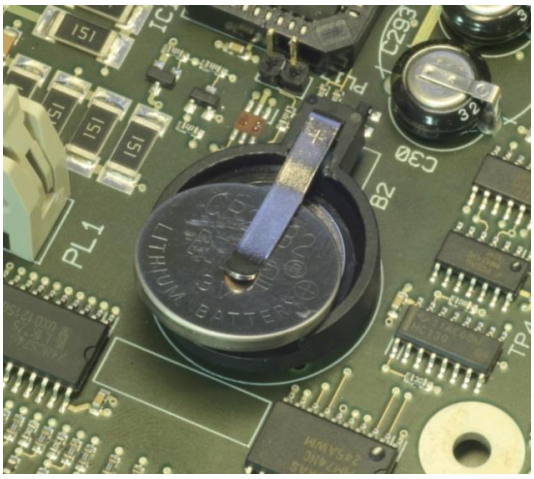
With the optional RTC battery backup in place the RTC backup period will be in excess of three years. The recommended battery replacement period is three years

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

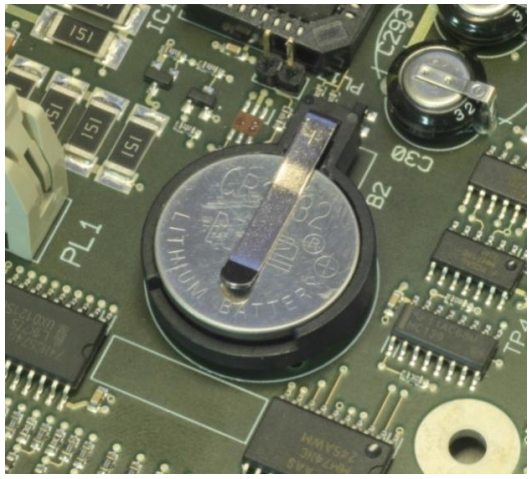


Empty holder

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

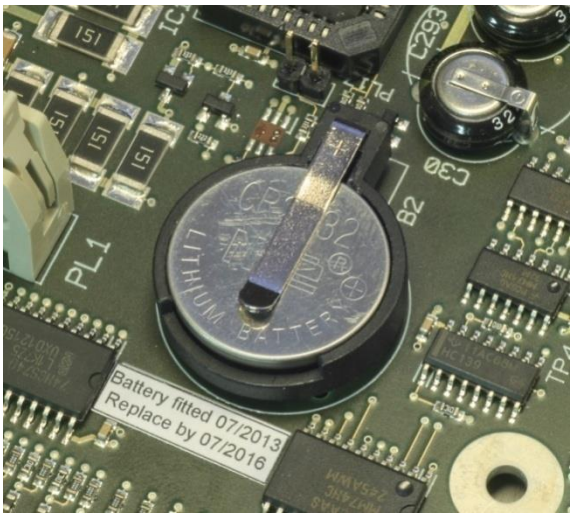


Cell partially in holder



Cell fully in holder

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



Cell and Label in fitted

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.

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.

7.5.3 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.

7.5.4 Loading Licences

The ST950 requires licences to be fitted before certain facilities can be used. The licences currently available 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.

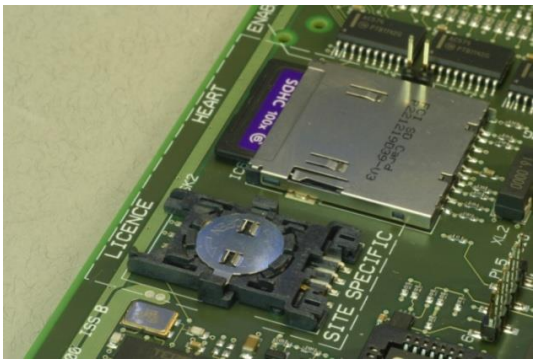
Distribution and Storage of Licences

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.

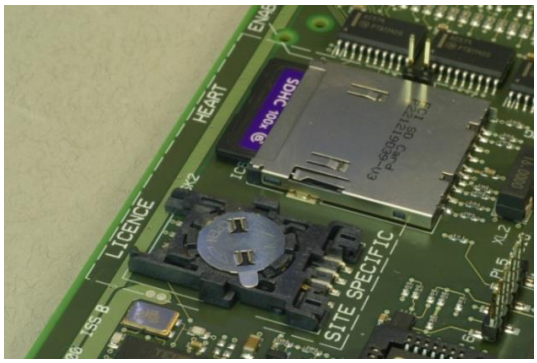
Installing Licences on the Controller

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.

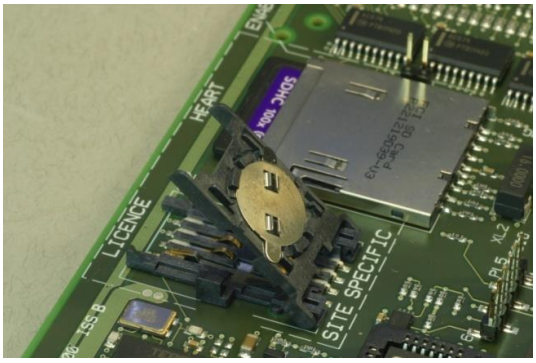


No Card – Locked



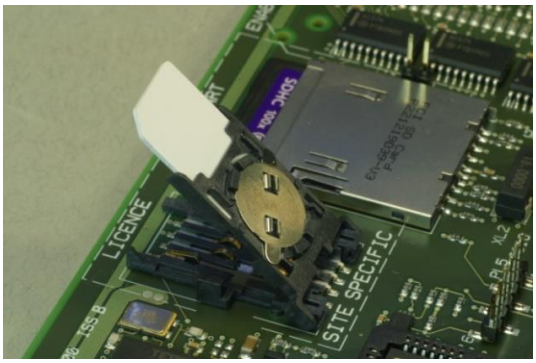
No card - Unlocked

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

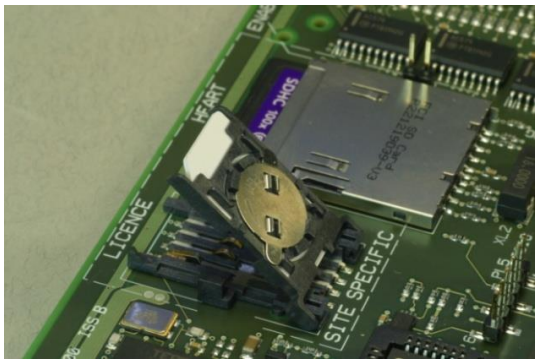


No Card, container Open

- 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.

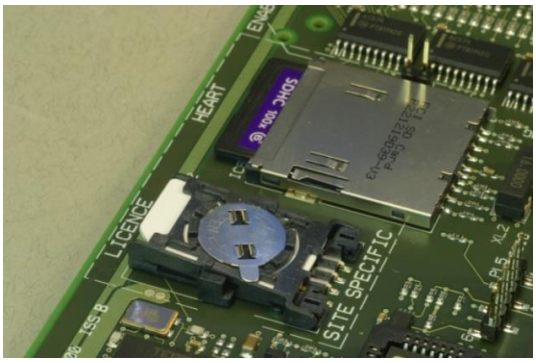


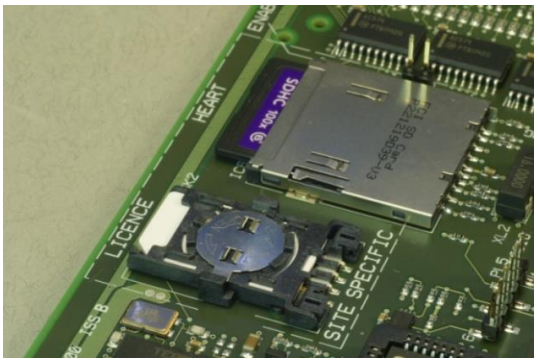
Card partially in container



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.

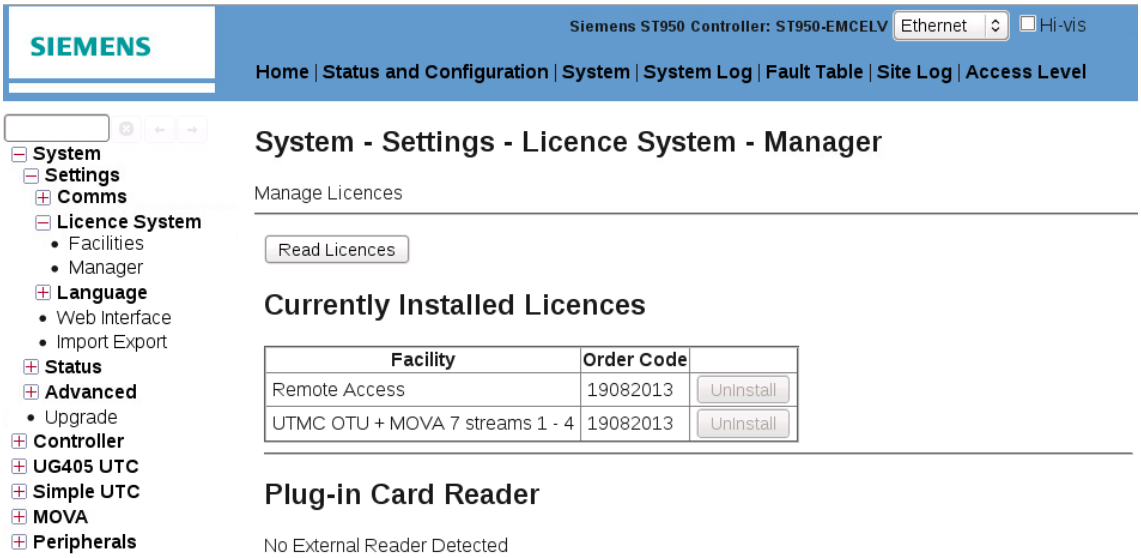


Figure 24 - Licence Manager web page with no external reader fitted

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.

