SIEMENS

Plus+

ST950 Plus+ User Manual

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Issue 2

667/HE/53000/000

Change History

Version	Date	Change	Author
1	Jan 2020	First Issue	Siemens
2	Apr 2021	Updates and corrections	Siemens

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

SAFETY INFORMATION

General Hazards

IT IS RECOMMENDED THAT DUE TO THE MAINS PRESENT WITHIN THE CONTROLLER CABINET ALL POWER TO THE CABINET IS DISCONNECTED BEFORE REMOVING OR INSTALLING ANY MAINS POWERED EQUIPMENT INTO THE CABINET. WHERE A RISK ASSESSMENT AND METHOD STATEMENT FOR THE WORKS TO BE COMPLETED AND / OR THE INSTRUCTIONS FOR THE EQUIPMENT BEING INSTALLED OR REMOVED ALLOWS, LIVE WORKING MAY BE CONSIDERED.

Safety of Installation and Maintenance Personnel

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

(1) 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 this equipment. All work shall be performed in accordance with the local regulations[1].

(2) 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:

i. The equipment must be correctly connected to the specified incoming power supply.
ii. Only trained / competent persons should work on this equipment.
iii. Any power tools must be regularly inspected and tested.
iv. Any personnel working on site must wear the appropriate protective clothing, e.g. reflective vests, etc.

[1] For UK this refers to Electricity at Work Regulations 1989.

Re-Commissioning the Junction

When re-commissioning signals, the following sequence is recommended to ensure that the correct signal start-up 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 specific activities or situations.

RJ45 Connections

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

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

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

Equipment Compatibility

Do not connect any device that has not been specifically designed or evaluated for compatibility with the ST950 Plus+ system. If in doubt, contact Siemens Mobility Limited for further information.

ST950 Plus+ compatible equipment such as Helios Plus+ traffic signals, near-side pedestrian signals and Plus+ LED regulatory signs are all clearly marked "Plus+". If equipment is not marked "Plus+" then additional care should be taken to ensure that it is suitable for use in a Plus+ system.

Safety of Road Users

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

Ensure that appropriate traffic management and is signed at the junction area 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 of Lithium Battery

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

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

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

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

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

Important Plus+ Considerations

To provide the most reliable operation, the Siemens ST950 Plus+ controllers use a DC supply.

To maintain all street voltages within ELV limits, equipment outside the cabinet must be supplied with voltages within the band 0 to +48V DC with respect to earth. Voltages beyond that will result in overall voltages within the system being in excess of the ELV limit as defined by BS7671.

Care should be taken to ensure that no LV (Mains Voltage) equipment is installed within the ST950 Plus+ street furniture as this will result in risks to personnel and risk of catastrophic failure of equipment.

The Siemens ST950 Plus+ controller has been designed and proven to meet the following requirements for Protective Extra Low Voltage (PELV) and the operation of a signal compliance monitoring system with ELV voltages:

1) The Siemens ST950 Plus+ system is PELV and the earth is connected all the way through, as allowed for in BS7671 414.4.1. The source is a safety isolating PSU as allowed in BS7671 414.3 (iv). Protective Isolation within the controller cabinet is achieved between the PELV circuits and those higher than band I by **ALL** conductors having insulation rated for the highest voltage 250V, as mandated for in BS7671 414.4.2 (iii), and where the parts of the circuits are not wires / conductors, then physical isolation as allowed for in BS7671 414.4.2 (v) may be used.

Disposal

As will all modern equipment, there are a number of security artefacts that exist within the hardware. When replacing equipment, the swapped-out CIC and Nodes must be disposed of in a secure way.

Contents

1 INTRODUCTION

1.1 Purpose

The purpose of this handbook is to describe the procedures for the Installation and Commissioning of the ST950 Plus+ system 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.

Equipment Detail

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 support.ts.uk.mobility@siemens.com.

1.3 Reference Documents

1.3.1 Controller (Essential)

Publisher	Reference Number	Document Title
ITS	667/HB/46000/001	ST950 Facilities Handbook for ST950
ITS	667/HB/46000/003	MOVA 7 HANDBOOK - ST950
ITS	667/HB/46000/004	UTMC OTU Handbook for ST950 And Stratos Outstation
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/GA/53000/ETC	Plus+ Top Level General Assembly
ITS	667/DZ/53000/000	ST950 Plus+ Family Tree

1.3.2 Intersection Design

Publisher	Reference Number	Document Title
ITS	667/HQ/53000/200	ST950 Plus+ Layout Design Tool Quick Start Guide
ITS	667/HE/31699/000	Loop Inductance and Turns Calculation Spreadsheet
ITS	667/HB/20168/000	IC4 Configurator Handbook

1.3.3 Installation and Commissioning

Publisher	Reference Number	Document Title
ITS	667/HQ/53000/300	ST950 Plus+ Installation App Quick Start Guide
ITS	667/HE/20662/000	Installation & Commissioning – Signals & Poles
ITS	667/HB/30000/000	Helios General Handbook
ITS	667/HB/31900/000	Heimdall Above Ground User Manual
ITS	667/HB/45200/000	SLD4 Loop Detector Handbook
ITS	667/HE/20663/000	Loop Detector and Cable Terminations – Installation and Commissioning
ITS	667/HE/20664/000	Installation and Commissioning Handbook - Installation Testing (General)

1.4 Pre-Requisites

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.

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[2]:

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

[2] 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
Android Tablet + Wi-Fi Dongle	
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

1.4.3 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[3]	4/MC 289
Manual Panel key Type 900	667/4/13651/000

1.4.4 Spares

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

[3] In some areas customers' specified keys may be used

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)
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
BCD	Binary Coded Decimal
CET	Central Earth Terminal
CLF	Cableless Linking Facility
CIC	Controller Interface Card
CLU	Cableless Linking Unit
CPU	Central Processing Unit
CRC	Cyclic Redundancy Code
CRL	Certificate Revocation List
CTB	Controller Terminal Backplane
DC	Direct Current
DFM	Detector Fault Monitor
DHCP	Dynamic Host Configuration Protocol
DNS	Domain Name System
ELV	Extra Low Voltage
GSPI	Generic Serial Peripheral Interface
HI	High Intensity
HFF	Hardware Fail Flash (ST950 LV/ELV Only)

Abbreviation	Meaning
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
PDU	Pedestrian Demand Unit
PI	Periodic Inspection
PROM	Programmable Read Only Memory
RAG	Red Amber Green
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
SEB	Sealing and Earth Bar
SSH	Secure Shell
TCP	Transmission Control Protocol
TLS	Transport Layer Security
UDP	User Datagram Protocol
UTC	Urban Traffic Control

Abbreviation	Meaning
VA	Vehicle Actuated

1.7 Third Party Information

Embedded in this product are free software files that you may copy, distribute and/or modify under the terms of their respective licenses, such as the GNU General Public License, the GNU Lesser General Public License, the modified BSD license and the MIT license. In the event of conflicts between Siemens license conditions and the Open Source Software license conditions, the Open Source Software conditions shall prevail with respect to the Open Source Software portions of the software.

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
Intelligent Traffic Systems
Siemens Mobility Limited
Sopers Lane
Poole
Dorset
BH17 7ER
UK

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Open source software components used within the product are listed on the controller's web and mass storage device interfaces.

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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 PLUS+ INTRODUCTION AND BASIC PRINCIPLES

The Siemens ST950 Plus+ system is part of the wider ST950 family of controllers and associated equipment. The ST950 Plus+ system will run very similar firmware and offers same facilities as the rest of the ST950 family, including license enabled integral MOVA8 and integral UTMC OTU facilities.

The ST950 Plus+ Controller is supplied as a single-door outer case with a 6U logic rack and equipment mounting frame.

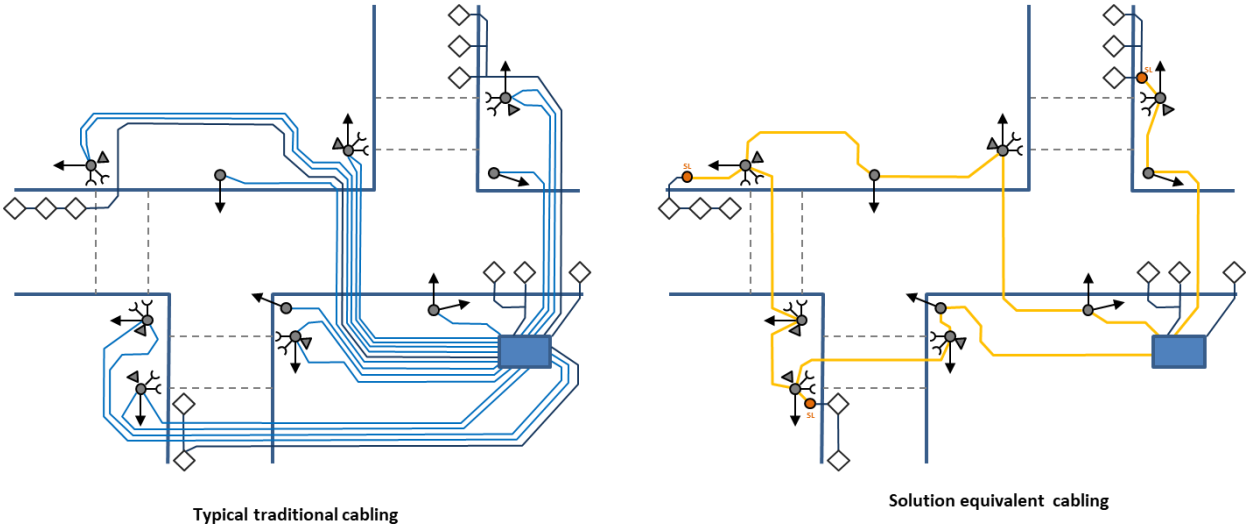


Figure 1 : Comparison of Traffic Cabling Methodologies

The Plus+ Traffic Controller provides ELV Power and communications, using a four-core armoured cable, to a number of intelligent Plus+ Nodes on the street. The cable connects at the cabinet to a 'Cabinet Interface Card' (CIC) via its 'Cable Termination Backplane' (CTB).

Each CIC supports a number of on-street cables (arms or rings) each with individual electronically controlled power switch off capabilities.

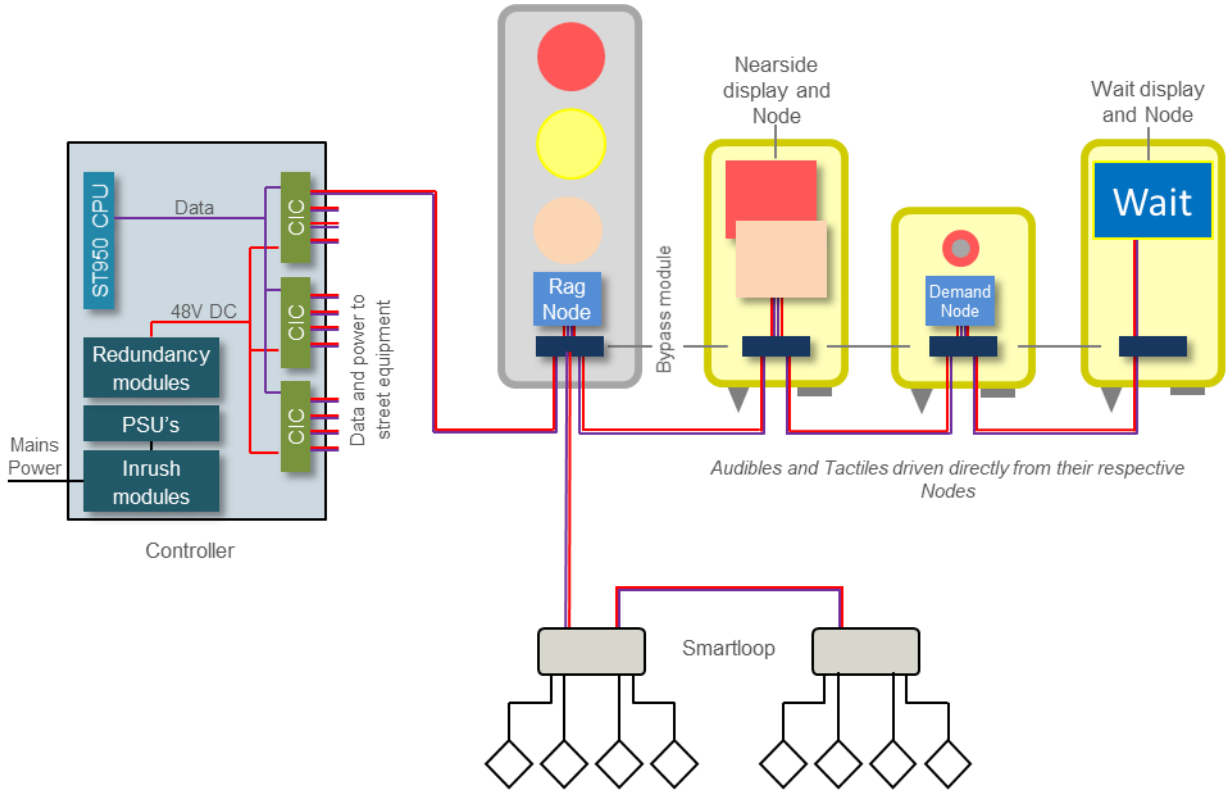


Figure 2 – System Overview

On the street, the armoured street cables terminate at a "Pole Top Board" (PTB) within the Traffic Signal Pole, located inside the Pole Cap. An option for mid-level or low-level access poles is also available (using a 16-way protected terminal block assembly, 667/1/58200/026).

From the terminations in the pole, a more flexible non-armoured cable (also known as the Plus+ Dropper cable) then extends the power and communications to the Plus+ Nodes, housed in arrange of signal enclosures attached to the pole.

The Plus+ Nodes provide distributed signal control and monitoring functions as well as loop detection (Smartloop).

The Plus+ Nodes provide an interface for the use of direct connection for a range of appropriate detection devices (e.g. Vehicle Actuation, push buttons, solar cell), thus avoiding the need for additional cabling routed back to the controller cabinet.

Where Plus+ Nodes have a safety function (Signal Heads, Nearside Display Units, Pedestrian Demand Units and Wait Indicators), they are designed to be inherently safe to prevent situations that could endanger traffic or pedestrians in the event of communications disruption or internal component failure. The Nodes are designed so that they cannot give a false 'proceed' indication under fault conditions.

Specifically, these safety Traffic Signal Nodes are named the 'RAG Node' (Signal Heads and Farside Pedestrian Signals), 'Nearside Node' (Nearside Display enclosure) and 'Wait/PDU Node' (Pedestrian Demand Unit and Wait Indicator enclosure), according to their installation location and function.

2.1 Plus+ System Components: An Overview

2.1.1 ST950 CPU Card

The CPU Card performs all high-level control functions for the junction and communicates with the peripheral I/O cards and CIC cards using high speed serial communication protocols. The physical interfaces are the same as those used in the existing ST950 family of controllers.

The ST950 family use an updated I/O card protocol which improves system performance and adds functionality. This protocol is known as GSPI - Generic Serial Peripheral Interface. Typically, the need to use I/O cards in a Plus+ system is much reduced because most I/O functionality is performed by the Nodes directly. However, where I/O cards are required these may be fitted in the cabinet. ST950 compatible I/O cards are easily recognized by the text 'I/O CARD 667/1/32990/95x' printed on the board cover.

Reference Section 3.12 and 3.13 for further information.

2.1.2 CIC (Cabinet Interface Card) and CTB (Cabinet Termination Board)

The Plus+ Cabinet Interface Card (CIC), along with its associated Cabinet Termination Backplane (CTB), provides for connection and communications to the remote street equipment. It also provides for the control and monitoring of system power.

The CIC interfaces with, and is ultimately controlled by, the ST950 CPU PCB.

The CIC, fitted to its associated CTB, is situated within the controller cabinet in a similar fashion to how the ST950 ELV controller mounts its Lamp Switch Card assemblies and are typically mounted on the side walls of the controller.

Up to three CICs may be fitted in the controller cabinet. For complex installations requiring a large number of street terminations an additional cabinet may be deployed, housing a maximum of three additional CICs.

Street wiring is terminated directly to the CTB via cage clamp terminal blocks. The CTB in turn routes its connected signals to the CIC via DIN standard connectors.

The CIC is fitted with a metallic cover to provide a degree of protection from accidental contact. However, there are no hazardous voltages present on the PCB.