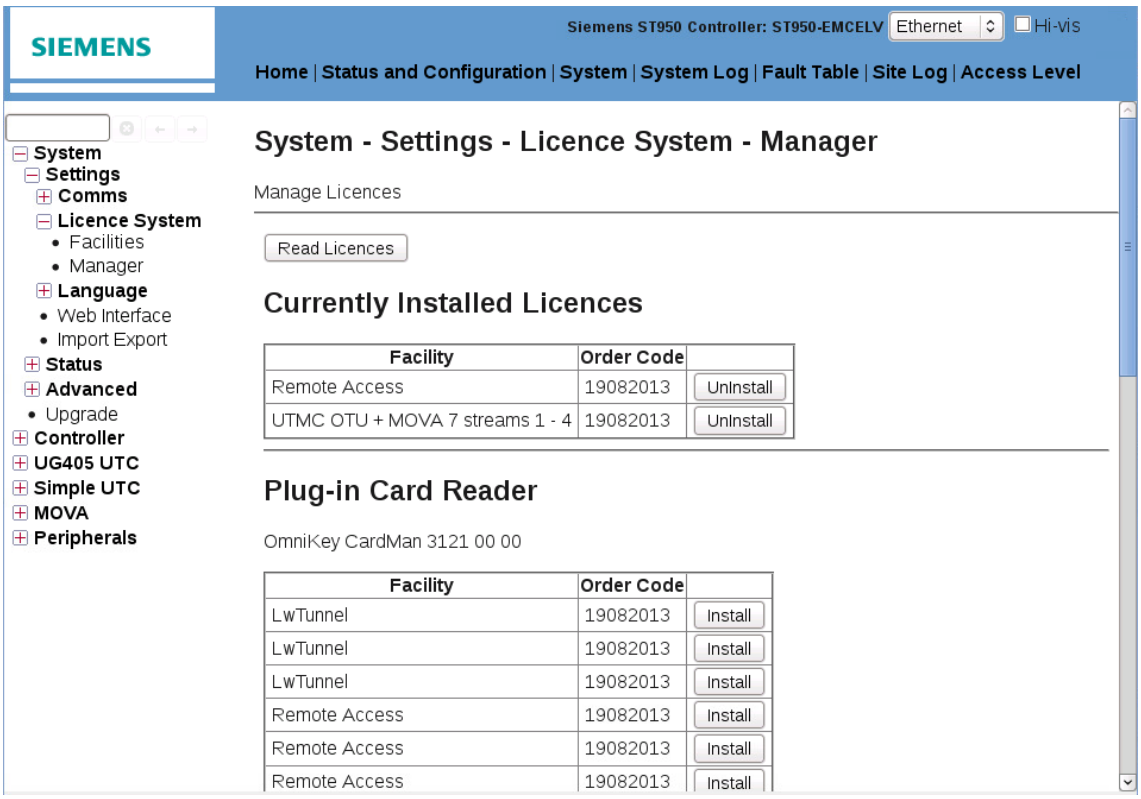


Figure 25 - Licence Manager web page with external reader fitted

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.

7.5.5 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 7.5.6) & a non-Stratos system e.g. UTC (section 0). 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.

7.5.6 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:

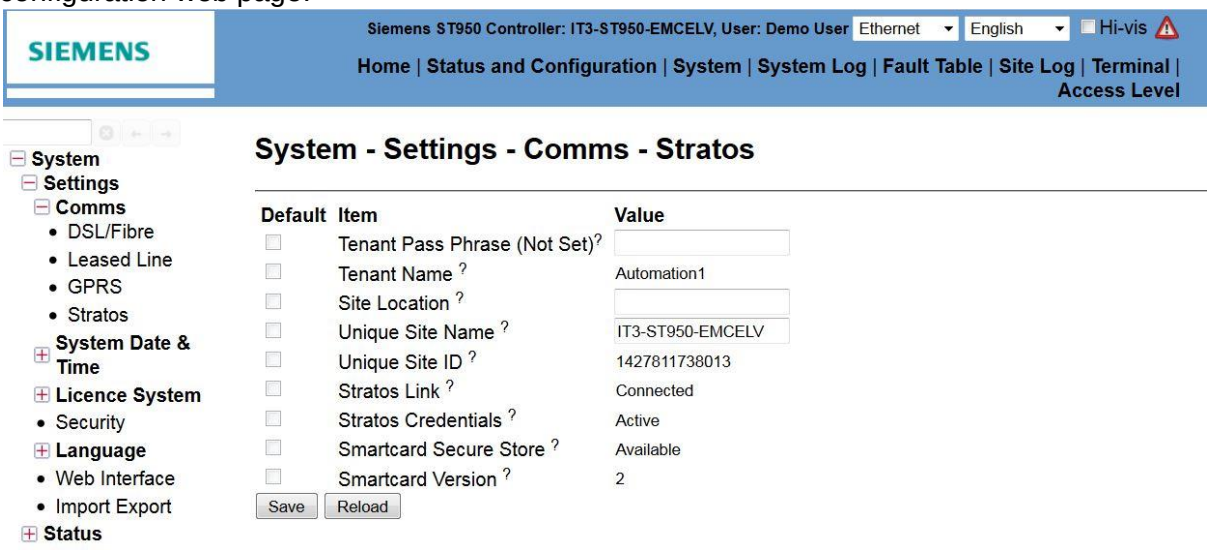
- DHCP (UDP 67 & 68)
- DNS (UDP 53)
- NTP (UDP 123)
    - pool.ntp.org
- HTTPS (TCP 443)
    - www.stratostraffic.com (TLS trusted time)
    - www.stratosemerge.com (CRLs)
    - ovpn1.stratostraffic.com (OpenVPN)
- HTTP or HTTPS (TCP 80 or 443)
    - OCSP authenticator for stratosemerge HTTPS certificate (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 7.5.4.

Ethernet Configuration

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

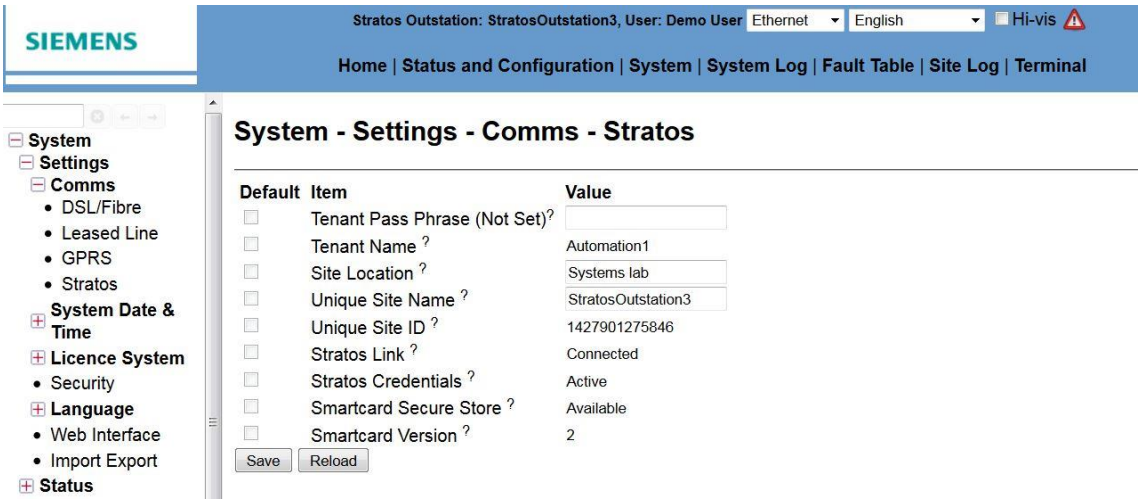
To connect the equipment to Stratos perform the following:

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

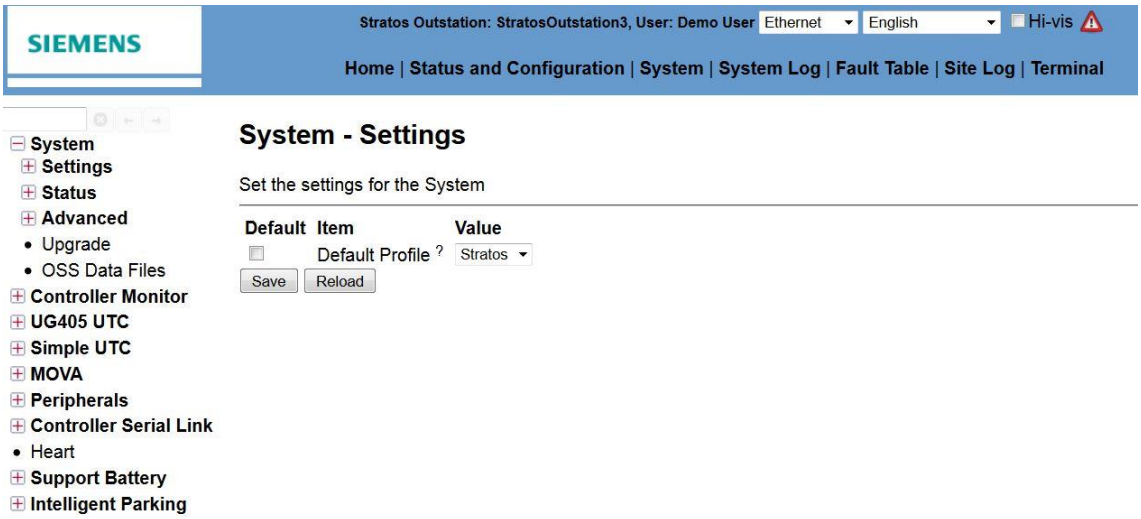
These items are set on the System – Settings – Comms – Stratos configuration web page.