Key Features:

- Provision for 3-off rings or 6 arms
- Input for up to 3-off 48V DC Power supplies
- 48V PSU monitoring inputs
- Relays for isolation of the 48V supply to the 3 rings/arms
- Relay monitoring for functional test and Power bank overcurrent
- Mosfets for the disconnection of the 48V supply to the 12 passive safety arms **(not currently used)**
- GSPI and SPB bus interfaces
- I2C interface for Aspect Mimics
- Zero crossing interface

- CPUA and CPUB microprocessors
- EEPROM / FRAM for inventory, identification and fault information
- Lightning protection for the RS485 ring/arm interfaces
- Diagnostic LEDs

Reference section 3.16 for further information.

2.1.3 Nodes and Bypass Module

An example of a Node is the RAG Node. This is typically fitted inside the green aspect of the Helios signal. It operates as a fail-safe unit which ensures that the LED signals are guaranteed to be off in the event of any malfunction.

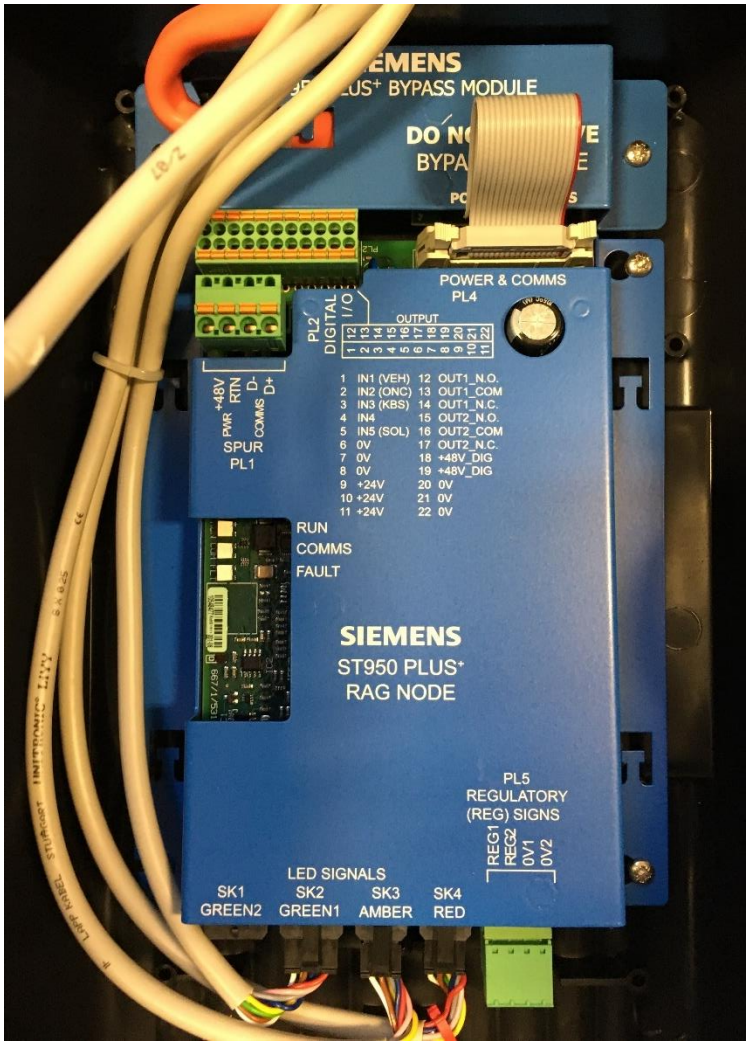


Figure 3 : Bypass Module and RAG Node

The RAG Node is provided with a cover to give some mechanical protection and has several status LEDs. which indicate the operational status of the Node. The RAG Node PCB is conformally coated to provide additional protection and improve reliability.

A Bypass Module is included which plugs into the RAG Node. The Bypass Module allows for the continuation of the Plus+ communications and operation even if a RAG node has been disconnected (PL4) for example in the case of a 'hot' swap. The Bypass Module also provides addressing functions in order to assist the controller in the management of Nodes.

Controller Monitoring

The controller monitors the status of all nodes and if any phase loses all signals (equivalent to the failure of an aspect drive in a conventional controller), the controller will register a compliance failure and extinguish all signals on controller, or the affected stream if configured.

Impact of Bypass Removal

The bypass module must **NOT** be removed and/or swapped from a RAG assembly without consulting the Technical Support team in the first instance.

The RAG Node provides:

- Drive and monitoring circuits for up to 4 Plus+ LED signals (Red, Amber, Green and a separate green arrow),
- Drive and monitoring circuits for up to 2 Plus+ Regulatory Signs,
- An above ground detector power supply providing 24V DV (@0.5A),
- Four TOPAS 2523 compliant digital inputs with an additional one which is configured to be used as a solar cell input.

Two TOPAS 2523 compliant digital outputs which may be used for linking or other similar functions.

Reference section 4.2 for more details.

48V is Not Lamp Supply

The 48V supplies to the Nodes may remain on even if fault conditions require the Signals to be switched OFF. The 48V supply that is distributed through the network is not considered a 'Lamp Supply' and this is a fundamental difference between Plus+ and 'conventional' traffic controllers. The Nodes guarantee the signals are off as requested, even though there is 48V to the Nodes.

2.1.4 Smartloop Modules

The Smartloop unit is a combination of a node and an SLD4.

The combination of these devices, developed as a single PCB, is housed in a plastic enclosure and then fully potted. The Smartloop device can then be connected to the Plus+ network and provide an interface for inductive traffic detection loops. This implementation continues the principle of minimising the amount of street cables routed back to the controller.

The Smartloop provides:

- Connections for up to four inductive loops.
- Permanently active LED indicator of detection state
- Connections to allow further Smartloops to be connected downstream.
- Bluetooth interface for configuration.

Note that:

- Both loops of an SDE/SA or U/D pair must be assigned to the same Smartloop device.
- N+1 count inputs are not currently supported by Smartloop and must continue to use standard loop detector cards (e.g. SLD4).

2.2 The Principles of Plus+ Wiring

2.2.1 Voltage Drop in Plus+ Network

The IET regulations have defined values for voltage drop within a network to ensure that any equipment connected to that network is maintained within its likely operating range. Within a traffic control signals network the rule of thumb of 4% does not necessarily apply directly, as signals have their own operating range and requirements. The applicable design and maintenance limits are defined in our design and equipment handbooks for our signals, (Note signals supplied by third parties may have different operating characteristics and ranges and the design and maintenance limits for those should be obtained from the OEM).

For Plus+ the complex design calculations have been built into our Plus+ junction layout design tool. The equipment will then inform users / maintainers if the supply as seen at any pole / node is outside to the normal operating range for a period.

2.2.2 Wiring

The Plus+ system elements are wired up by a collection of 4-way street cables (armoured) and 6-way (dropper) cables. The diagram below outlines the principles behind the wiring particularly with regards to cable types and colours.

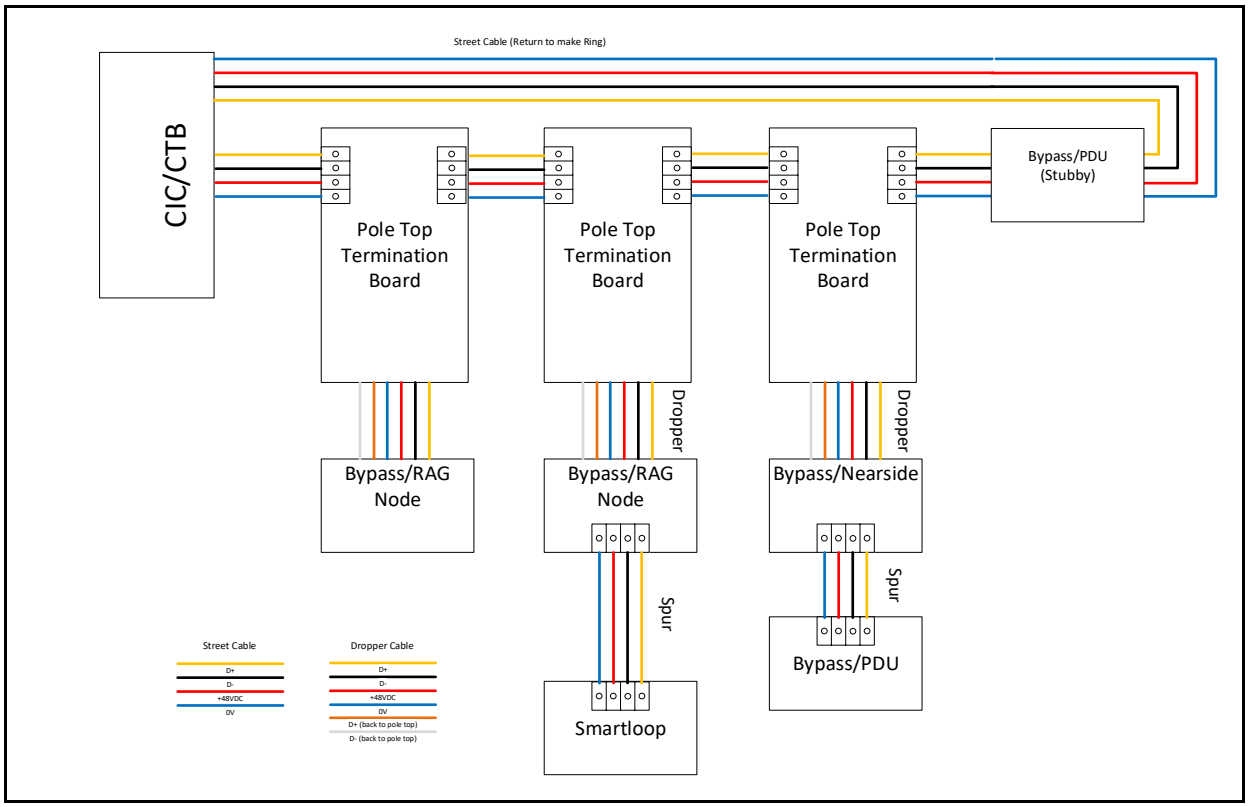


Figure 4 : Principles of Plus+ Wiring

The 'street' cable is a 2-pair armoured cable. Red and Blue as designated for supply(+48VDC) and the Yellow and Black are data connections (D+ and D-) respectively.

Connections between the pole top and nodes (RAG or Ped devices) use a six-way dropper cable.

Colour designation is as above with the additional Orange and White (D+ and D- respectively) used to maintain a data loop from nodes back to the Pole Top Board.

2.2.3 Stub Pole Wiring

The same principles also apply for the Stub Pole. This is treated much like a normal pole whereas the difference will be that there is no Pole Top Board (PTB). Rather, the street cables are terminated at the Pedestrian Equipment terminal block and the armouring are terminated using two CT glands, within the stub pole. There will be an earth link between the two CT glands and a second earth link that is either terminated on the pole earth stud or then passed through to the Pedestrian Demand Equipment.

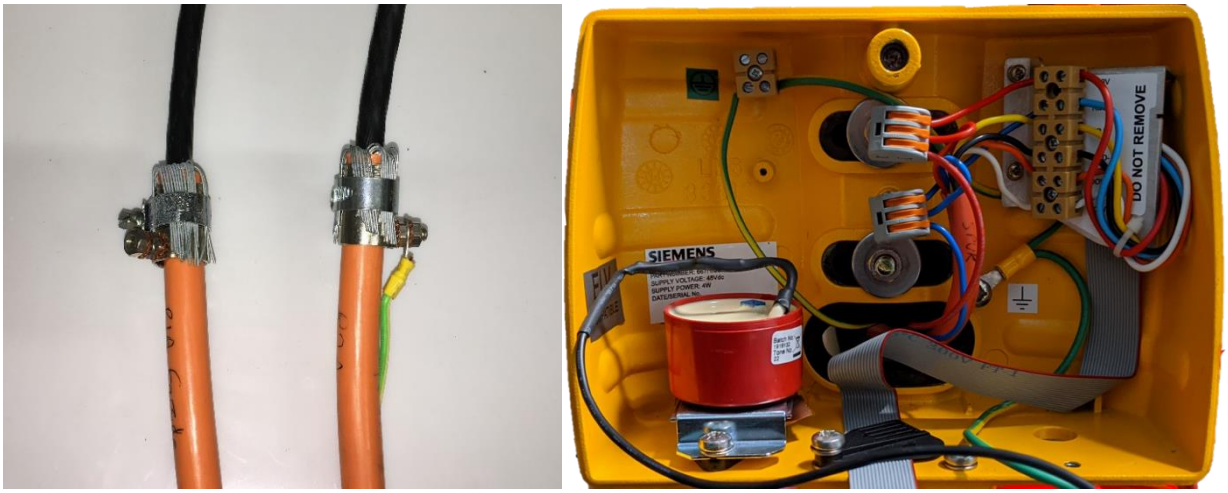


Figure 5 : Stub Pole Wiring Arrangements

2.2.4 Smartloop Wiring Options

The Smartloop can be wired in a number of different arrangements depending on the design/topology. The following diagrams are examples of possible installation configurations.

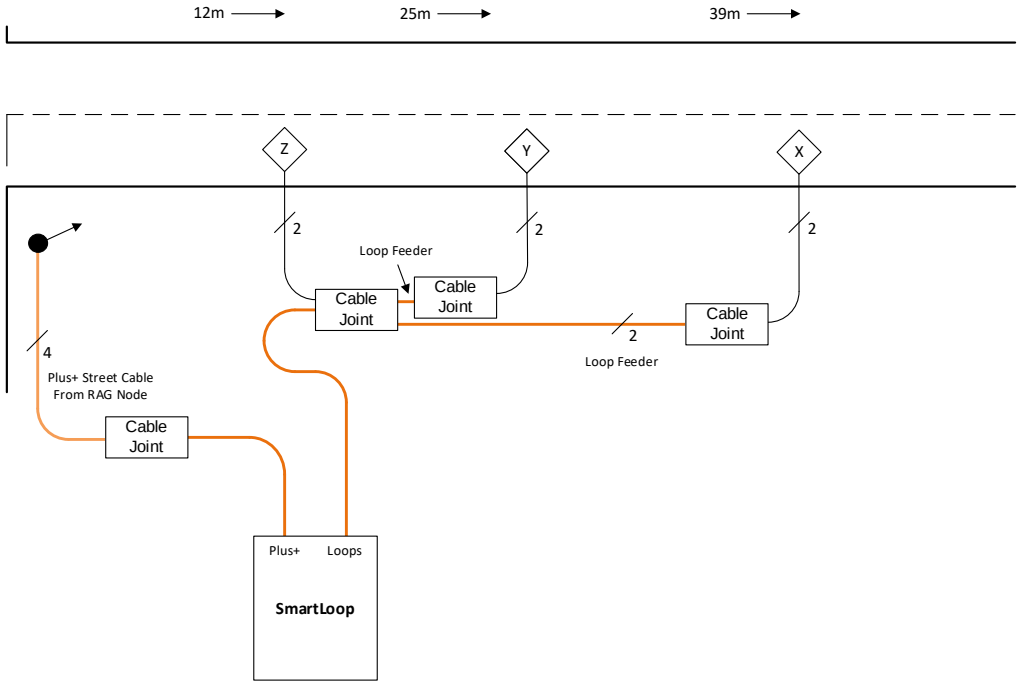


Figure 6 : Smartloop Layout Example 1 : VA

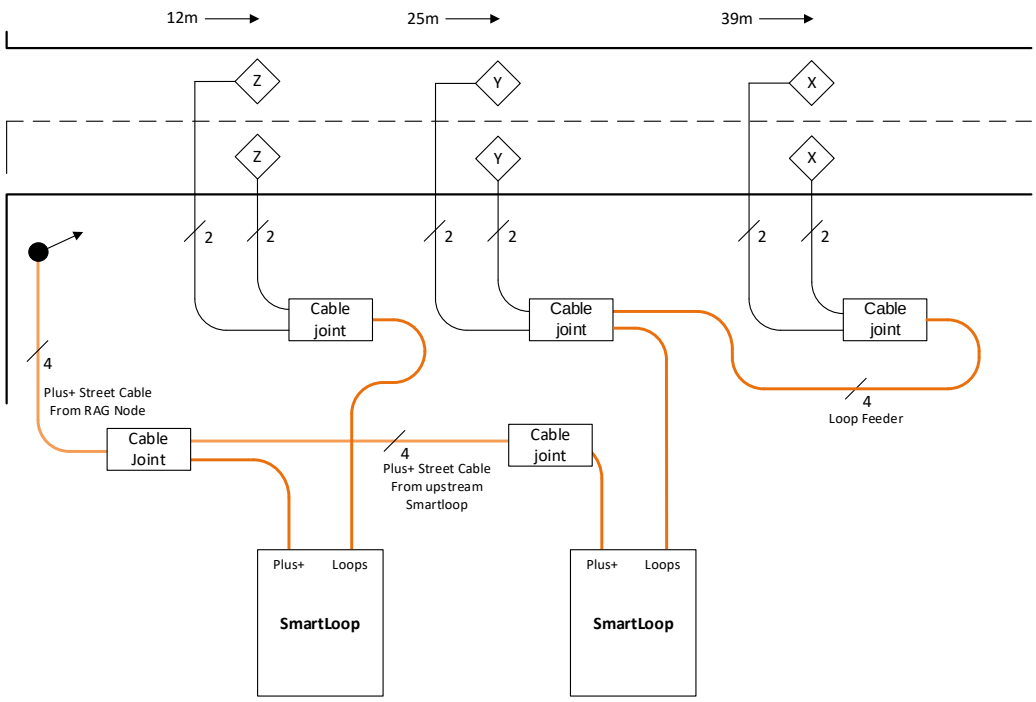


Figure 7 : Smartloop Layout Example 2 : VA

Note: Unlike other Plus+ Nodes the Smartloop has no Bypass Module. In the unlikely event of the failure of a Smartloop unit, then communications will also be lost to further Smartloops connected downstream. Smartloops are connected to the Plus+ network via the Spur Connection (PL1) of a Plus+ RAG Node, and so failure of the RAG Node that provides the Spur connection also results in the failure to communicate with all the devices on that Spur.

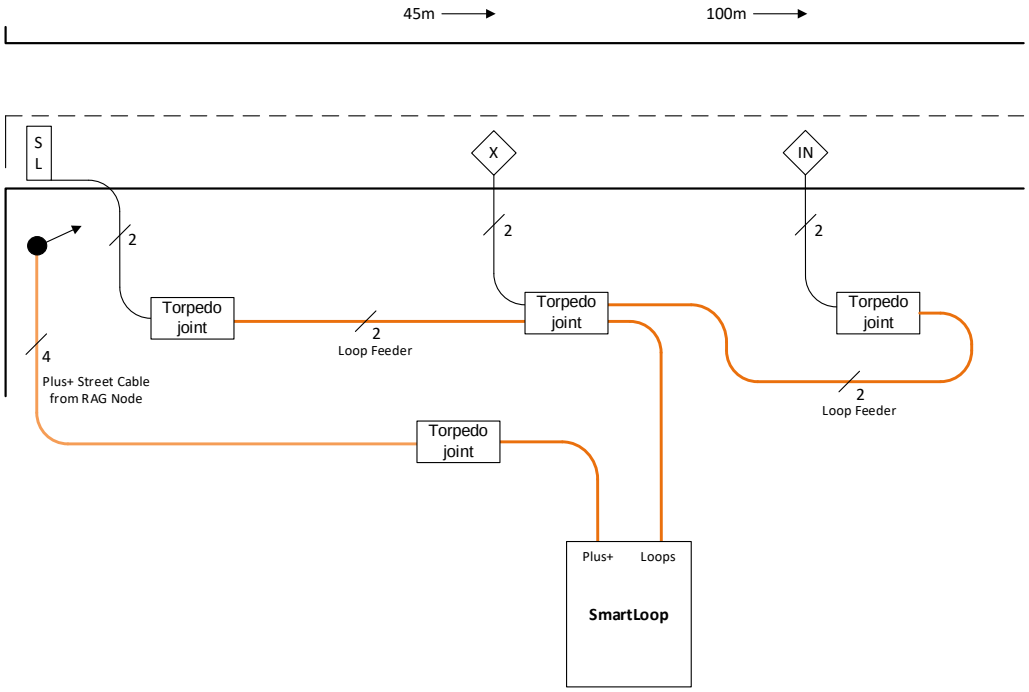


Figure 8 : Smartloop Layout Example 3 : MOVA

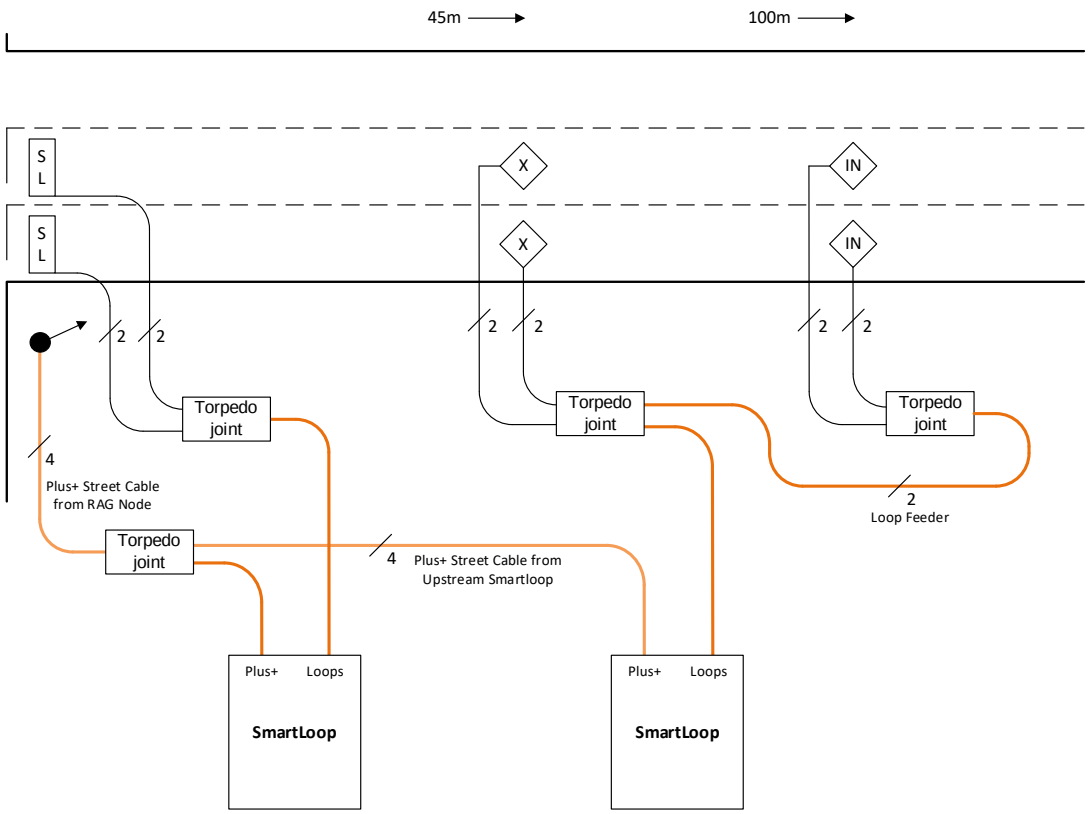


Figure 9 : Smartloop Layout Example 4 : MOVA

2.3 Configuration

One of the fundamental changes, that has been brought about by Plus+, is that there no longer is a 1:1 link between outputs from a controller lamp switch card and the individual aspects. This link is now achieved out on-street, between the Node and the aspect, push button or pedestrian display unit.

In order to 'link' the functional design (IC4) and the on-street equipment a new layer of configuration is required. It is known as the Plus+ Design Layout Configuration.

For Plus+, the IC4 configuration is fundamentally unchanged, where the traffic junction configuration (operation) is defined, terms of streams, phases, lamp monitoring and detector inputs.

The Plus+ Design Layout Configuration now provides the link between the IC4 configuration and the junction layout as designed – as opposed to wiring in a Lamp Switch Card.

Siemens Mobility has developed the Plus+ Design Layout Tool, which works hand in hand with KeySignals (KeySoft product). KeySignals provides a toolset for Traffic Engineers to design their junctions within the AutoCAD product suit.

The Plus+ Design Layout Tool exposes the features, within KeySignals, such as Traffic Phases and Detection naming, that is referenced by the controller when defined by IC4.

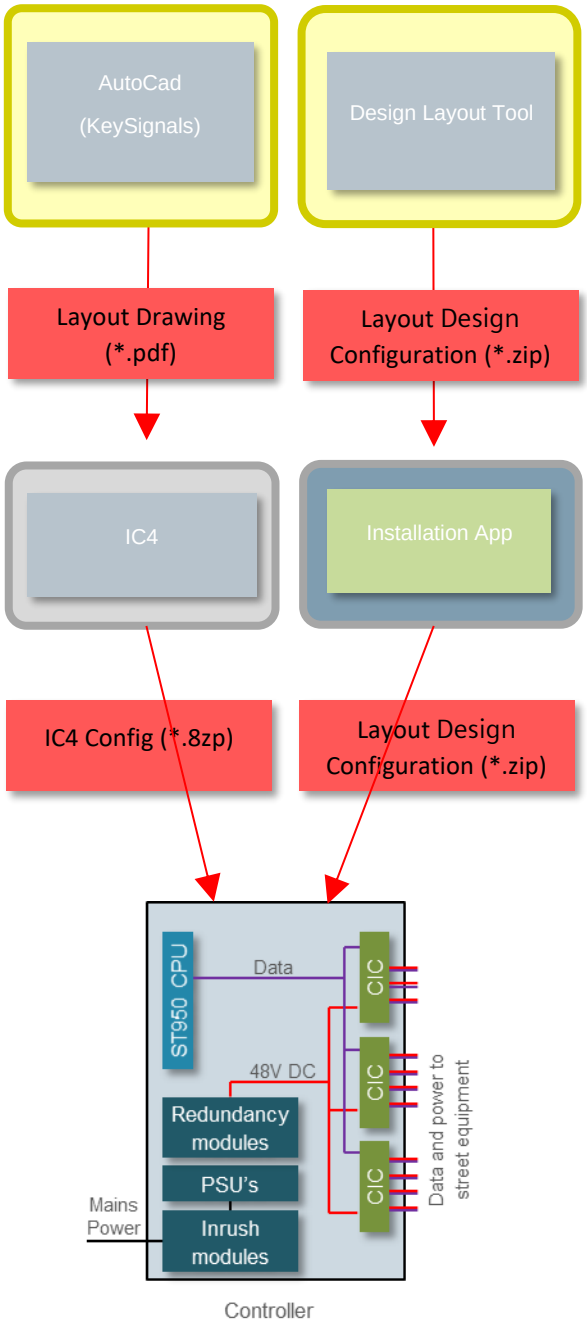


Figure 10 : Plus+ Design Layout Configuration and IC4 Configuration

To facilitate the layout design, the Plus+ Design Layout Tool enforces several design decisions and checks. For example, calculating the number of CICs, 48V PSUs and redundancy modules required based on the equipment loading.

Plus+ STS drawing

On completion of a Traffic Junction Design (STS Drawing) the Plus+ Design Layout Tool will be used to generate the Plus+ Design Layout Configuration. This configuration can either be imported directly to a controller or passed to the Plus+ Installation App.

The STS drawing contains all the pertinent information for on- street cable connections and should be referred to accordingly.

When a Traffic Junction is being built up, within a depot or out on street, the Plus+ Installation App provides an easy method (scanning) to populate the Plus+ Design Layout Configuration with the serial numbers of the relevant Nodes.

It is this mapping between Nodes, having a defined function, and the serial number of the physical Node that is going to implement the function that ensures the configuration from IC4 is implemented in the controller when on street.

Further information on using the Plus+ Design Layout Tool can be found in the Plus+ Design Layout Tool Quick Start Guide 667/HQ/53000/200.

Further information on using the Plus+ Installation App can be found in the Plus+ Installation App Quick Start Guide 667/HQ/53000/300.

2.4 Plus+ : Key Considerations

2.4.1 Reserve State

The reserve state, in Plus+, is slightly different from the standard ST950 controller.

- Ped Phases are no longer inhibited
- The user can now add and should include Ped stages in the Fixed Time sequence.
- Audible devices all switched off
- Tactile devices continue to operate, but ignore tactile disable from S/C using SCTACDIS
- I/O still unavailable so Wait / Demand Indicators illuminate and on-crossing clearance periods run to max.

Note that the IC4 defaults for Reserve State have not been changed for Plus+ Controllers, so:

- junctions with RLM configured to extinguish streams (typically part-time junctions) are still extinguished by default
- stand-alone pedestrian crossings are held at vehicle green / pedestrian red.

2.4.2 Red Lamp Monitoring

When the IC4 configuration is being compiled the user may see a warning message: "*For Plus+ Controllers it is recommended that RLM RLF1/RLF2 actions are NOT latched until manually reset (RFL=1) unless there are valid traffic engineering reasons.*"

This warning occurs when, in the LMU General screen, a customer has “RLF2 only cleared by RFL=1” ticked on this screen.

This warning has been added because the Plus+ Controller may trigger RLM faults during some power and/or communications scenarios. It has been designed so it shouldn't do this during 'normal' power breaks. However, if some Reds Signals/Nodes are temporarily missing, the Controller will take the configured RLM actions, so RLM faults are triggered. But by avoiding the latching those faults will clear automatically and signals to resume normal operations should those Nodes/Signals reappear.

3 ST950 PLUS+ CONTROLLER CABINET

This section details the main elements, of the ST950 Plus+ system, that are held within the controller cabinet.

3.1 The Primary Plus+ Controller Cabinet

Figure 12 and Figure 13 below show the ST950 Plus+ controller CPU card fitted in a standard ST950 Controller Cabinet.

The Master Switch Panel and two CIC cards are all installed on the right-hand side panel of the cabinet.

The 24V PSU, the 48V PSUs along with the redundancy modules, collectively known as the Power Bank, a third CIC card and some other miscellaneous equipment are installed on the left hand side panel of the cabinet. The 48V PSUs for a third CIC are mounted on the bottom of the rear panel.

The 19" Controller Rack is installed in an equipment swing 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.

The ST950 Plus+ controller cabinet is normally supplied on an appropriate pallet. Transport of the cabinet can be via Pallet truck or using recyclable wheels.

Cabinet Stool

The ST950 Plus+ controller cabinet is **not** provided with the Cabinet Stool. Several stool types may be used with ST950 Plus+ cabinet and must be ordered as a separate item. Reference section 6.4 for details.