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*.



7.5.7 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.

7.5.8 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 time-zone and daylight saving settings can be set on the web page (the default values are correct for the UK):

- Status and Configuration → System → Advanced → Date and Time

The user should configure the clock mode and, if outside the UK, set the time-zone and daylight saving times as required 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 with a mains synchronised clock are to be used it is important that the controller clock be set accurately to ensure that the plans operate as expected. Refer to the Handset Handbook for the procedure to set the mains synchronised clock.

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

7.5.9 Calibrating the lamp supply voltage reading

The lamp supply voltage measured by the controller can be viewed and adjustments made on the Controller - Supply web page and using the 'KEV' controller handset command.

Carefully measure the bright lamp supply using a calibrated multi-meter.

If this differs from the value displayed, enter the correct value to calibrate the controller's reading.

It is important that the controller has an accurate reading of the lamp supply voltage because it has to suspend monitoring of the LED signals (except those monitored for RLM) when the supply is outside of the normal working range to avoid reporting erroneous lamp faults.

7.5.10 Checking the dim lamp supply voltage

If dimming is required, set transformer output to the 160V tap.

Measure the actual dim voltage and check that it is no higher than 160V. If dim voltage is higher, move the input to the next higher tap, e.g. from the 230V input tap to the 240V input tap.

If the dimming voltage is still too high, then the 140V tap can be used to reduce the dimming voltage further.

IMPORTANT: The use of the 120V tap is not supported by Helios CLS signals.

7.5.11 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.

7.5.12 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'.

7.5.13 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

7.5.14 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.

7.5.15 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.

7.5.16 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.

7.6 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 that the clock is correctly set.
- Check current plan. If CLF is configured, use the user interface to verify that the correct plan is in operation bearing in mind 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 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 control.
- 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. PCB changed etc.) and any follow up action required or details of what actions are required should the fault recur.
- 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 to be performed at an ST950 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.

If for any reason the power is switched off to the controller, a total installation megger test should be carried out as defined in the Installation and Commissioning Handbook - Installation Testing (General) (667/HE/20664/000).

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 outercase for serious damage. The outercase 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 must 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 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.

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.

Ensure that no fault indications are showing.

The following tests will result in the signals extinguishing.

Test the 300 mA 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 cableforms, particularly any of the more vulnerable small gauge, single insulation wires and cables, such as ribbon cables. Repair or replace if necessary.

The battery on the Main CPU Card must be replaced if it has failed. Any replacement battery should be suitably marked with an appropriate date label. Having done this, the controller records should be updated accordingly.

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

Tests of the Voltage Drop of Neutral Conductors. This test should be carried out during each periodic/annual inspection as a simple check of neutral cables, which can also provide a good indication of the state of the intersection cabling.

(i) Take a digital multimeter or voltmeter and set it to a range suitable for the local mains supply.

(ii) Select a phase and wait until its green has just terminated. Measure the voltage between the controller neutral and the green feed; the voltage should be no greater than 4V (RMS) throughout the controller's cycle, except when the phase next goes to green voltage. If the voltage between the green feed and neutral is greater than 4V then do the following:

Check all joints in the appropriate neutral cable run, ensure that they are all tight and none are seriously corroded. Replace or tighten them as necessary.

Re-test the cable

If the fault still persists then:

- Increase the number of conductors/cable cores used for the neutral.
- Re-test the cable to ensure that corrective action taken has removed the problem.

- With the handset, check that all inputs used are operating correctly.
- 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 as per section 7.3.12

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 7.5.2
- Addition & removal of licences - see section 7.5.4
- Loading new IC4 configuration - see section 7.5.3
- Update of firmware - see section 7.5.16
- Export of site information - see section 7.5.15

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 Appendix A.

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 or not they know of a requirement for the signals to be in this state.

e) Before leaving for the site check that after clearance of the fault the controller can 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 spares list in the appendix.

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 that 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, proceed with the installation or inspection procedure.

If the visit is to investigate a reported fault, 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. Now check the controller `visit log book' to see if any previous visits/faults are similar, as previous actions may have a bearing on this visit. Make a visual inspection of all of the wiring and cards.

Check for any entries in the Controller fault table and System 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 ST950 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 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 MDU 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 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 Lamp Switch Card

Each Lamp Switch card is equipped with 8 sets of red, amber and green LEDs indicating the state of the phase it controls.

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 MDU has failed.

Check the +24V DC output from the MDU. 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 MDU 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 MDU, the check the AC mains input to the MDU. If present, replace the MDU 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 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.

10.2.9 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 PCBs in the ST950. 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 the fault label and return the faulty card for repair.

10.3.3 Access to Cards in the 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. See section 10.3.9 for details.

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

10.3.4 Access to Cards in Other Cabinets

See section 6.

10.3.5 Replacement of MDU

Remove the 4 retaining screws at the front of the MDU and withdraw the MDU from the rack. As there are now several variants of the MDU ensure the replacement is the correct part number for the controller.

Replacement is the reverse of removal.

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.

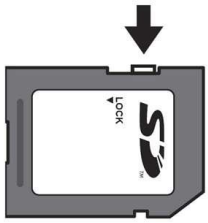
When replacing a CPU card it is possible to clone the system running on the CPU card being replaced onto the new CPU card using the Heart of the Controller. The steps to perform this are described in this section.

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.

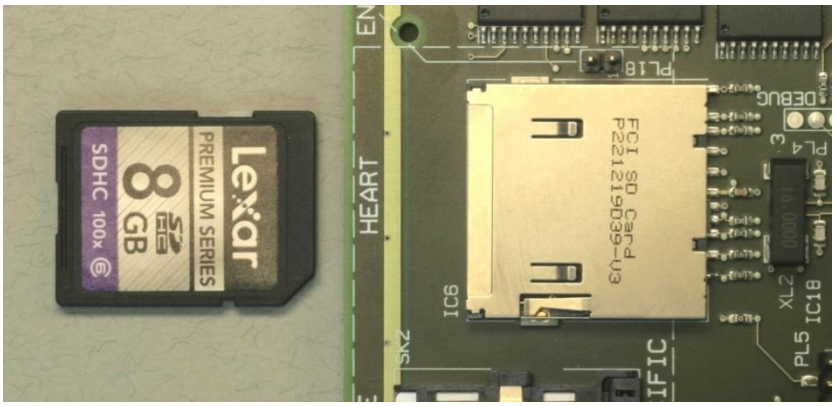
Move Heart to new CPU card

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:

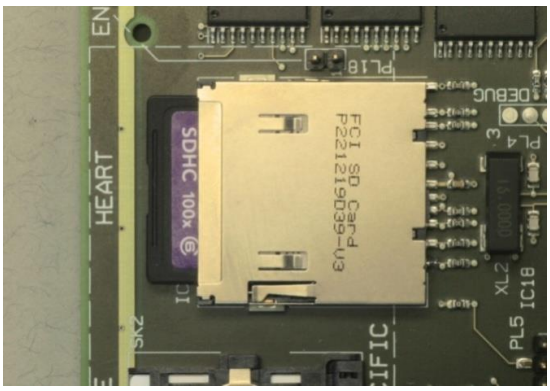


SD card Write Enable switch position



SD Card Orientation

× SD card partially inserted – incorrect



✓ SD card fully inserted – 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

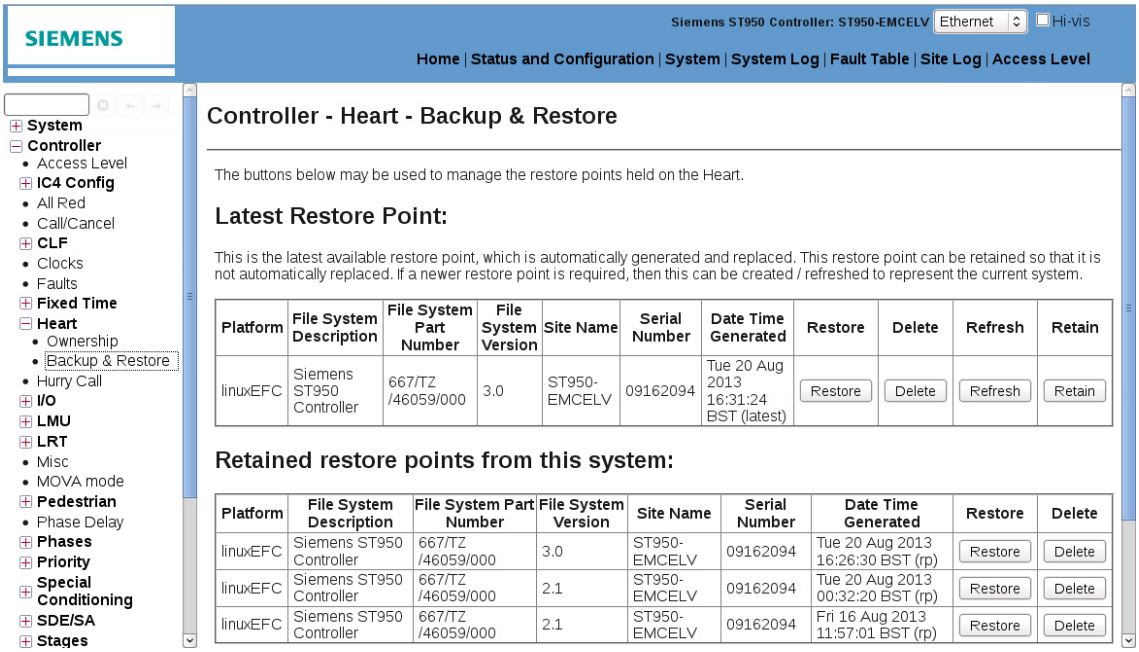


Figure 26 - Restore Points available for use

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.