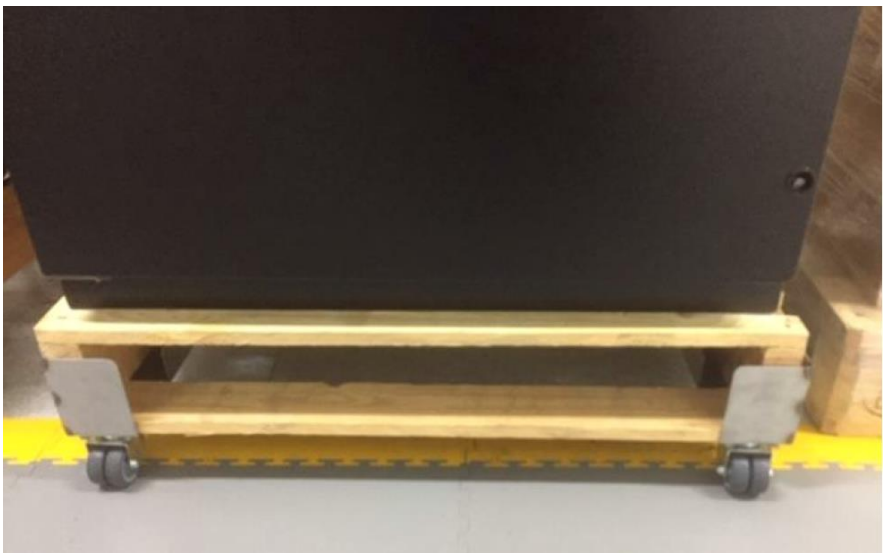


Figure 11 : ST950 Plus+ Cabinet and Recyclable Wheels

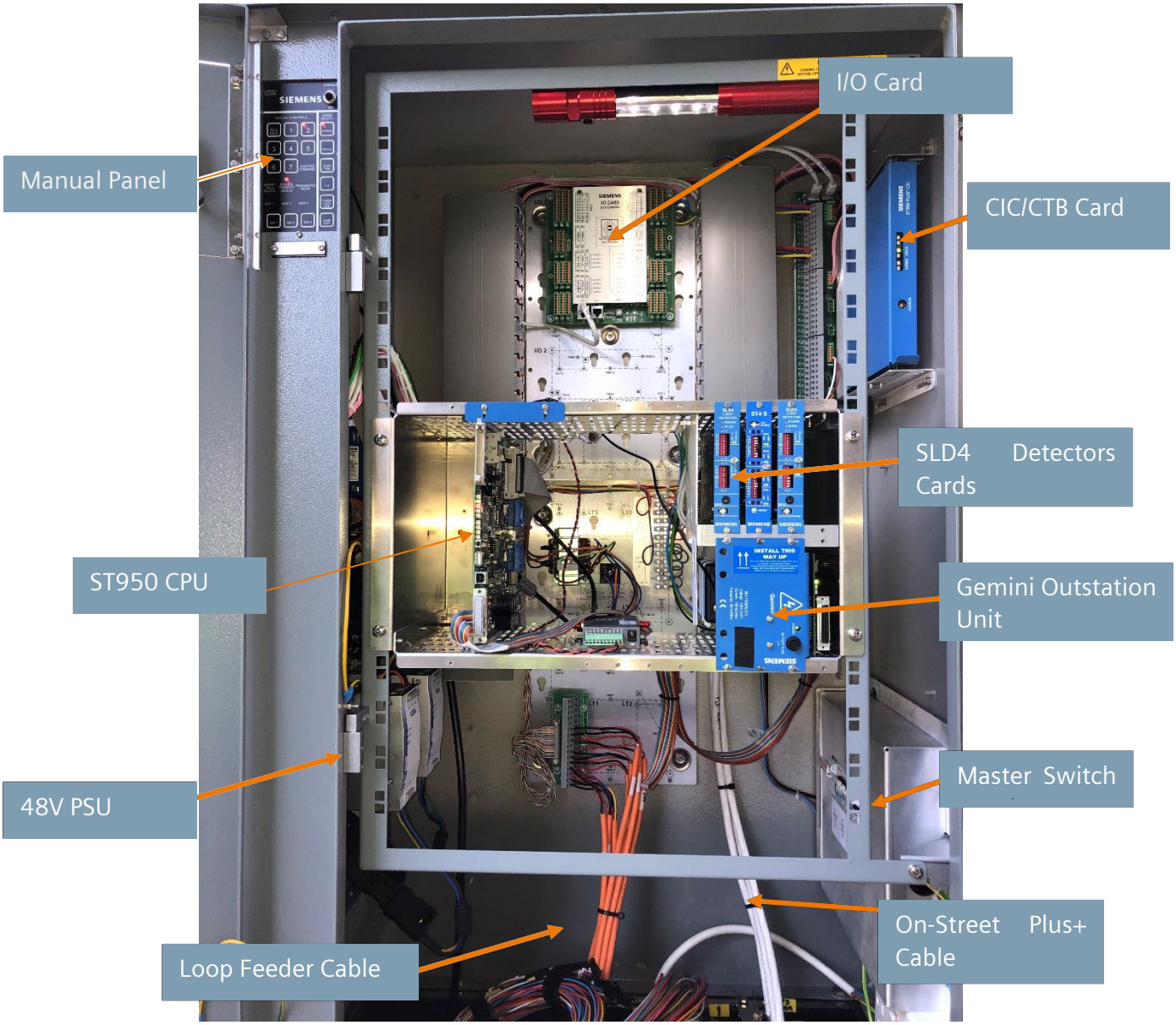


Figure 12 : ST950 Plus+ Cabinet

3.2 The Controller Rack

Figure 13, below, shows the ST950 Plus+ controller in a 6U 19" rack. The 19" Controller Rack is sub-divided into one 6U-high bay and two 3U-high bays. The 6U bay is fitted with the CPU Card.

The arrangement of the rear panel and the rack allows for a number of I/O card or detector options to be provided:

- 24in 16out rear-panel mounted I/O module - 667/1/46085/001
- 24in 4out rear-panel mounted I/O 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

Where standard loop detectors are required to be installed in the cabinet, the two 3U-high bays can be fitted with up to two Intelligent Detector Backplanes and the middle 6U section can be converted to mount a further two IDBs, thereby supporting a total of 16 Loop Detector cards[4] (each IDB supports up to 4 Loop Detector cards and each Loop Detector card supports up to 4 loops).

If required, a Stratos Outstation unit may be fitted in the bottom right bay, as shown in Figure 13.

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

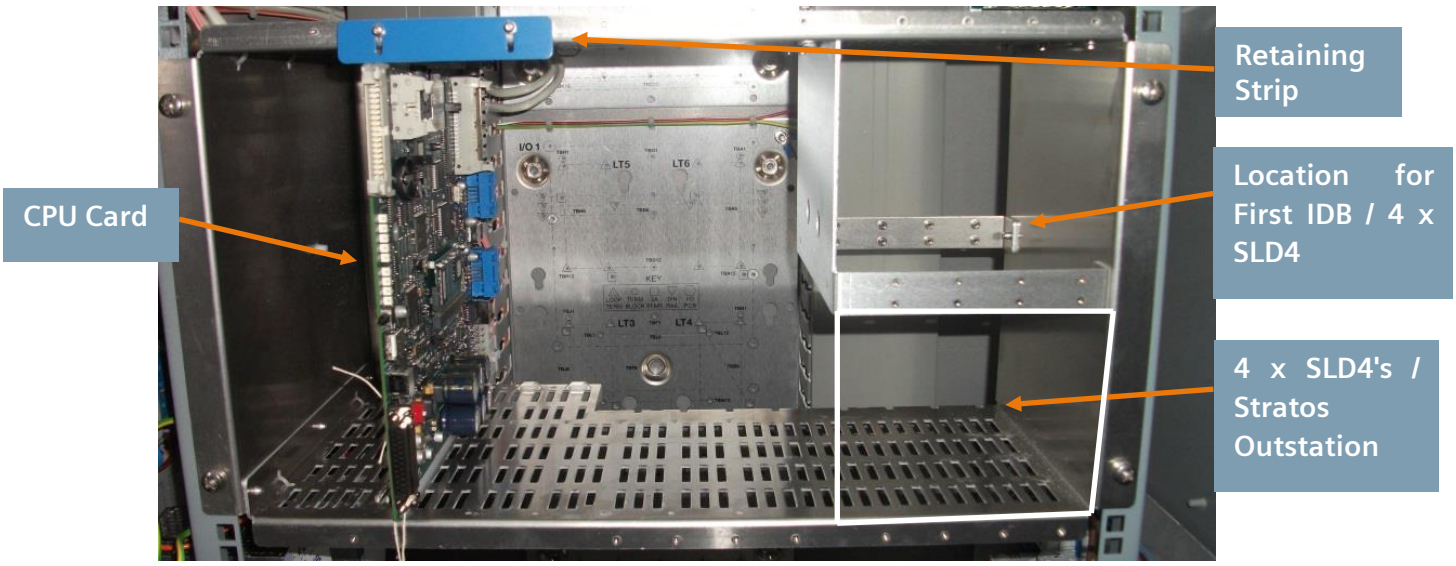


Figure 13 – ST950 Plus+ 19" Rack - Front

[4] Depending on loading. Reference section 3.14 for details.

3.3 Cabinet Stool Options

As standard the Plus+ cabinet is not supplied with a stool pre-assembled. Instead the customer may select from a number of stool options namely; ST950 Plus+ Stool, standard Siemens Stool or NAL stool. Please refer to Section 6.4 for more information.

Stool Type	Part Number
ST950 Plus+ Cabinet Stool + Base Seal Assy Grey	667/1/53060/000
ST950 Plus+ Cabinet Stool + Base Seal Assy Black	667/1/53060/100
ST800 STOOL GREY RAL 7004	667/2/27096/210
ST800 STOOL Black	667/2/27096/200
NAL Cabinet Base – ST800/ST900/950-GREY	667/7/46690/000
NAL Cabinet Base – ST800/ST900/950-BLACK	667/7/46690/001
Cabinet Pallet	667/2/53099/000

3.4 Master Switch Panel

The **Master Switch Unit**, which comprises the switch gear and some monitoring elements, for all the incoming mains and the Power Bank. The Power Bank is comprised of the 48VPSUs and Redundancy Module(s).

There are two variants of the Master Switch Panel, in order to suit a standard or a Hi-load build configuration.

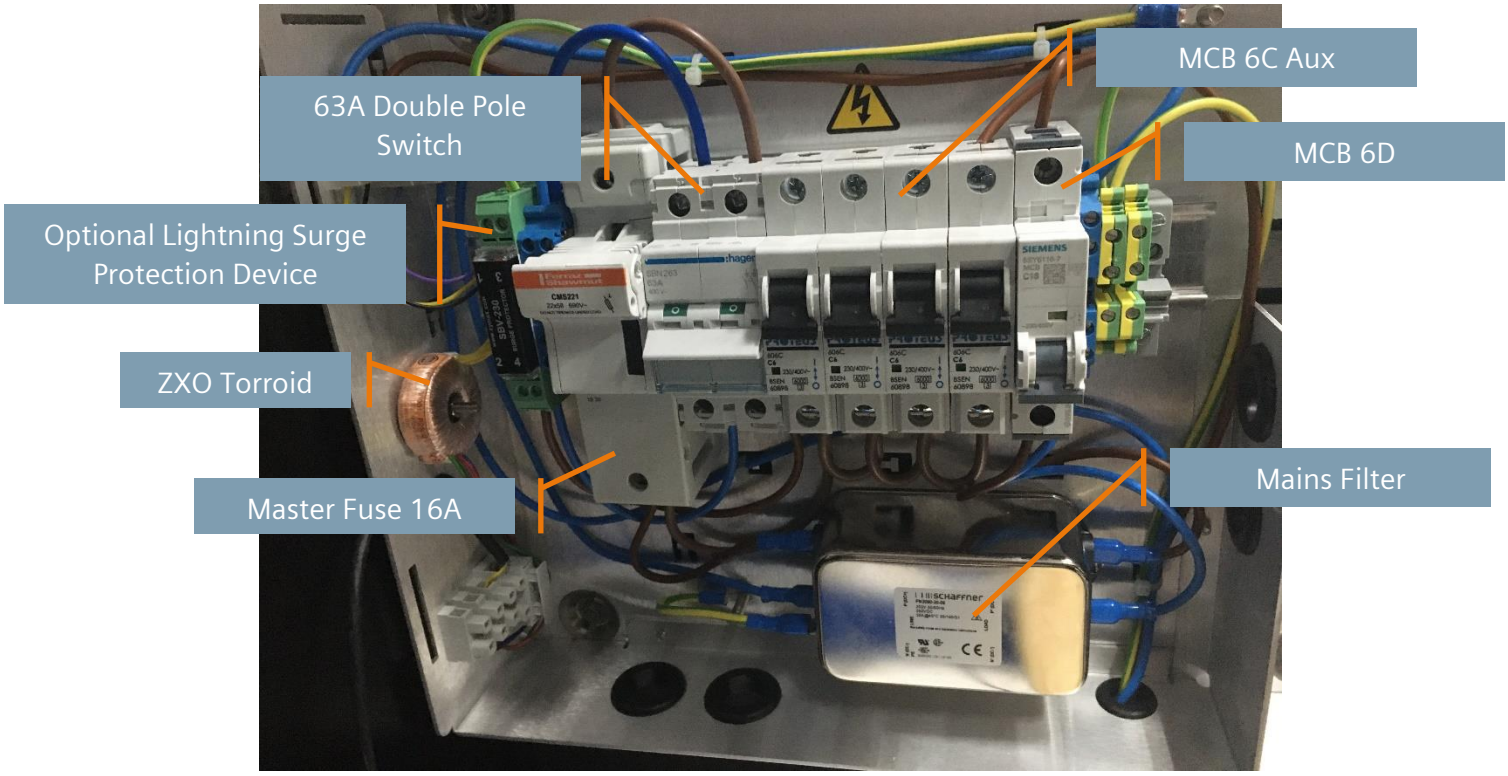


Figure 14 : Master Switch Unit – Standard

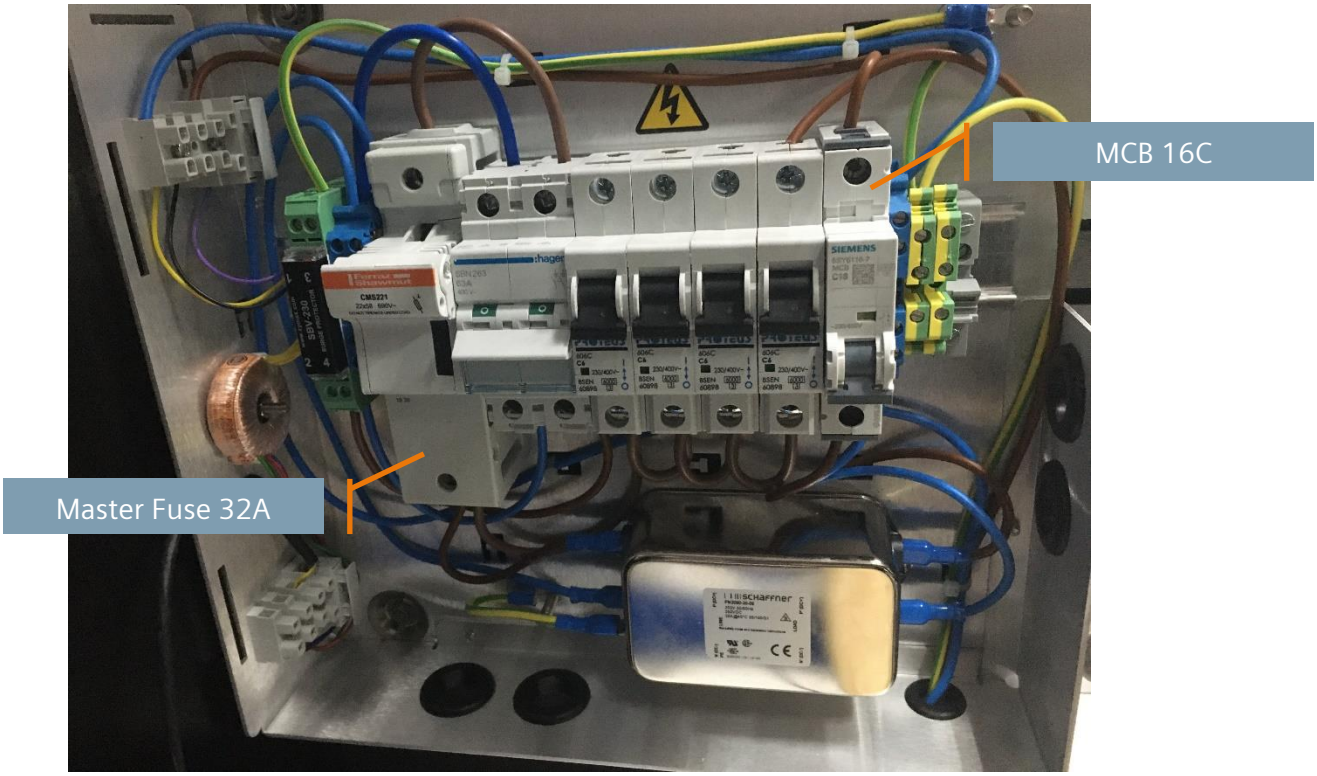


Figure 15 : Master Switch Unit – Hi-Load

The selection of Standard or Hi-Load will depend on the controller loading. However, the selection of the MSP is automatically made by the Plus+ Design Layout Tool. For information the decision is based on Table 1 below.

Number of CICs	Number of PSUs	MSP type	Cabinet power (max)	Total junction power (max)[5]	Number of passive safety outputs in Junction (max)
1	2	Standard	0.6kW	0.6kW	12
1	3	Standard	1kW	1kW	12
2	4	Standard	1kW	1kW	24
2	5	Hi-Load	1.4kW	1.4kW	24
2	6	Hi-Load	1.7kW	1.7kW	24
3	6	Hi-Load	1.7kW	1.7kW	36

Table 1 : MSP Selection Criterion

[5] Excluding Aux equipment

3.5 24V PSU

The 24V PSU is a DIN rail mounted 100W device. The 24V PSU is used to provide the supply for the ST950 CPU and the logic supply for the CIC(s). In addition, the 24VPSU is used to provide power to auxiliary equipment such as I/O cards, including the IDB.

The 24V PSU has 1A spare capacity[6] and is rated such that it can provide sufficient power for the following:

Number of I/O Cards	Number of SLD4[7]	Number of WiMag Loop Detector Replacement cards[8]
1	24	0
1	12	2

Table 2 : 24V PSU Capacity for Aux Equipment

3.5.1 Parts

Replacement 24V PSU 605/4/08717/000

3.6 48V PSU

The 48V (480W) DIN rail mounted PSUs distribute the 48V supply to the Nodes via a redundancy module and subsequently the CIC/CTB PCBs.

Figure 16 : 48V 480W Node PSU

[6] Spare capacity is calculated after considering 3 CIC, CPU, 1 I/O.
[7] With IDB
[8] With 1 Access Point.

In order to ensure high reliability, the Plus+ system includes power supply redundancy, see below, so that failure of one 48V PSU will not extinguish the signals, improving the availability of the Traffic Signals. An additional advantage is that the 48V PSU can, individually, be swapped out without impacting junction running.

3.6.1 Parts

48V PSU including Main Kit 667/1/53057/000

3.7 Redundancy Module

3.7.1 Overview

The redundancy module is designed to be connected to two or three incoming 48V DC power supplies, combining their power to produce a single 48V DC supply output for connection to a single CIC/CTB. The module provides PSU redundancy by ensuring that if a PSU fails, the output is maintained by the other supplies. The Redundancy Module combined with the 48V PSUs are collectively known as the Power Bank.

The module provides load balancing to ensure that each connected supply provides an equal share of power to the system, which maximises reliability. The selection as to whether two or three PSUs are required for each CIC/CTB is managed by the Design Layout Tool. Each CIC/CTB is connected to its own redundancy module.

LEDs on the redundancy module indicate the state of each of the incoming supplies. The supply status information is also provided, via analogue signals to the connected CIC/CTB for the purpose of monitoring and fault detection.

3.7.2 Redundancy Module Connections

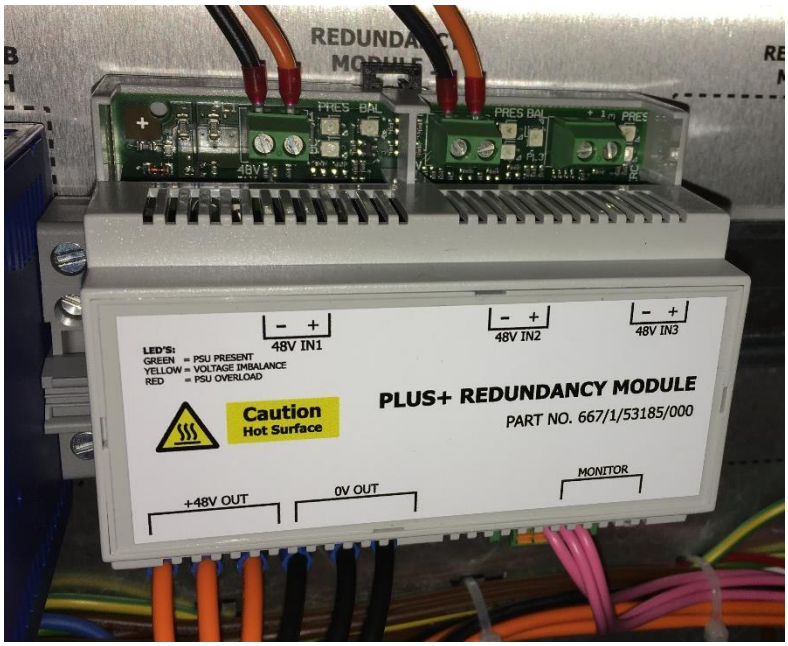


Figure 17 : Redundancy Module Wiring

The incoming 48V DC PSUs connect to the Input terminal block. The outgoing connections to the CIC/CTB, made via spade terminals, connect to the +48V OUT and 0V OUT terminals. At the CTB the orange wires are connected to the PWR BNK1 IN, PWR BNK2 IN and PWR BNK3 IN terminals. The Black wires are connected to the GND terminals.

The Monitor connection connects to PL3 of the CTB and provides status to the CIC indicating whether the connected PSUs are Present, Imbalanced or Overloaded.

3.7.3 Configuration

The Redundancy module provides no user configurable options or controls.

3.7.4 Fault Indication

LEDs on the module indicate the health of the connected PSUs.

Led Indicator	Function		Meaning
Green x 3	Presence	On	Energised PSU is connected.
Yellow 1	Imbalance LED	On[9]	Voltage Imbalance between PSU 1 and 2
Yellow 2	Imbalance LED	On[10]	Voltage Imbalance between PSU 2 and 3
Red x 3	Overload	On	Too much current is being drawn from a PSU[11]

Table 3 – I/O Card LEDs

PSUs are factory adjusted and should not give a voltage imbalance. If it occurs, solving an Imbalance issue involves the careful adjustment of the connected PSUs. Please contact Siemens Engineering in Poole for assistance before attempting any adjustment.

Should an Overload LED become illuminated the likely causes are incorrect street wiring from the CTB or a badly installed traffic system i.e. too many nodes connected to a particular power source.

As well as the LED indication the controller will also record the above faults in the fault table.

3.7.5 Parts

Redundancy Module 667/1/53185/000

[9] Solving an Imbalance issue involves the careful adjustment of the connected PSUs. Please contact Siemens Engineering in Poole for assistance before attempting any adjustment.

[10] Flickering - lightly loaded systems may show one or more flickering Imbalance LEDs this is not a fault.

[11] A severe voltage imbalance could lead to an overload on one PSU. An overload indication provides early warning of a possible PSU shutdown: the PSU will self-protect if the overload becomes significant.

3.8 ST950 Plus+ CPU Card

The CPU card for Plus+ is common with that used for LV and ELV versions of the ST950. There are two variants of the CPU card which differ only in the amount of RAM available on the EFC module. For Plus+, only the 128M RAM variant is appropriate.

3.8.1 General

The CPU Card controls the system. It holds the controller configuration and performs the function of configuration, control and management. The primary external data interfaces are shown in Figure 19 and detailed in Table 4.

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

The RJ45 socket marked “LSLS” on the ST950 CPU Card is connected to the first position CTB.

The two GSPI interface RJ45 sockets are identical and both marked “SIO”. The first, marked GSPI 1 is connected to the first position CTB. The second can be used for other GSPI peripherals e.g. IO cards and/or Intelligent Detector Backplanes.

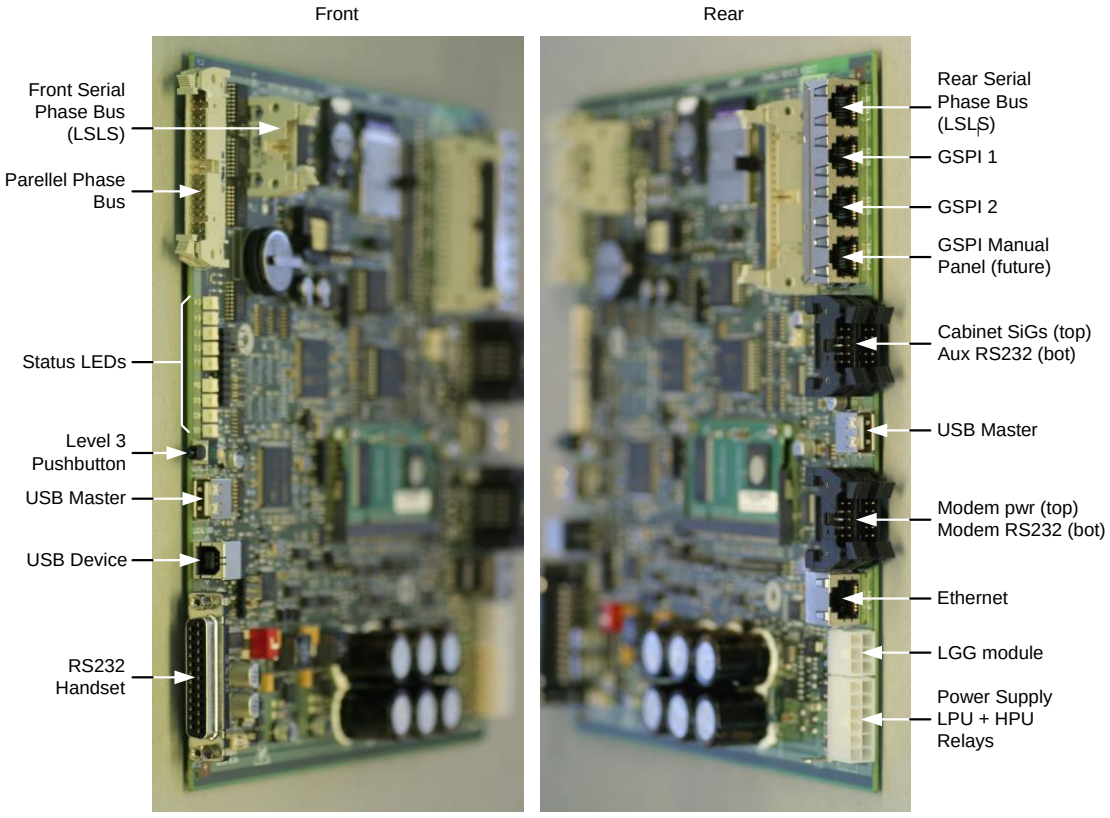


Figure 18 – ST950 Plus+ CPU Card (front and rear views)

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

The significant part positions, of the ST950 CPU Card are identified in Figure 19 below and detailed in Table 4.

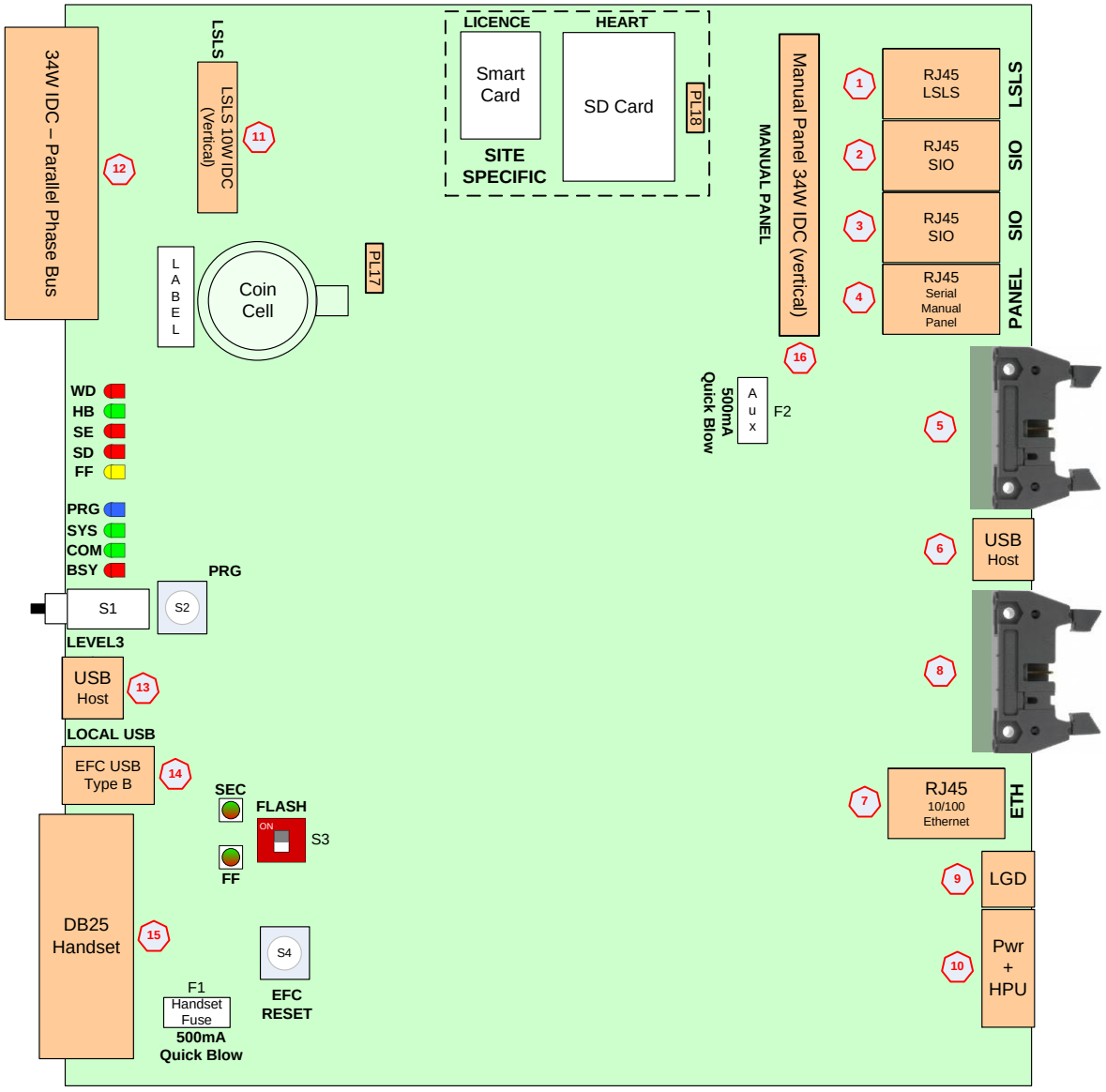


Figure 19 – ST950 CPU Card Layout

	Description	Connector
1	Serial Phase bus to CTB	RJ45
2	GSPI Bus to CTB	RJ45
3	GSPI Bus to I/O Cards (SIO) or other GSPI peripherals	RJ45
4	GSPI Manual Panel (PANEL) [Future Use]	RJ45
5	Cabinet Signals (Top) Auxiliary RS232 Connection (Bottom)	Double stacked 10 way IDC Refer to Table 2 for pinout
6	Rear USB Host Port	USB Type A
7	10/100 Ethernet (ETH)	RJ45
8	Modem Power / Ancillary I/O (Top) RS232 Modem Connection (Bottom)	Double stacked 10 way IDC Refer to Table 3 for pinout
9	Battery Backup module connector	6 way Molex Mini-Fit Jr.
10	Power Supply Connector (24VDC PSU)	12 way Molex Mini-Fit Jr.
11	Serial Phase bus (**not used for Plus+)**	10 way IDC
12	Parallel Phase Bus (**not used for Plus+**)	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 4 – Connector Functions and Types

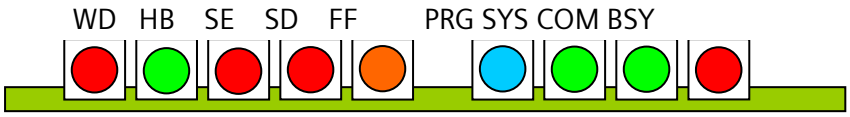
3.8.2 Processor Status LEDs

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. start-up

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) : not used for Plus+

Flashes when hardware fail flash is active.

PRG – Program (blue)

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

Single pulse	IC4 configuration available for programming
Double pulse	Firmware upgrade available Heart restore pending Wipe request pending
Fast flash	Programming in progress
Solid on	Programming complete, power cycle required

SYS – System (green)

Flashes to indicate status

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

COM – Communications (green)

On	Under UTC control, pulses off indicate receipt of messages

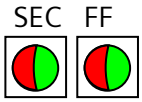
Off	Not under UTC control, pulses on indicate receipt of messages

BSY – Busy (red)

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

BEHIND HANDSET CONNECTOR

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



The function of each LED is described below.

SEC – SEC Status

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

FF – Fail Flash Status (not used for Plus+)

Green flash, equal on and off	Normal operation

3.8.3 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:

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

Location	Pin	Function
	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

Table 5 : Double Stacked 10W IDC – Top: Cabinet Signals Bottom: Aux RS232

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).

Location	Pin	Function
Top	1	Modem +5V DC fused output from MDU/LPU (not battery backed)
	2	Connected to pin 1 above
	3	Modem 0V DC output (+5V return)
	4	Connected to pin 3 above
	5	Isolated Shutdown O/P +
	6	Isolated Shutdown O/P -
	7	External supply monitor signal (digital)

Location	Pin	Function
	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

Table 6 : Double Stacked 10W IDC- Top: Modem Power + Monitors, Bottom: EFC Modem

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.