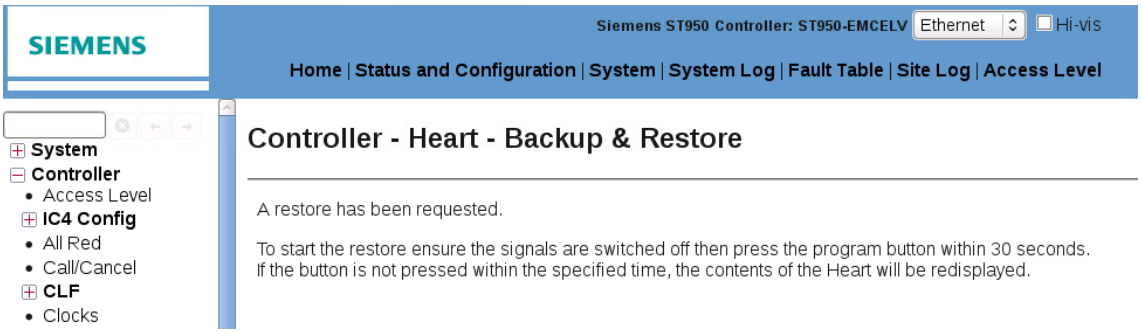


Figure 27 - Restoration instruction screen

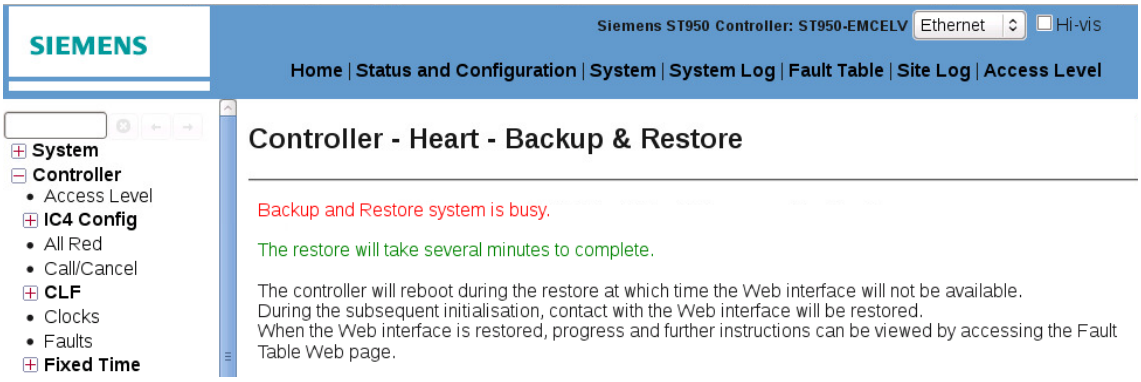


Figure 28 - Restoration progress screen

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.

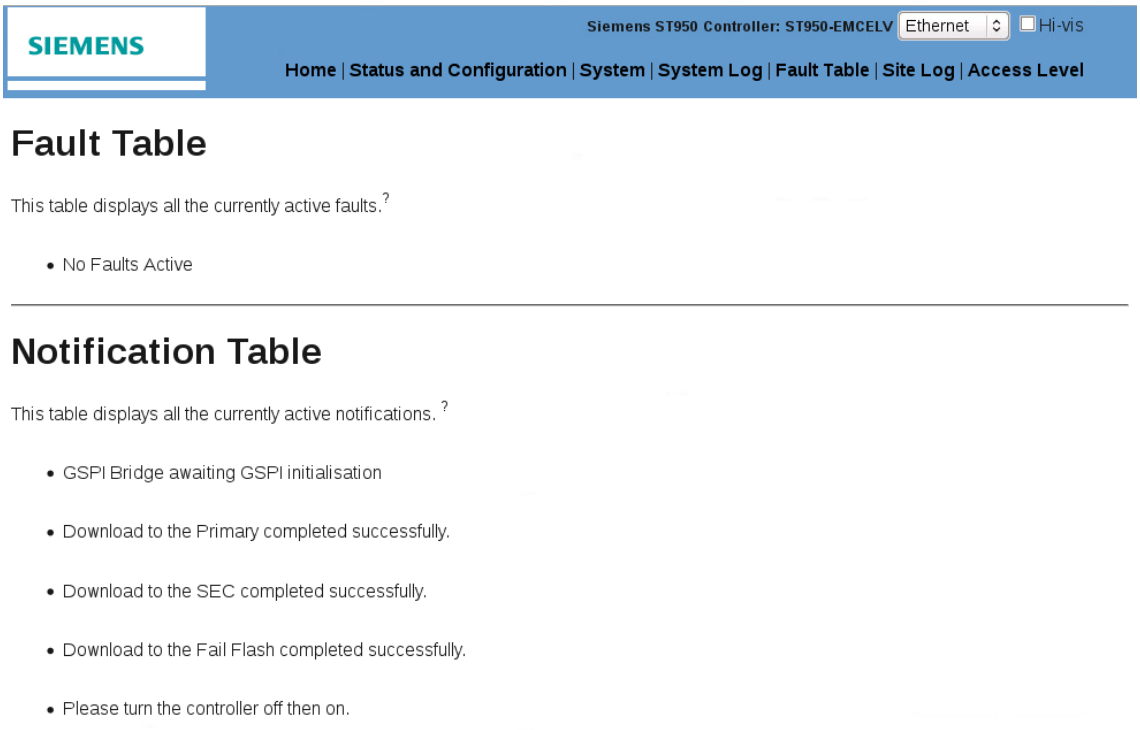


Figure 29 - Fault Table on completion of restoration from Heart

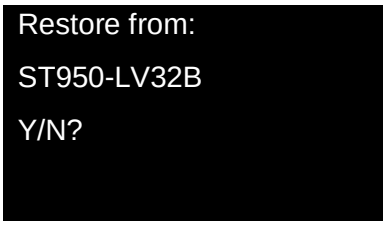
Restoring from the Heart Using WIZ

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.

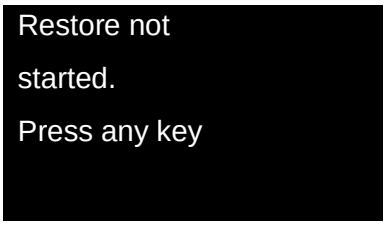
The user is presented with a sub-menu containing the following two options.

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.

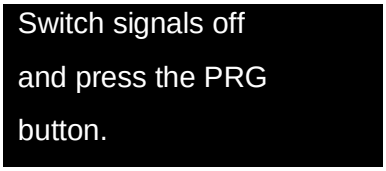


Selecting “N” will display the following.



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.



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

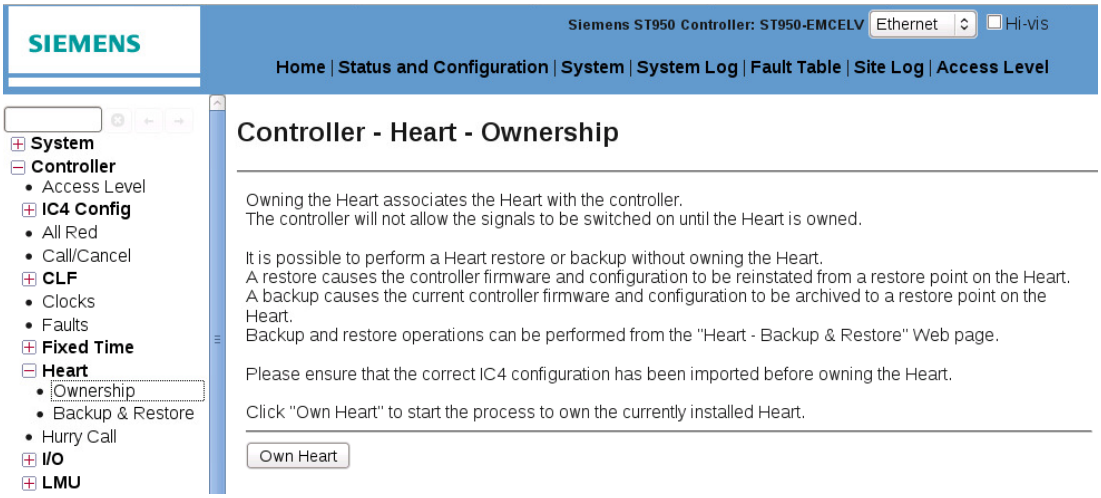


Figure 30 - Web page used to own the Heart

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.