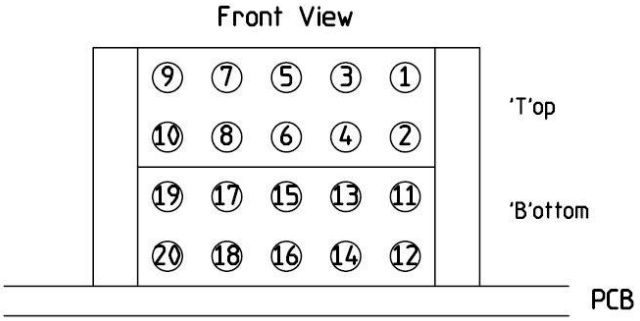
Isolated Shutdown Output (5,6) – These two pins provide an opto-isolated controller shutdown signal. The + signal is the collector and the – signal is the emitter of the opto-transistor. The output is active low (i.e. low impedance) when the controller is in the shutdown state. The maximum current that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

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

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

Bottom connector – Serial port for future use.

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



– Figure 20 - Double stacked connector pin numbering

3.8.4 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.

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.

3.8.5 Parts

ST950 Plus+ CPU Card (128M RAM) 667/1/46010/101

3.9 Fuses

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

Fuse Replacement

When replacing a fuse, it is important to fit the correct type for continued protection of the ST950 CPU Card and user's 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.

3.10 Heart of the Controller

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

Formatting the SD Card

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:

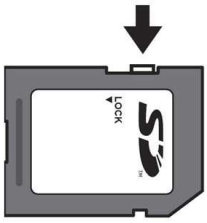


Figure 21 : SD card Write Enable switch position

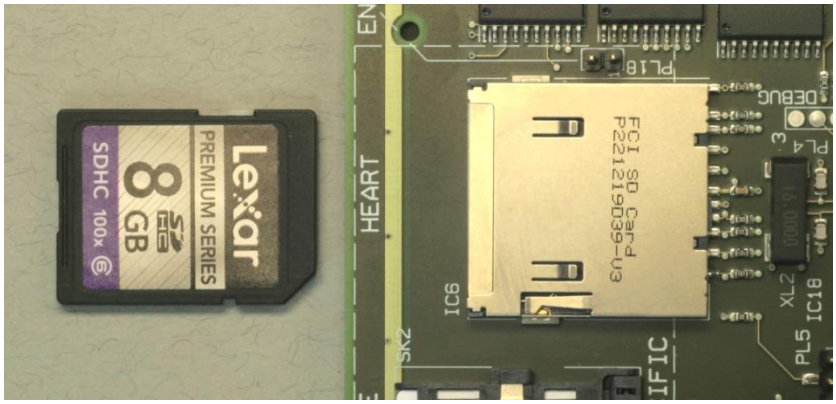
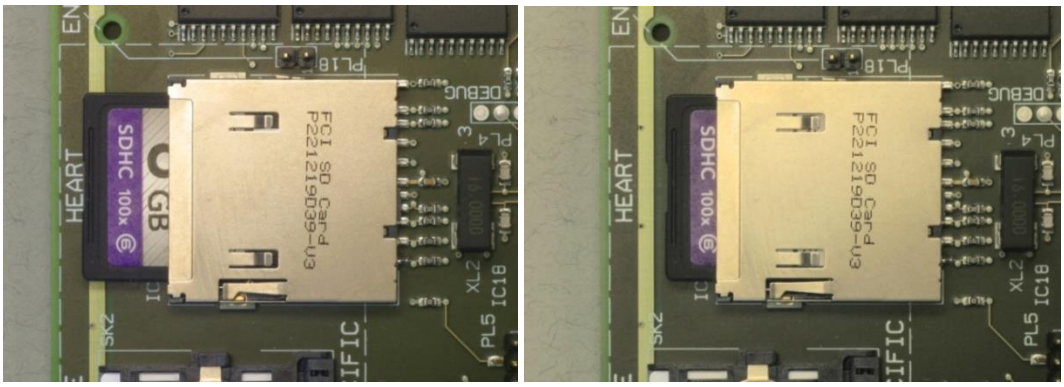


Figure 22 : SD Card Orientation



✗ SD card partially inserted - incorrect ✓ SD card fully inserted - correct

3.11Gemini3 (Stratos Outstation)

For information regarding the Gemini3 equipment, see:

667/HB/52250/000 - Stratos Outstation Handbook

3.12Panel Mounted I/O Cards

3.12.1 Overview

The need to use I/O cards in a Plus+ system is much reduced since most I/O functionality is performed by the Nodes directly. However, the standard ST950 I/O cards are supported for cases where centrally located I/O is required, for example to support a free standing OTU or MOVA unit.

The panel mounted I/O Cards 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.

3.12.2 Panel Mounted I/O Cards

The standard I/O card provides a rugged interface for up to 24 TOPAS 2523 compliant digital inputs and up to 16 TOPAS 2523 compliant changeover outputs.

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.

IO Card Fuse

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 may have been damaged and must be replaced.

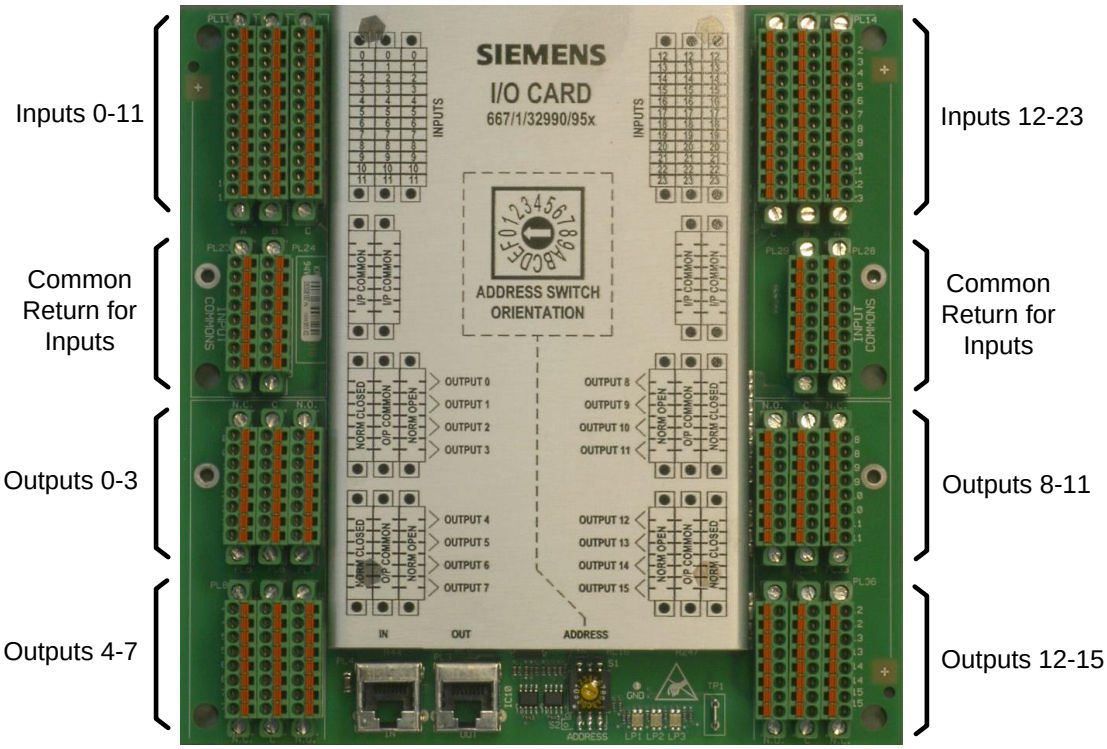
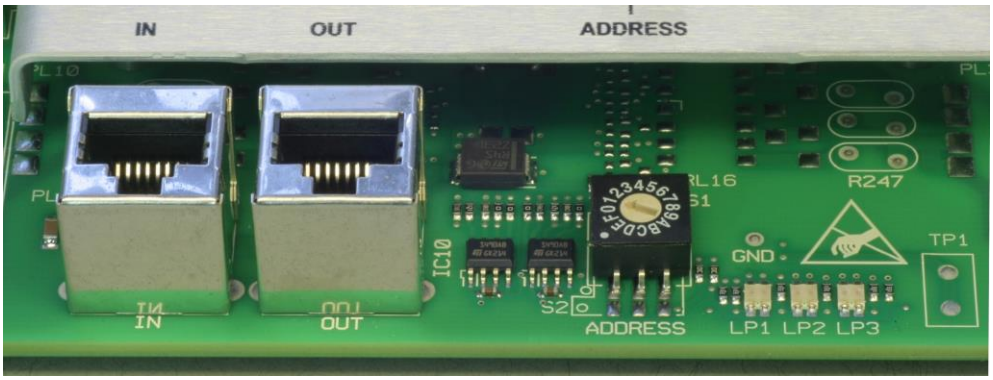


Figure 23 – I/O Card (Showing 16-output variant)



GSPI comms input from Processor Card or Previous IO card

GSPI comms output to next IO card

Address switch

Status LEDs

Figure 24 – I/O Card Address Switch and LEDs

3.12.3 I/O Card Status LEDs

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

Figure 24, which are used to indicate various conditions[12], 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[13]	Green Flash	Off	Communications Active
Off	Green / Red Alternating	Off	Invalid Address
(As above depending on state)	Red Flash	Off	Major Fault Detected

Table 7 – I/O Card LEDs

3.12.4 I/O Card Rotary Address Switch

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

Figure 24 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 9. Address 0 is the default address switch position for spare cards.

GSPI Address Range

The address range is shared with the Intelligent Detector Backplane cards and must be unique. The address range is limited to 1 to 9. Addresses 10 and above are used by the CTBs. Due to architecture of Plus+ this is not expected to be a practical limitation.

3.12.5 Parts

24in 16 out panel mounted module - 667/1/46085/001

24in 4 out panel mounted module - 667/1/46085/002

[12] Conditions other than those identified above should not occur and can be treated as faults.
[13] May flash so fast that it looks like Green Steady.

3.13CPU 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 TOPAS 2523 compliant. LEDs and GSPI ports are as described above for standard IO cards and the CPU IO card has a fixed address: 1.

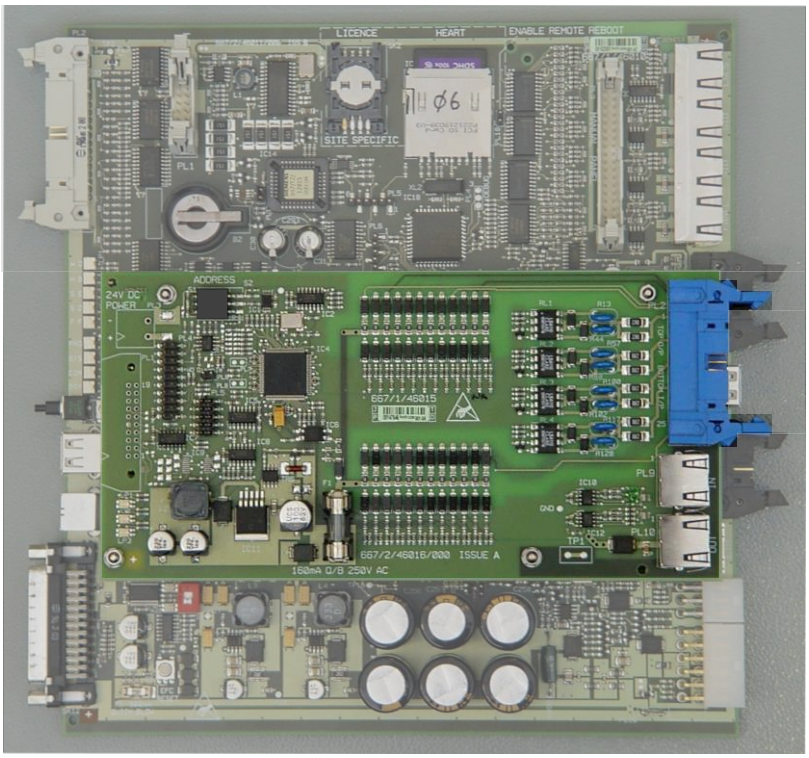


Figure 25 – CPU I/O Card

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 8 - CPU IO Card Connector Pin Out

3.13.1 Parts

ST950 CPU I/O kit 24in 4out - 667/1/46014/000

3.14Intelligent Detector Backplane Card

The Intelligent Detector Backplanes (IDB) are mounted within the rack. Each IDB provide support for the connection of up to 4 Loop Detector Cards, such as Siemens SLD4 or the WiMag Loop Replacement Card.

The IDB 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 any additional terminal blocks and twisted wire kits.

The Intelligent Detector Backplane itself connects to the CPU Card, or previous[14] Intelligent Detector Backplane, via the GSPI interface serial cable through which the card also obtains its power supply.

The Loop Detector supply is cabled separately as shown in Figure 26. This supply is derived from the system 24VDC PSU. An appropriate wiring kit is required.

If required, a twisted ribbon cable provides the connection between the loop detector cards and the road loops, via the loop termination card. The SLD4 /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.

[14] In terms of a linked communications chain

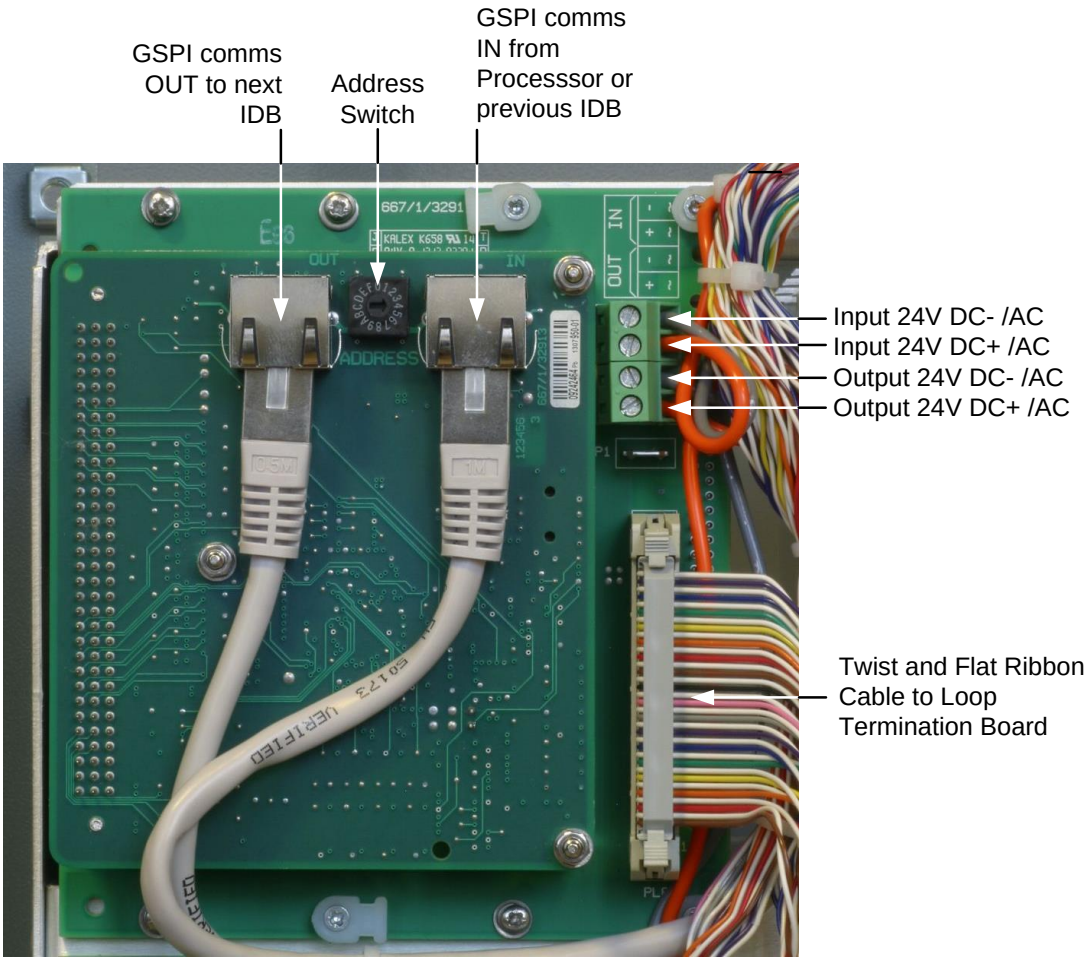


Figure 26 – Intelligent Detector Backplane (rear view)

3.14.1 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 3.13 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[15] 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[16]	Communications Active
Off	Green / Red Alternating	Off	Invalid Address
Off	Red Flash	(As above depending on state)	Major Fault Detected

Table 9 – Intelligent Detector Backplane Card LEDs

3.14.2 Intelligent Detector Backplane Card Rotary Address Switch

This screwdriver-adjustable switch is located on the Intelligent Detector Backplane card(s) as shown in Figure 26 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 9. Address 0 is the default address switch position for spare cards.