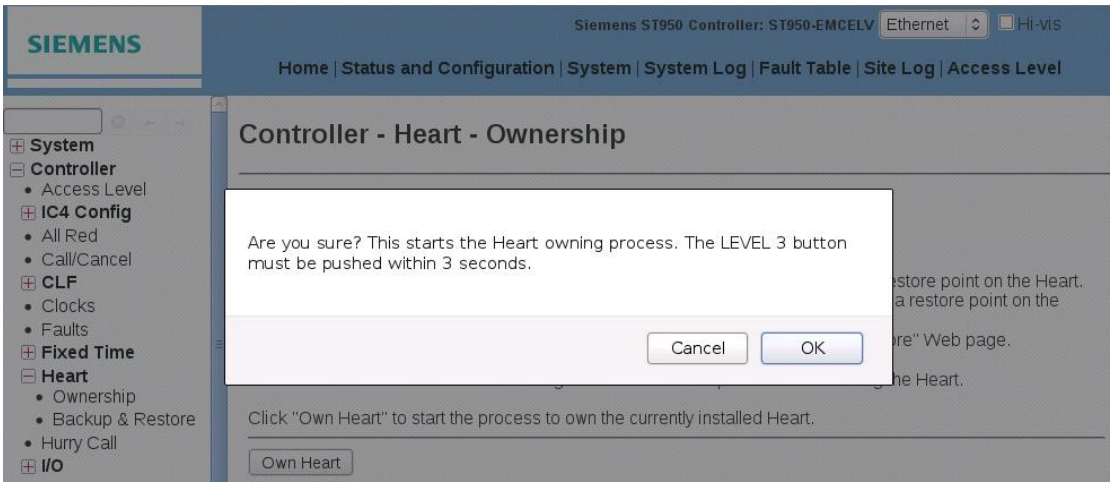


Figure 31 - Request to press Level 3 button during Heart ownership sequence

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

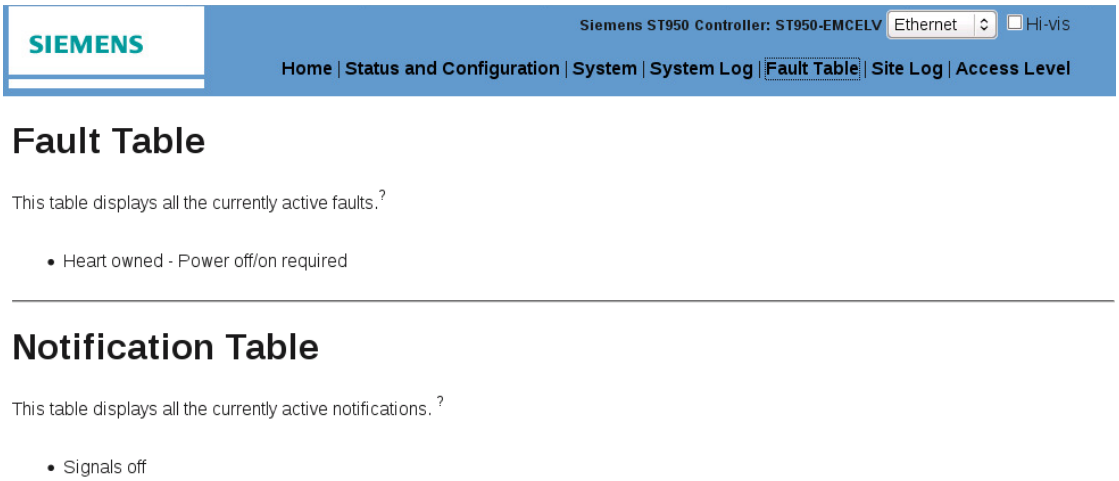


Figure 32 - Fault Table indication that the controller must be turned off then on to complete the Heart ownership

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
```

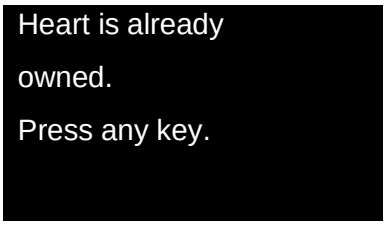
Power the controller off then on and the controller will start normally and allow the signals to be turned on.

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 Lamp Switch Card

Removal of the Lamp Switch cards may be done individually after disconnection of the ribbon cable at the front of the card.

The connectors at the rear, carrying the main voltages, are fixed to the logic rack so no rear access is required if replacing only a Lamp Switch card.

Check on any replacement card that the heatsink/cover plate retaining rivets/screws are all properly tightened. These ensure proper thermal contact between the triac mounting bars and the heatsink. Without this, overheating may occur thus leading to subsequent failure.

Check that the replacement PCB is the same variant as the original PCB fitted in the controller. The variant is identified by the last three digits of the part number and may be located on the serial number sticker. PCBs with the same form and fit may have different part numbers and / or variants but may still be used as replacements. Please refer to 667/SU/46950/000 for details of compatibility.

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.

Generally speaking, only the Intelligent Detector Backplane card will need replacing, although the replacement kit includes the passive Detector Backplane. They are supplied as a kit 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

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 connected 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.

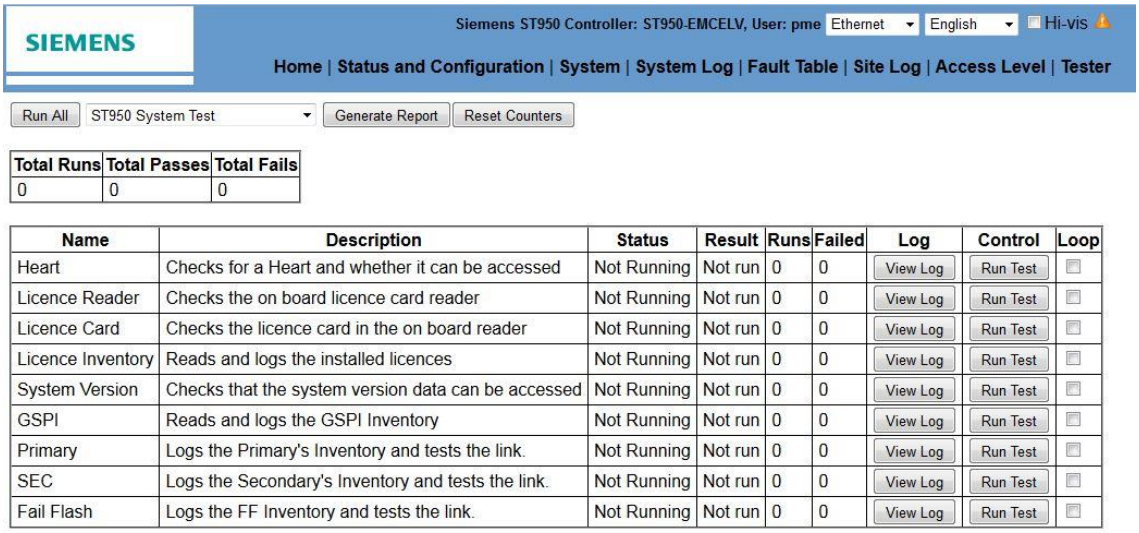


Figure 33 - ST950 System Test Scenario

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.

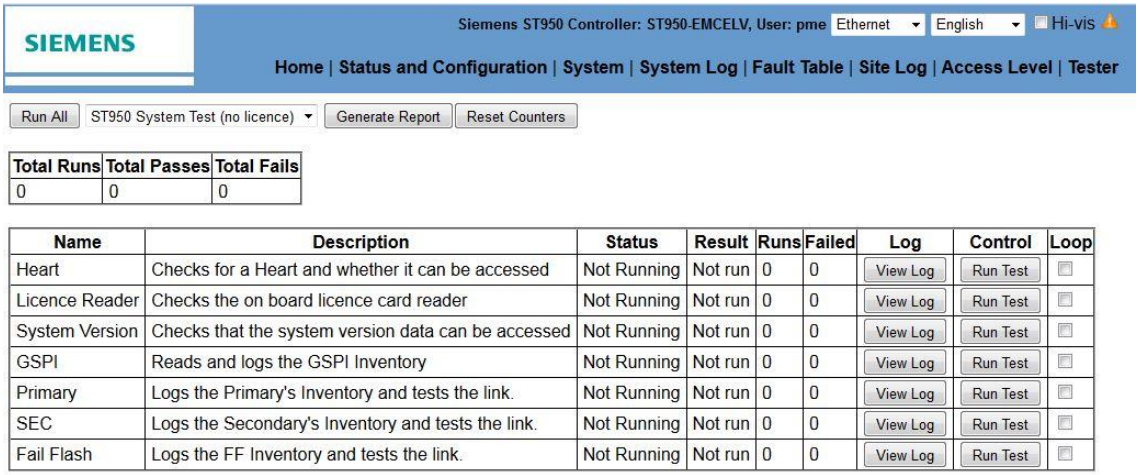


Figure 34 - ST950 System Test (no licence) Scenario

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 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 depressed. Note that the 'Lamp Test' button illuminates all the LEDs, as it does for normal operation.

To test the signals on/off switch and the cabinet alarm LED, switching the switch to the signals 'on' position illuminates the cabinet alarm. Switching it to the 'off' position extinguishes the cabinet alarm indicator. Note that 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

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 – none will be found in an LV system	`LSLS Cards...------` `No LSLS cards Found`
PHP CPU	Checks that the PHP processor is running and identifies the firmware and version	`PHP CPU......Active` `SIC:PB815 ISS 4`
Lamp switch card identification	Searches for LSC cards and reports the number and type found.	`L/S Cards..--21` `2 Eight Phase Cards`
Controller	Type Confirmation	`Ok, LV 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	`Platform 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	`Aux3: Loopback:`

	DTR-CTS RTS-DSR	
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		
ZXO	Source of ZXO detected and reported	`ZXO from.....PHP`
Mains Supply	Mains frequency measured and reported	`Mains Freq...50.0Hz`
LSC tests	ADC tests performed: 0V,2.5V,5V within tolerance	`ADC Tests....Passed`
	2.5V Reference voltage checked	`2.5V Reading x% LO/HI`
Lamp Supply	Lamp supply 'off' voltage checked to ensure 0V is measured. Should return 0V	`L/Supply off=0V`
	Red/Amber/Green Voltage monitors checked for consistency and value. Should return all monitors indicate off because no lamp supply present	`V/Mons off...Passed`
PHP CPU	Phase bus CPU initialisation	`P/Bus Init...Passed`
	Monitor Validation functioning as expected	`M/V Test.....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 LSC cards that it has found. It then displays a scrolling pattern on the amber LEDs on these LSC cards to prove that it can address all the cards correctly and to show that the first part of the Self-Test is complete.

11.5 Test Failures

On power-up, the Self-Test facility checks the integrity of the Main CPU Card:

```
RAM FAULT
DPR RAM FAULT
```

```
PRG PROM FAULT
XLT FAULT
DPR R/W FAULT
```

All the above faults point to problems internally on the Main CPU Card.

Checks communications with the secondary / phase bus processor:

```
P/BUS CPU...
```

If the processor cannot be detected, check that the processor and its firmware are fitted.

Examines the Lamp Switch cards to see how many are fitted:

```
No LSC or LSLS!
```

No cards were detected, check the ribbon cable.

```
Bad L/S Cards Found
```

e.g. if the first and third cards are detected, but not the second.

Detects Four Phase Lamp Switch Cards:

The controller Self-Test also automatically detects whether each Lamp Switch card is equipped with either four or eight phases.

When displaying each amber LED on each card in sequence at the end of Part 1, it only illuminates the four amber LEDs on a four phase Lamp Switch card.

If an eight phase card appears as a four phase card to the Self-Test, the bottom four LEDs on the card do not illuminate. This must be checked visually by the operator, so it is vitally important that all the amber LEDs on all the Lamp Switch cards are seen to illuminate in sequence before the button is pressed again to continue the Self-Test.

If a four phase card appears as an eight phase card to the Self-Test, this fault is recognised when the Self-Test attempts to pulse the triacs and check the monitors on the bottom four phases during Self-Test Part 2.

Note that the controller can currently only support one four phase Lamp Switch card and it must be the only card fitted or the last card fitted after a number of eight phase cards. The Self-Test shuts down (as does normal operation - see FLF 44) if a bad combination of Lamp Switch cards is detected.

Waits for ZXO synchronisation and checks the mains frequency:

```
ZXO From...
```

If the Phase Bus Processor cannot synchronise to the mains zero cross-over signal, e.g. because the ZXO wires are not connected to the back of the first Lamp Switch

card, Self-Test waits indefinitely at this point with the red system error LED illuminated.

```
Mains Freq Error
```

If the mains frequency is more than 5% out from either 50Hz or 60Hz.

Checks all the ADC test voltages on all of the Lamp Switch cards:

```
ADC Tests...Failed
ADC Test Readings
0.0V 2.5V 5.0V
B0+ nnnn nnnn nnnn
B0- nnnn nnnn nnnn
... .... .... ....
```

If the test fails, the readings from each card, taken at both the positive and negative mains peaks for each of the three test voltages (0V, 2.5V and 5V) are displayed on the handset.

Ideally the values should be 0, 512 and 1024, so try replacing any cards with readings which are very different. If all the readings appear too high or too low, particularly the 2.5V readings, this may point to a problem with the 5V logic supply.

Note: If 'LED Lamp Switch' Cards are fitted (see 667/HB/32921/007), the 2.5V test is replaced by a 3.6V test (with an ideal ADC value of 748 not 512).

Checks that the lamp supply and voltage monitors are detecting no mains:

```
L/Supply Off=240V
L/Supply Stuck On
```

If a lamp supply is being detected, this implies that the lamp supply relays are all switched on (very unlikely) or the lamp supply monitoring transformer (in the MDU) or its connection to the first Lamp Switch card is incorrect.

```
V/Mons Off...Failed
R-00000000+00000400
A-00000000+00000000
G-00000400_00000000
```

If any of the voltage monitors appear to be detecting mains, even though the lamp supply and all the triacs are switched off, this implies a problem with the hardware on one or more of the Lamp Switch cards.

Initialises the phase bus processor:

```
P/Bus Init...
LS/Card Fault (Lat)
Bad L/S Cards
```

Once initialised, the phase bus processor performs more thorough checks on the Lamp Switch cards and may detect faults. These tests check the data lines and board select lines using test latches on each card '(Lat)', the address lines to each card '(Adr)' and the ADC test voltages '(ADC)'. If more than one test fails, 'Bad L/S Cards' is displayed instead.

Checks the monitor validation signal:

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

The monitor validation signal is generated by the Main Processor and travels down the phase bus cables to each of the Lamp Switch cards, so a failure can be due to a faulty Main CPU Card or Lamp Switch card. See FLF 2:252 for more details.

Step 1 Complete, Start Step 2:

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

If no LEDs illuminate on one of the Lamp Switch Cards, switch off the controller and investigate; the controller has not detected that card.

In the scrolling pattern, on each Lamp Switch Card, either one or two amber LEDs are illuminated at a time. On "LED Lamp Switch" Cards (see 667/HB/32921/007), two LEDs are illuminated at the same time in pattern. On all other variants, only one amber LED is illuminated at a time.

This pattern remains until the operator presses the level 3 button to confirm that the pattern is scrolling correctly on all the cards fitted and that the Self-Test may switch on the lamp supply and continue its tests.

11.6 Self-Test Handset Output After Lamp Supply On

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

Therefore, check that the diagonal scrolling pattern illuminates all the amber LEDs on all the Lamp Switch 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 LSC 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.

If standard HI 12V halogen lamps are used (with a transformer in the signal heads), this pulse is not seen on the street and so the signals need not be covered. However it may be possible to see the pulse on lamps that are not driven by any transformer, i.e. that run directly off the 240V.

All 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
Lamp Switch card 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...`
	**The second test stage is undertaken with power applied to the Lamp Switch cards.**	
Lamp Switch card voltage monitoring	Mains supply is now applied to the lamp switch cards and checks that no outputs switch on. Should return 0V	`V/Mons off=0V`
Lamp Supply switching – Relays & Triacs	Measure lamp supply and report value	`Lamp Supply..237V`
	SSR switching check. Should return 0V	`SSR Off Test=0V`
	Measures and reports the dim lamp supply	`Dim L/Supply=161V`

	Switches each Red channel triac on in turn for 40ms	`Triac Tests..Reds`
	Relay A tested by switching off from the Primary CPU, measure and reports the lamp supply with the relay switched off. This should return 0V	`Relay A-PRI..0V`
	Switches the Amber channel triacs on in turn for 40ms	`Triac Tests..Ambers`
	Relay B tested by switching off from the SEC CPU, measure and reports the lamp supply with the relay switched off. This should return 0V	`Relay B-SEC..0V`
	Switches the Green channel triacs on in turn for 40ms	`Triac Tests..Greens`
	Relay B tested by switching off from the PHP CPU, measure and reports the lamp supply with the relay switched off. This should return 0V	`Relay B-PHP..0V`
Test Status		`Triac Tests.. Passed`
Supply Arrangement	Determines how the controller is configured to provide lamp supply	`Checking Lamp Supply Arrangement:`

	Switches Relays A & B off to determine how the lamp supply is switched either for 'Fail to Blackout' or 'Fail to Flashing'
	If both relays turn all signals off
		`RelayB:All sigs off`
		`RelayA:All sigs off`
		`Controller Set-up:`
		`'Fail to Black-Out'`

	If hardware fail flashing is available
	(For more detailed information see the ST950 LV Installation handbook)
		`RelayB:All sigs off`
		`RelayA:Ok, GSup Off`
		`Rack L/S Cards CPU`
		`FL __+__+FL+FL BO`
		`FailFlash Available`
		`But Not Selected.`

	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`
		`==================`

11.6.1 Test Failures

Self-Test switches on the lamp supply and then checks that the voltage monitors still show no mains (triacs still switched off):

```
V/Mons Off...Failed
R-00000000+00000400
A-00000000+00000000
G-00000400+00000000
```

If any of the voltage monitors appear to be detecting mains, it would imply that those triacs are not holding off the mains and those Lamp Switch cards should be replaced.

Checks a lamp supply can be detected:

```
ZXO Wires Reversed
```

The ZXO wires from the MDU to the first Lamp Switch card are connected the wrong way round.

```
L/S Monitor Fault
```

The lamp supply can be detected on the voltage monitors, but no signal is present from the lamp supply monitoring transformer. Check the transformer and its connections.