GSPI Address Range

The address range is shared with the IO cards and must be unique. The address range is limited to 1 to 9. Addresses 10 and above are used by the CTBs. Due to architecture of Plus+ this is not expected to be a practical limitation.

[15] Conditions other than those identified above should not occur and can be treated as faults.
[16] May flash so fast that it looks like Green Steady.

3.14.3 Loop Detector Power

The power for the Loop Detector cards is taken from the 24VDC PSU. See Figure 27 for the power connections on the Intelligent Detector Backplane.

If additional Intelligent Detector Backplanes are required, then the 24VDC can be daisy chained from the first IDB.

For the purposes of loading the 24VDC PSU has 1.5A available for additional peripherals, outside of running the ST950 CPU. This would be sufficient for up to 6 intelligent detector backplanes and 1 I/O Card.

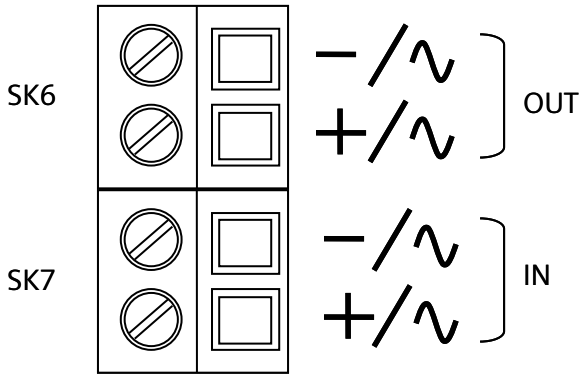


Figure 27 – SK6 and SK7 Connections for Loop Detector Power

3.14.4 Parts

Intelligent Detector Backplane - 667/1/32910/950

24V PSU to IDB Wiring Loom - 667/1/53047/000

3.15Loop Detector Cards

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

Further detailed information regarding Loop Detector Cards is available in the SLD4 Loop Detector Handbook (667/HB/45200/000).

3.16CIC Card and CTB (Backplane)

3.16.1 Overview

The CIC is the Plus+ communications hub and provides controller power distribution for the remote nodes, via the street wiring. Its main role is to provide safe communications to remote nodes such as RAG, Wait and Nearside nodes in order to control the traffic signalling. It provides the facility to disable the 48V power supply to selected nodes in the event of safety events.

The CIC, fitted to its associated CTB, is situated within the controller cabinet in a similar fashion to how the ST950 ELV controller mounts its LSLS assemblies and are typically mounted on the side walls of the controller. In order to maintain consistency of mounting arrangements the size of the CIC is constrained to 6U and the CTB retains the same footprint as the LSLS backplane.

The CTB is a passive backplane used for the termination of various signals including 48V Power, on street cabling (including power and communications), ST950 (power and communications), and control for ancillary equipment.

Up to three CICs may be fitted in the controller cabinet.

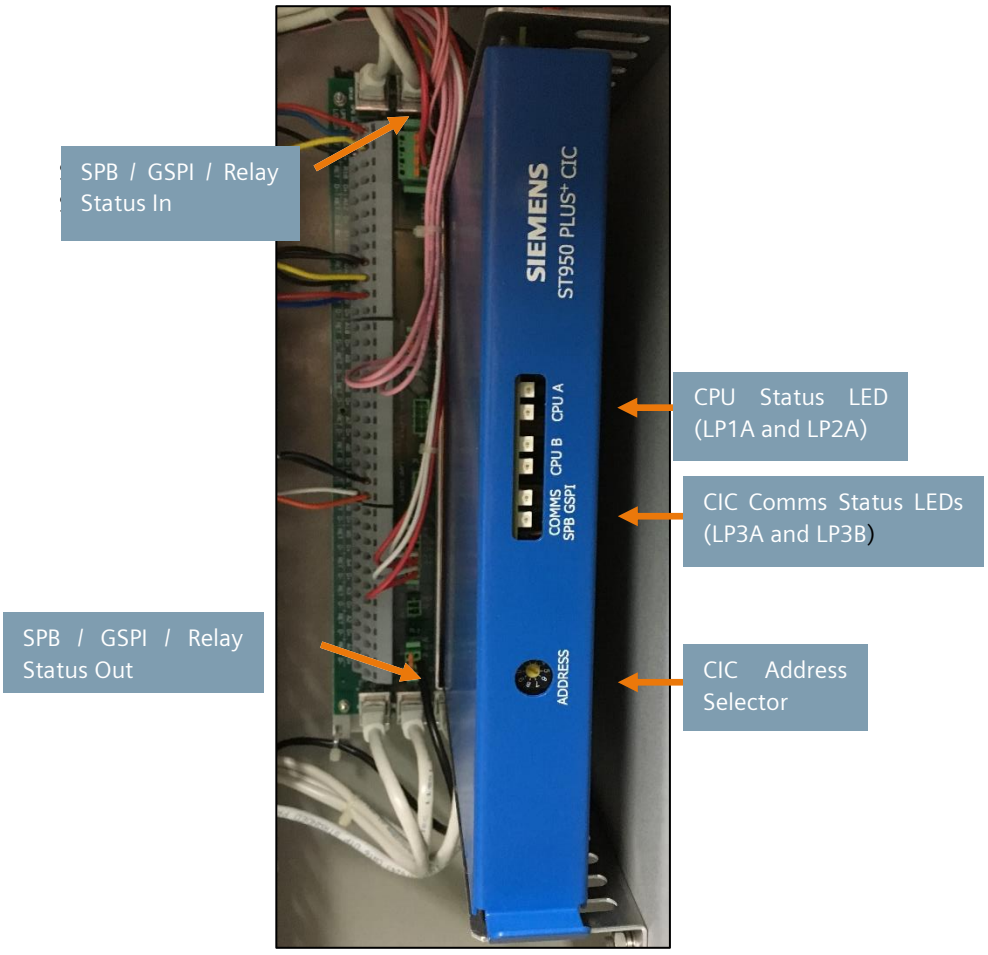


Figure 28 – CIC and CTB (Backplane)

Street wiring is terminated directly to the CTB via cage clamp terminal blocks. The CTB in turn routes its connected signals to the CIC via DIN standard connectors.

The CIC is fitted with a metallic cover to provide a degree of protection from accidental contact. However, there are no hazardous voltages present on the PCB.

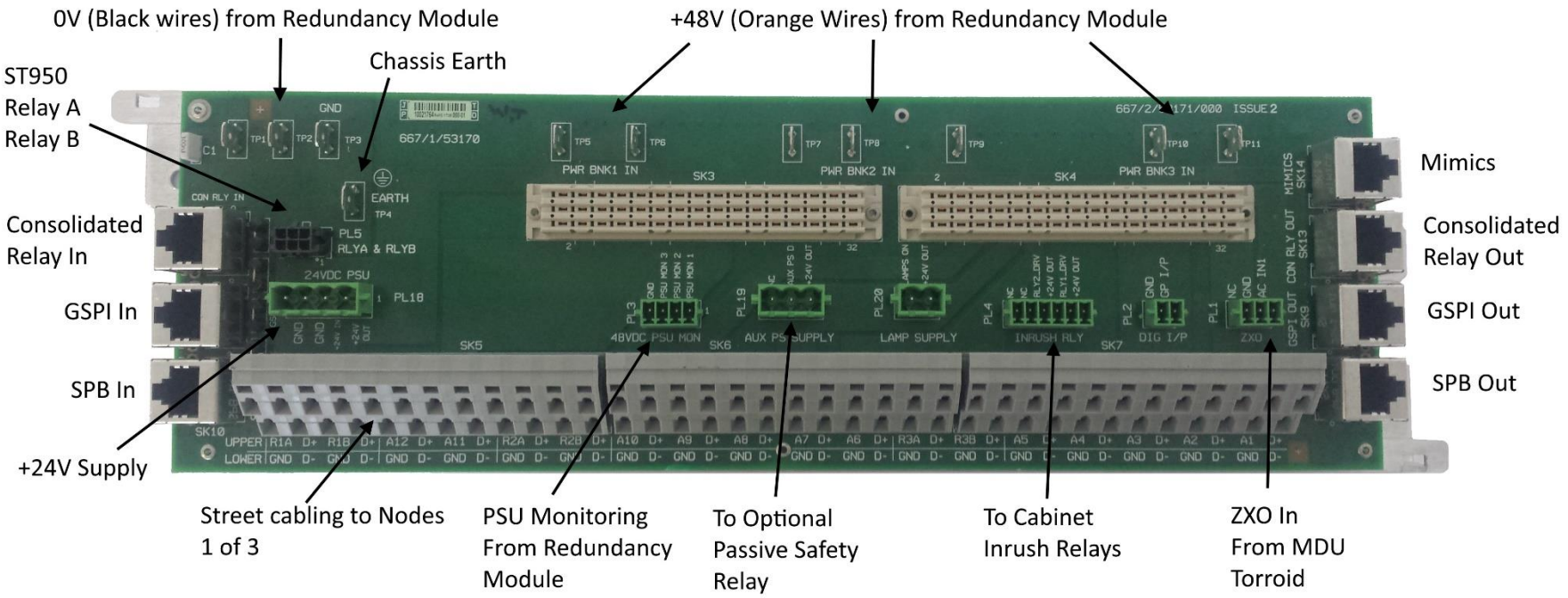


Figure 29 : CTB Terminations

3.16.2 CIC/CTB Interfaces: Serial Phase Bus (SPB)

The CIC/CTB has two SPB interfaces, SPB In and SPB Out. The SPB-IN connection for the first CIC/CTB in the system connects to the ST950 CPU. The SPB Out connects to the next CIC/CTB in the system via its SPB-IN connector.

Over this interface the ST950 CPU can obtain lamp states as well as inventory and fault information from the CIC and the Nodes.

The scheme is arranged such that messages sent by the ST950 CPU are routed to, and seen by, all devices on the bus but replies from downstream devices are directly routed to the ST950 CPU without being seen by other devices on the bus.

3.16.3 CIC/CTB Interfaces: GSPI Bus

The CIC/CTB has two GSPI interfaces, GSPI In and GSPI Out. The GSPI In connection for the first CIC/CTB in the system connects to the ST950 EFC. The GSPI Out connects to the next CIC/CTB in the system via its GSPI In connector. The last CIC/CTB in the system may, via its GSPI Out, connect to optional Serial I/O Cards. Refer to section 3.16.11.

Over this interface the ST950 CPU can obtain I/O input states as well as inventory and fault information from the CIC and the Nodes.

The communication scheme is arranged such that messages sent by the ST950 CPU are routed to, and seen by, all devices on the bus but replies from downstream devices are directly routed to the ST950 CPU without being seen by other devices on the bus.

3.16.4 CIC/CTB Interfaces: Street Terminations

The Plus+ street cabling connects to the cage clamp terminals (SK5, SK6 and SK7). Each Plus+ street cable carries four wires; +48V (Red), 0V (Blue), D+ (Yellow) and D- (Black). Each street cable will terminate to a Ring or Arm connection as specified by the site configuration. The following diagram shows a connection to Ring 1A.

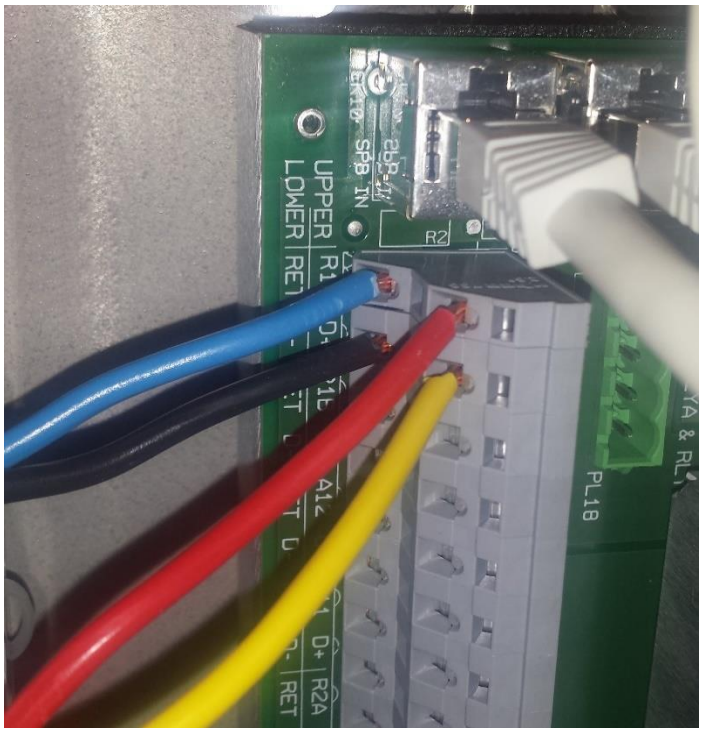


Figure 30 CTB Street Termination to Nodes

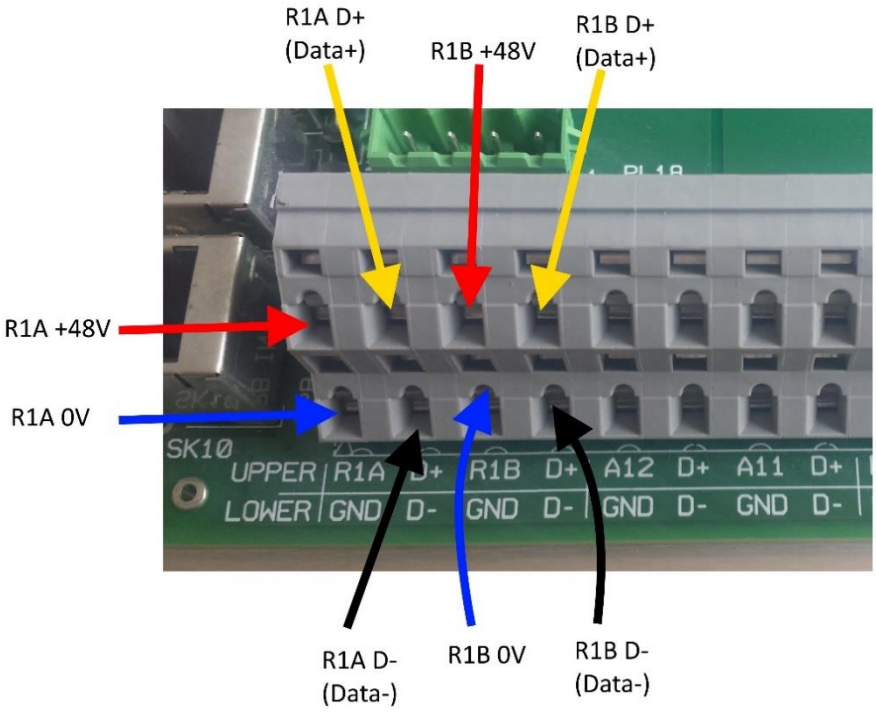


Figure 31 CTB Street Termination Detail

Figure 31 shows the function of the terminals. The arrows are coloured to indicate the conductor colours of connected cables (in the above example two cables).

The +48V and 0V carry power to the nodes, whereas the D+ and D- carry the RS485 data communications.

3.16.5 CIC/CTB Interfaces: 48V Power In

With reference to Figure 29 the incoming 48V from the Redundancy Modules is terminated to the Faston terminals on the CTB. The black 0V wires terminate to the GND terminals, and the Orange wires terminate at the Power Bank terminals.

In addition, the Redundancy module also provides power supply monitoring signals to the CTB, terminated at PL3 "48V PSU MON", with the following pin connectivity:

Pin	Legend	Function
1	PSU MON 1	Analogue monitor for PSU 1 of the Redundancy Module.
2	PSU MON 2	Analogue monitor for PSU 2 of the Redundancy Module.
3	PSU MON 3	Analogue monitor for PSU 3 of the Redundancy Module.
4	GND	Return (not used)

3.16.6 CIC/CTB Interfaces: Inrush Relay

The Inrush Relays control how the system PSUs power up on mains application and act to minimise inrush currents, protecting the input fuses to the system. One inrush relay is fitted as standard to the ST950 Plus+ cabinet, which can support up to 3 PSUs. Where more than 3 PSUs are required an additional Inrush relay kit is required.

PL4 provides drive connectivity for up to two inrush relays which are controlled by the CIC.