```
L/Supply Failure
```

No lamp supply has been detected by the lamp supply monitoring transformer but further investigations by the Self-Test facility cannot determine the cause. Check the lamp supply circuits, relays, fuses, etc., in and around the MDU.

Checks that each lamp supply relay can switch off the lamp supply independently:

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

Failure of any of these tests implies that the relay is not switching off, i.e. that it is either stuck closed, short-circuited by a wiring fault or the control signals from the Main CPU Card are stuck active.

If the Self-Test terminates and the controller starts up normally when it attempts to test the SSR*, the power supply may be overloaded. Check the number of detector cards for example. See Section 2 of the ST950 Controller General Handbook.

* It is easy to tell when the Self-Test checks the SSR, since it briefly illuminates all the LEDs on all the Lamp Switch cards.

Checks that the dimming relay is functioning:

```
Dimming Fault
```

A fault is only logged on 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, no link should be fitted between the dim input and the dim output on the back of the MDU. If dimming is configured as not present, i.e. KDP is set to zero, the controller simply never attempts to switch to dim.

Note that this test does not fail if there is no dim lamp supply, e.g. if no dimming transformer is fitted, since Self-Test may be performed on the just the controller rack. Therefore, the dim voltage should be checked manually, e.g.

```
Dim L/Supply=160V
```

Checks all of the triacs in turn by applying a very short pulse to each phase's colour:

```
A/RED;Extra Signs On
R-00000001+00000001
A-00000001+00000001
G-00000001+00000001
```

A fault is logged if extra signals are detected as on when one particular aspect is pulsed. The top line identifies the Phase and Colour (A/Red in this example) that was under text, and the additional data indentifies which outputs appeared to be ON. This would normally imply a short-circuit in the street cabling or an open neutral connection. In this example, all three colours of Phase A appeared ON when Phase A/Red was checked.

```
No Voltages On...
R-00000F00+00000F00
A-00000F00+00000F00
G-00000F00+00000F00
```

A fault is also logged if no voltages were detected, e.g. when one of the fuses on one of the Lamp Switch cards has blown.

Checks the Lamp Supply arrangement:

The Self-Test checks the lamp supply arrangement of the controller ('fail to flashing' or 'fail to blackout') after checking each lamp supply relay and each triac and monitor circuit.

With the SSR and relay A switched on but with relay B switched off, it pulses a selection of triacs to check that the lamp supply to all the triacs on all of the cards has been removed:

```
Checking Lamp
Supply Arrangement:
RelayB;All Sigs Off
```

If any voltage monitors detect lamp supply during this test, the Self-Test shuts down and displays the fault on the handset, e.g. if Phase A Red detects voltage:

```
Relay B Off But...
R-00000000+00000001
A-00000000+00000000
G-00000000+00000000
```

It then switches relay B back on and switches off relay A instead and again pulses a selection of triacs and checks which, if any, still have lamp supply.

From this, the controller can determine whether the wiring on the back of the rack is set-up for 'fail to black-out' only, i.e. for UK use, or whether it is wired for 'fail to flashing', i.e. for non UK.

If the rack is set-up for 'fail to black-out', relay A also switches off the lamp supply to all the triacs on all of the cards, i.e. only the 'green supply' from the MDU (which can be switched off by any of the lamp supply relays) is passed to the Lamp Switch cards. If this is the case, this result is displayed on the handset and the Self-Test continues as before:

```
RelayB;All Sigs Off
RelayA;All Sigs Off
Controller Set-Up:
'Fail To Black-Out'
```

However, if the rack is set-up for 'fail to flashing', the red/amber lamp supply on the back of the MDU which is not switched off by relay A is used to power the red and amber triacs on the Lamp Switch cards. However, the green lamp supply is still switched off:

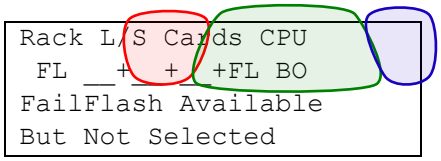
```
Checking Lamp
Supply Arrangement:
RelayB;Sigs Off
Relay A;Ok, Grns Off
```

The 'fail to flashing' Lamp Switch cards also differ from the 'fail to black-out' Lamp Switch cards. Both have two lamp supply input connections, each one separately fused on the card, but which triacs each supplies is modified by links:

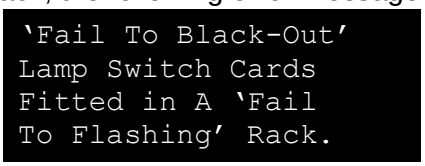
On a 'fail to black-out' Lamp Switch card, one input supplies the first four phases while the other independently supplies the last four phases.

On a 'fail to flashing' Lamp Switch card, one input supplies the red and amber triacs while the other independently supplies the green triacs.

On the handset, Self-Test shows the state of the Rack, the state of up to four Lamp Switch (L/S) Cards and the state of the link on the CPU Card. If a Lamp Switch card is not fitted, '__' is displayed. Even if the Rack and L/S Cards at allow 'fail to flashing' (FL), normally the link on the CPU Card is set to the 'fail to blackout' (BO) position, so the controller still extinguishes all the signals until the Hardware Fail Flash facility is actually required:



If one or more 'fail to black-out' Lamp Switch cards are fitted in a 'fail to flashing' rack, the following error message is displayed and the Self-Test shuts down:



Regardless of whether the link on the Main CPU Card is set to 'fail to black-out' or 'fail to flashing', if the rack and Lamp Switch cards allow the 'fail to flashing' option the controller flashes the red and amber LEDs on all of the Lamp Switch cards for five seconds.

At the end of the test, the Self-Test switches off the lamp supply and displays a multicoloured scrolling pattern on the Lamp Switch card LEDs to show that all the tests have passed successfully.

After a few seconds, Self-Test repeats the tests from section 11.6, allowing the controller to be soak tested.

11.6.2 Test Failures

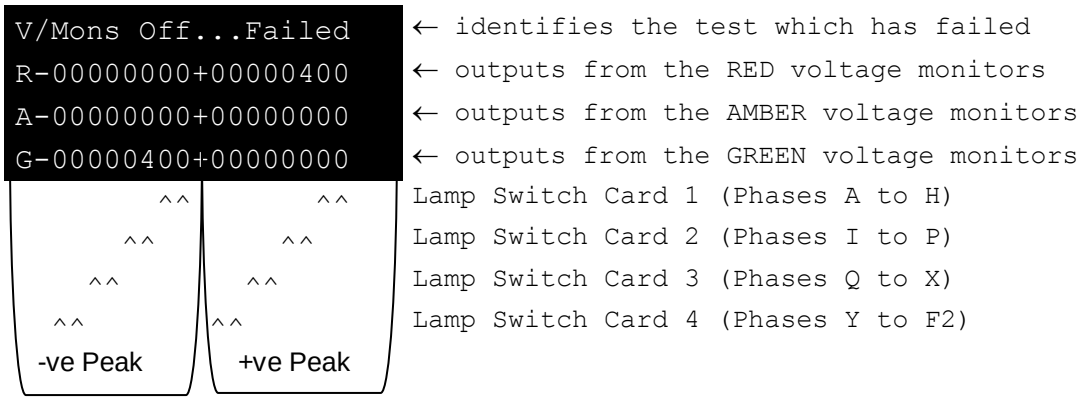
General Lamp Switch Card Failures:

Should one of the general tests on the Lamp Switch cards fail, try repeating the Self-Test with only the first Lamp Switch card connected and then repeat this with each card (and ribbon cable) in turn until the faulty card (or ribbon cable) is detected.

Note that it is possible that an obscure fault on one card may cause a later card to appear faulty due to the nature of the 'bus' communications system.

Resolving problems with Lamp Switch cards and triacs:

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



The numbers are in hexadecimal notation. Each pair of digits covers one lamp switch card (eight phases) making it possible to quickly determine the faulty card. In this example, the second lamp switch card is faulty (on a phase on that card).

To identify faulty phases, each of the eight digits encodes four phases and each possible combination of those four phases is encoded to a value as follows:

0	0	0	0	0	4	0	0
0= - - - -	0= - - - -	0= - - - -	0= - - - -	0= - - - -	0= - - - -	0= - - - -	0= - - - -
1= - - - C	1= - - - Y	1= - - - U	1= - - - Q	1= - - - M	1= - - - I	1= - - - E	1= - - - A
2= - - D -	2= - - Z -	2= - - V -	2= - - R -	2= - - N -	2= - - J -	2= - - F -	2= - - B -
3= - - D C	3= - - Z Y	3= - - V U	3= - - R Q	3= - - N M	3= - - J I	3= - - F E	3= - - B A
4= - E - -	4= - A - -	4= - W - -	4= - S - -	4= - O - -	4= - K - -	4= - G - -	4= - C - -
5= - E - C	5= - A - Y	5= - W - U	5= - S - Q	5= - O - M	5= - K - I	5= - G - E	5= - C - A
6= - E D -	6= - A Z -	6= - W V -	6= - S R -	6= - O N -	6= - K J -	6= - G F -	6= - C B -
7= - E D C	7= - A Z Y	7= - W V U	7= - S R Q	7= - O N M	7= - K J I	7= - G F E	7= - C B A
8= F - - -	8= B - - -	8= X - - -	8= T - - -	8= P - - -	8= L - - -	8= H - - -	8= D - - -
9= F - - C	9= B - - Y	9= X - - U	9= T - - Q	9= P - - M	9= L - - I	9= H - - E	9= D - - A
A= F - D -	A= B - Z -	A= X - V -	A= T - R -	A= P - N -	A= L - J -	A= H - F -	A= D - B -
B= F - D C	B= B - Z Y	B= X - V U	B= T - R Q	B= P - N M	B= L - J I	B= H - F E	B= D - B A
C= F E - -	C= B A - -	C= X W - -	C= T S - -	C= P O - -	C= L K - -	C= H G - -	C= D C - -
D= F E - C	D= B A - Y	D= X W - U	D= T S - Q	D= P O - M	D= L K - I	D= H G - E	D= D C - A
E= F E D -	E= B A Z -	E= X W V -	E= T S R -	E= P O N -	E= L K J -	E= H G F -	E= D C B -
F= F E D C	F= B A Z Y	F= X W V U	F= T S R Q	F= P O N M	F= L K J I	F= H G F E	F= D C B A

So in the above example, the voltage monitor for phase K red on the positive peak and phase K green on the negative peak is stuck on.

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 Controllers. Sections A.1.1 and A.1.2 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 Family Tree (667/DZ/46950/000).

Spares List

In addition to the spares listed below, many of the parts listed in sections A.1.3 and A.1.4 may be ordered as replacement items. Contact Siemens Poole for details.

Description	Part Number
8 Phase Driver Cable form (Long)	667/1/27072/001
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
Additional rear Termination panel kit	667/1/27083/000
Dimming Transformer Assembly 0.5 kVA (LED)	667/1/27084/500
Dimming Transformer Assembly 1.5 kVA	667/1/27084/001
Dimming Transformer Assembly 3 kVA	667/1/27084/003
300mA RCD kit	667/1/27117/000
Current Monitoring Toroid	667/7/25171/000
Isolator Locking kit	667/1/33073/000
Screw Lock Key	667/2/20234/000
Manual Panel RS232 kit	667/1/27110/000
Manual Panel kit (Intersection Controller)	667/1/27056/001
DFM Lens kit	667/1/27104/000
Mounting Stool (Grey)	667/2/27096/000
CET Bar Kit	667/1/27063/000
24V AC 50VA Detector Supply kit	667/1/27853/000
24V AC 160VA Detector Supply kit	667/1/20292/008

A.1.1 UK Standard Types

Description	Part Number
ST950 Cabinet UK 1.5kVA 8PH Wired 8PH Grey	667/1/46950/010
ST950 Cabinet UK 1.5kVA 8PH Wired 8PH Black	667/1/46950/011
ST950 Cabinet UK 2kVA 24PH Grey	667/1/46950/020
ST950 Cabinet UK 2kVA 24PH Black	667/1/46950/021
ST950 LED Cabinet UK 500VA 8PH Wired 8PH Grey	667/1/46950/018
ST950 LED Cabinet UK 500VA 8PH Wired 8PH Black	667/1/46950/019
ST950 LED Cabinet UK 500VA 24PH Grey	667/1/46950/028
ST950 LED Cabinet UK 500VA 24PH Black	667/1/46950/029
ST950 Rack UK 8PH Wired 8PH	667/1/46950/800
ST950 19” Rack UK 24PH	667/1/46950/810
ST950 19” Rack UK 8PH LED Wired 8PH	667/1/46950/808
ST950 19” Rack UK 24PH LED	667/1/46950/818
ST800 Cuckoo kit	667/1/46980/000
T400L Cuckoo kit	667/1/46990/000
Microsense MTC Cuckoo kit	667/1/46992/000
Microsense Sentinel Cuckoo kit	667/1/46993/000
Peek TSC3 Cuckoo kit	667/1/46994/000
Peek TRX Cuckoo kit	667/1/46995/000
Lamp Switch Kit (UK)	667/1/27002/000
Lamp Switch Kit – LED (UK)	667/1/27002/002
16 Phase to 32 Phase Controller upgrade kit	667/1/27008/001
NAL Cabinet Base Grey	667/7/46690/000
NAL Cabinet Base Black	667/7/46690/001

A.1.2 Non-UK Standard Types

Description	Part Number
ST950 Cabinet Non UK 8PH Grey (No dim)	667/1/46950/110
ST950 Cabinet Non UK 24PH Grey (No dim)	667/1/46950/120
ST950SE Rack (11”) 8PH Wired 8PH	667/1/46950/960
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
Lamp Switch Kit (Non UK) Fail Flash	667/1/27002/100
Lamp Switch Kit – LED (Non UK) Fail Flash	667/1/27002/102

4 Phase Non UK Lamp Switch Kit (No lamp monitoring)	667/1/27223/403
8 Phase Non UK Lamp Switch Kit (No lamp monitoring)	667/1/27223/003
Lightning Protection Kit – Mains Surge Arrester (Non UK)	667/1/27118/000
Lightning Protection Kit – Telephone (Non UK)	667/1/26271/000
Dimming Transformer Assembly Sao Paulo Brazil TX	667/1/27084/005

A.1.3 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	667/1/45966/001
ST900 to ST950 Power Adaptor Cable Assy (Pink)	667/1/46961/000
Lightning Protection Kit – Ethernet	667/1/45972/001
Gemini^2	667/1/32600/000

A.1.4 Other Spares

Description	Part Number
24V/0V Wire Kit	667/1/27073/000
27C Yale Door Lock Kit	667/1/21384/000
Yale Lock Barrel Protector kit	667/1/21498/000
48V Wait Drive kit – 160VA	667/1/21029/001
48V Wait Drive kit - 50VA	667/1/21029/003
Additional Audio Rectifier Kit	667/1/27006/001
Audible Supply Kit	667/1/27006/000
Base sealant - Robnorganic PX212ZF (or similar)	992/4/00216/000
Current Sensor Toroid Long	667/1/25171/010
Dimming Transformer Wire Kit	667/1/27074/000

Door Stay Kit	667/1/27103/000
Equipment Mounting Frame Assembly	667/1/27087/000
Fail Flash Kit (Non UK)	667/1/27078/001
Greater than 16 Ph Kit	667/1/27078/000
I/O card RJ45 cable 0.2m length	998/4/88351/002
I/O card RJ45 cable 0.5m length	998/4/88351/005
I/O card RJ45 cable 1.0m length	998/4/88351/010
I/O card RJ45 cable 2.0m length	998/4/88351/020
I/O card RJ45 cable 3.0m length	998/4/88351/030
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
Lamp Switch 8 Phase Cableform (Short)	667/1/27072/002
Lamp Switch 8 Phase Cableform (Long)	667/1/27072/001
Lamp Switch PCB	(Refer to /SU/)
Lamp Switch Interconnect Ribbon Cable Assembly	667/1/27071/000
Locking Kit	667/1/21923/001
CPU Card Assembly	667/1/46010/001
CPU Card Power Cableform	667/1/46960/000
Mains Distribution Assembly UK (MDU)	667/1/27052/950
Mains Distribution Assembly Non UK (MDU)	667/1/27052/951
Mains Distribution Assembly LED UK (MDU)	667/1/27052/970
Manual Panel - Full Intersection	667/1/27056/001
Manual Panel - Ped Full Panel	667/1/27056/002
Manual Panel - Blank	667/1/27056/050
Manual Panel Gasket	667/7/27129/000
Manual Panel - On/Off Only	667/1/27056/010
Manual Panel - Signals On/Off and DFM Assembly	667/1/27056/301
Manual Panel - Signals On/Off only Assembly	667/1/27056/300
Manual Panel - Ped Sigs On + DFM Cable	667/1/20284/301
Manual Panel - Ped Sigs On (No DFM Cable)	667/1/20284/300
Master Switch Lock	667/7/21924/000
Master Switch Panel Assembly	667/1/27054/000
Neutral Kit	667/1/27068/000
PB815 Firmware (Latest issue – Phase Bus Processor)	667/1/12815/000

Sealant strip PVC 20mm wide x 6mm per m	667/4/04026/023
Solar/Neutral/Reg Wire Kit	667/1/27069/000
Additional Panel Kit (Left Hand Side)	667/1/33915/000
ST950 Preliminary Rack Assembly	667/1/27051/950
ST950 Termination Panel Assembly	667/1/33910/000
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.1.5 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 The Max size of this fuse should not exceed 100A (without reference to 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
Master Switch Fuse 45A HRC cartridge fuse to BS1361 on Master Switch panel	518/4/90637/003
Master Switch Fuse - ST900LED 20A HRC cartridge fuse 22 X 58mm 690V Bussman C22G20 or Lawson LFN22G20	518/4/97092/020
Aux. Supply Fuse e.g. OTU/OMU 5A HRC cartridge fuse to BS1361 on Master Switch panel	518/4/90638/000
Controller Switch Fuse 30A HRC cartridge fuse to BS1361 on the front of the MDU.	516/4/97053/003
Controller Switch Fuse - ST900LED 16A HRC cartridge fuse to BS88 on the front of the MDU.	518/4/90352/005
Regulatory Signs Fuse 10A cartridge fuse to BS88 on the front of the MDU.	518/4/90352/004
Maintenance Socket Fuse 5A cartridge fuse to BS1362 marked ‘MAINT’ on Mains Distribution card	516/4/97022/003

Solar Cell Fuse 5A cartridge fuse to BS1362 marked 'Solar' on the Mains Distribution card.	516/4/97022/003
Lamp Switch card Fuse Two 10A Mains fuses per Lamp Switch card (FS1 & FS2) – One fuse for each 4 phases. (If used for non UK with fail flashing, one fuse is for all the greens and the other fuse is for all the reds and ambers.)	518/4/97056/010
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
TEST Lamp Switch card Fuse Two 3.15A fuses used for initial testing on a rewired junction for Self-Test (See section 11).	518/4/97020/115