The connection detail is as follows:

Pin	Legend	Function
1	+24V OUT	+24V to Positive Control for Inrush Relay 1
2	RLY1_DRV	Open Drain Output for Negative Control Inrush Relay 1
3	+24V OUT	+24V to Positive Control for Inrush Relay 2
4	RLY2_DRV	Open Drain Output for Negative Control Inrush Relay 2
5	NC	No Connection
6	NC	No Connection

3.16.7 CIC/CTB Interfaces: Lamp Supply

PL20 provides an optional connection to an Outstation Monitoring Unit (OMU), where the OMU can monitor whether the signals (Lamps) are on or off. The 24V output from the CIC/CTB will normally drive an external relay (e.g. mounted on DIN-rail on a rear panel) with the relay switching a voltage which is capable of driving the OMC lamp supply input.

The connection detail is as follows:

Pin	Legend	Function
1	+24V OUT	+24V to the OMU Input Positive / positive of relay coil (if required)
2	LAMPS ON	Open Drain Output for connection to the OMU input / negative of relay coil

3.16.8 CIC/CTB Interfaces: Passive Safety Auxiliary Supply Control (Not Currently Used)

This interface provides for the control of an optional Passive Safety Relay. This relay may be used to isolate the power to auxiliary equipment during a passive safety event.

The connection detail is as follows:

Pin	Legend	Function
1	+24V OUT	+24V to the Positive of the Relay Coil
2	Aux PS D	Open Drain Output for connection to Negative of the Relay Coil
3	NC	No Connection

3.16.9 CIC/CTB Interfaces: Digital Input

This two-way connector provides for an optional digital input. This may be used for connection to switches such as a door alarm switch.

Pin	Legend	Function
1	GP I/P	For connection to one switch contact.
2	GND	For connection to the other switch contact.

3.16.10 CIC/CTB Interfaces: ZXO Input

The ZXO or Zero Crossing input is connected to the secondary of a toroidal transformer. The CIC processes the AC waveform from this transformer to produce timing signals where the AC waveform crosses 0V. These timing signals are used by the system for confirmation of the system clocks.

Pin	Legend	Function
1	AC IN1	ZXO AC In (Red)
2	GND	ZXO AC In (Yellow)
3	NC	No Connection

3.16.11 CIC/CTB Interfaces: Logic Supply Distribution (+24V DC)

The 24V logical supply is sourced from a DIN rail mounted PSU located on the left panel of the cabinet. This connects to the first CIC/CTB at PL18 '24V DC PSU'. The connector details are as follows:

Pin	Legend	Function
1	+24V OUT	Not currently used.
2	+24V IN	+24V DC in from the DIN rail mounted PSU
3	GND	0V Return for the +24V DC PSU
4	GND	0V Return for the +24V DC PSU

The first CIC/CTB provides 24V DC power to the ST950 CPU card via PL5 ('RLYA & RLYB Molex connector) and the GSPI IN connectors.

Subsequent CIC/CTBs receive their 24V DC power from the first CIC/CTB via the GSPI and Consolidated Relay connections see Figure 31 below.

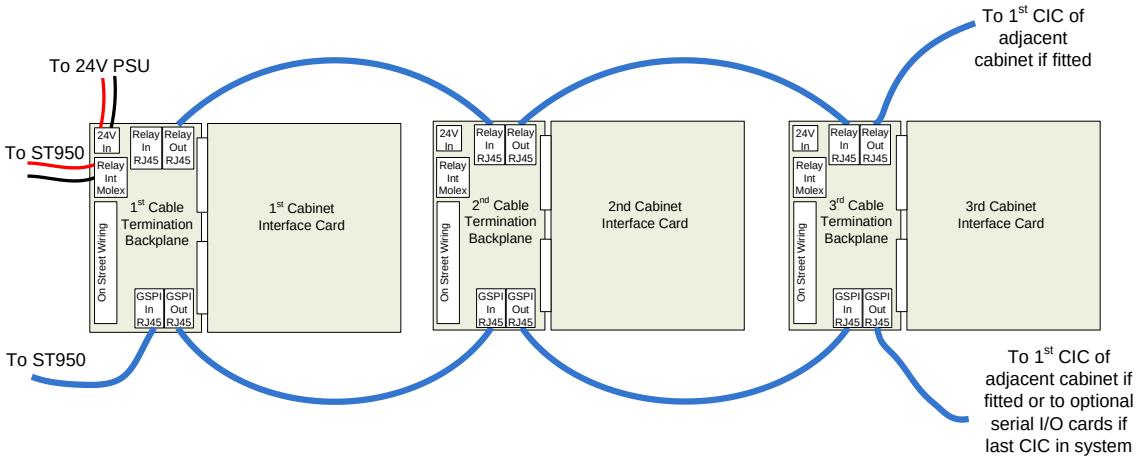


Figure 32 24Vdc Routing Via CTB

3.16.12 CIC/CTB Interfaces: Relay A and Relay B and Consolidated Relay

Relay A and Relay B are signals from the ST950 CPU that in normal operation are asserted (pulled low). If the ST950 detects a major fault it may de-assert either Relay A or Relay B or both Relays.

The first CIC/CTB in the system connects to the ST950 Relay A and Relay B via a 6- way Molex connector PL5. Detail for this connection is as follows:

Pin	Legend	Function
1	ST950 RLY A	ST950 Relay A
2	ST950 RLY B	ST950 Relay B
3	RLY GND	No Connection
4	NC	No Connection
5	+24V DC	+24V to power the ST950
6	GND	0V to power the ST950

Table 10 : CIC/CTB Relay Interface

The first CIC/CTB in the system consolidates the Relay A and Relay B signals into a single Consolidated Relay signal. This signal is passed on to each subsequent CIC/CTB in the system via the 'CON RLY OUT' and 'CON RLY IN' RJ45 connections.

If the ST950 de-asserts either Relay A or Relay B; **all** CICs in the system will open their Power-bank Relays and hence remove the +48V DC supply from all nodes in the system.

3.16.13 CIC/CTB Addressing

A single BCD address switch which is situated for easy access at the front of the CIC and visible when mounted to the CTB, provides a configurable address for the CIC for the purposes of GSPI and SPB addressing.

A system including adjacent cabinet may have up to 6 CIC cards with associated addresses. Three CICs in each cabinet.

The address selected by the BCD address switch is offset by 10. This is to ensure that there is no conflict with other GSPI or SPB (Serial Phase Bus) devices.

The Address switch position on each CIC needs to be uniquely set as follows:

- 0 = not used
- 1 = CIC 1
- 2 = CIC 2
- 3 = CIC 3
- 4 = CIC 4
- 5 = CIC 5
- 6 = CIC 6
- 7 or above = not used

3.16.14 CIC/CTB Status LEDs

The status LEDs provide an engineer with some information on the correct operation of the CIC.

The CIC has six LEDs (three per CPU) which are used to indicate various conditions as follows;

LED	Illumination	Function
LP1x – (Green) System/Software Run	Slow Flash	Software is operating normally (typically flashing once per second)
	Off	CIC has detected a persistent fatal error and has entered a non-operational state to prevent continual restarts. This state can only be left by power cycling the CIC (with Comms LED off and Fault LED illuminated).
LP2x – (Red) Fault	Off	Normal Operation
	On	Fault Detected
LP3A – (Green) Communications	On	Normal Operation.
	Off	No relevant messages received in the last second (implies loss of communications), or low power mode.
LP3B – (Green) Communications	On	Normal Operation.
	Off	No relevant messages received in the last second (implies loss of communications), or low power mode.

Table 11 : CIC LED Status Indicators

Indication of Fault

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

3.16.15 Parts

ST950 CIC Card Assembly 667/1/53090/000

ST950 CTB Replacement 667/1/53170/001

ST950 CTB Assembly 667/1/53050/000[17]

CTB cable kits for CIC position 2 667/1/53051/002

CTB cable kits for CIC position 3 667/1/53051/003

Additional Inrush Relay kit 667/1/53058/000

[17] Used when additional CIC is being added to a controller (includes Redundancy Module)

3.17 Manual Panel

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

The full intersection manual panel is shown in Figure 33 below.

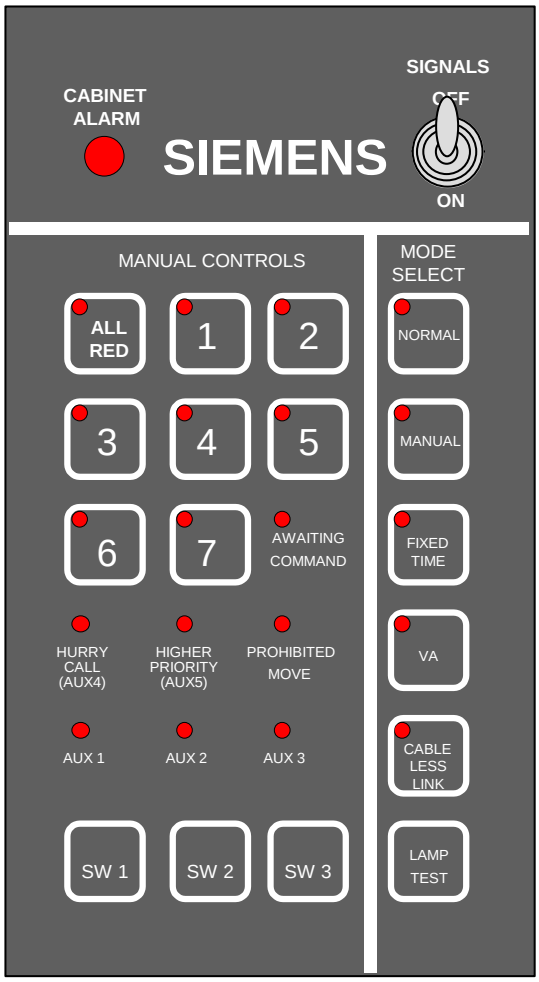


Figure 33 – Manual Panel

3.17.1 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 all variants.

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.

Table 12 : Manual Panel LED Indications

3.17.2 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.

Safe Traffic Conditions

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.

Isolation of On Street Equipment

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

When the switch is returned to the ON position, the signals turn on as per the configured switch on sequence.

3.17.3 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.

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

These keys select the required mode for the controller.

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

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

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

4 ST950 PLUS+ SYSTEM COMPONENTS : ON STREET

This section details the main components of the ST950 Plus+ system that are mounted on-street (i.e. outside of the cabinet).

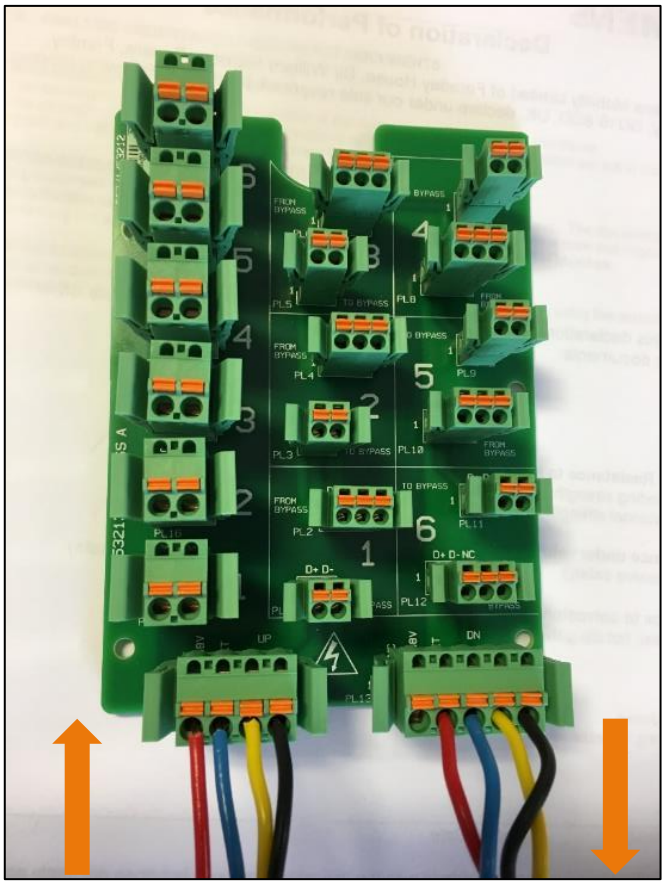
4.1 Pole Top Board

4.1.1 Overview

The Pole Top Board is used to ensure a quick and uncomplicated way of wiring to and from a range of nodes held on traffic poles.

Figure 34 : Pole Top Termination Kit

Street cable from cabinet or from upstream Pole Top Termination Board.



Street cable to the next Pole Top (downstream)

Figure 35 : PTB with 4 Way Street Cable

Each node on the pole, which the Pole Top Board services, will have a six way (three pair) dropper cable attached.

The termination board is numbered such that, starting from 1, each subsequent node will then take the next connector position.

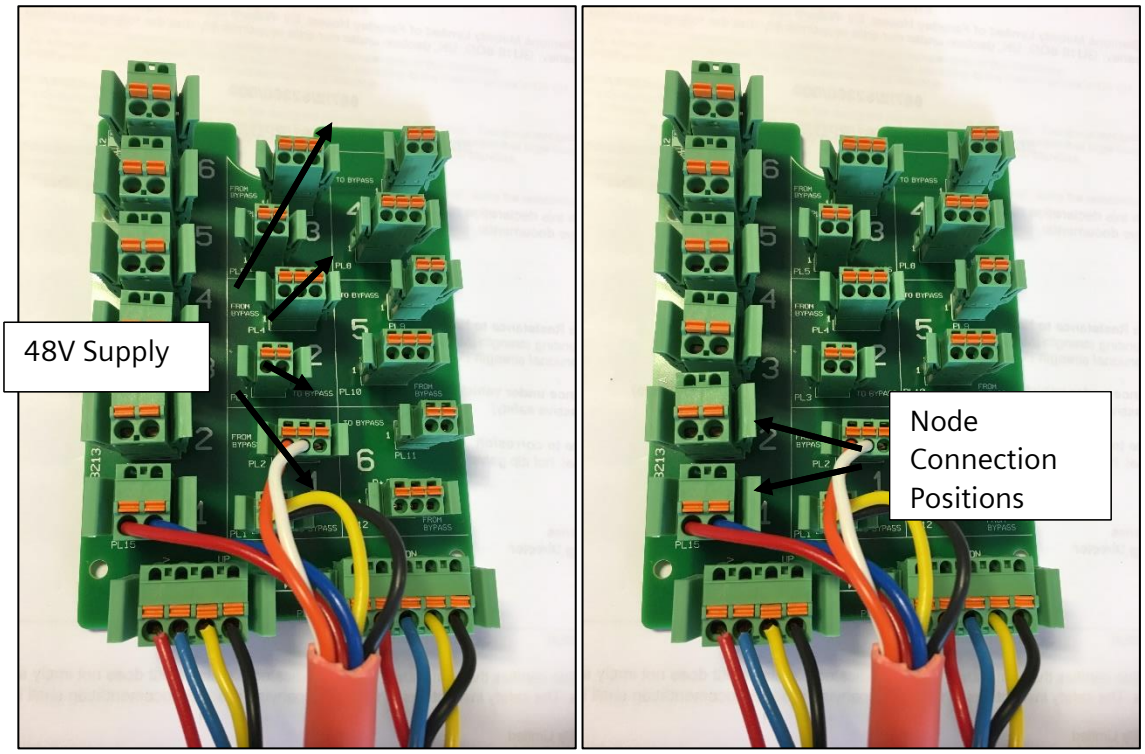


Figure 36 PTB with 4 Way street cable and Dropper Cable for the first Node

The power pair (Red and Blue) will be connected to the first supply column (PL15), which is also numbered 1.

The data pair to the node (Yellow and Black) are connected to PL1 (labelled “To ByPass”). The data pair from the node (Orange and White) are connected PL2 (labelled “From ByPass”).

In order to complete the circuit onwards to a downstream Node, a link pair (yellow and black) is required from PL3 to PL12.

If a second node requires connection, then the next set of connectors are used (all labelled ‘2’) and the link pair will then be moved to link PL5 to PL12.

Terminal blocks mounted on the opposite side of the PTB bracket are available for Spur connections. Spur connections from PTB to Node use Red, Blue, Yellow and Black wires in the Plus+ dropper cable (Orange and White wires are unused for Spur connections). Spur wiring from the terminal block to the remote Node uses armoured street wiring.

4.1.2 Stub Pole

The stub pole does not use a PTB and instead the wiring arrangement (street cable downstream and street cable upstream) is all held within the pole and the pedestrian demand equipment itself.

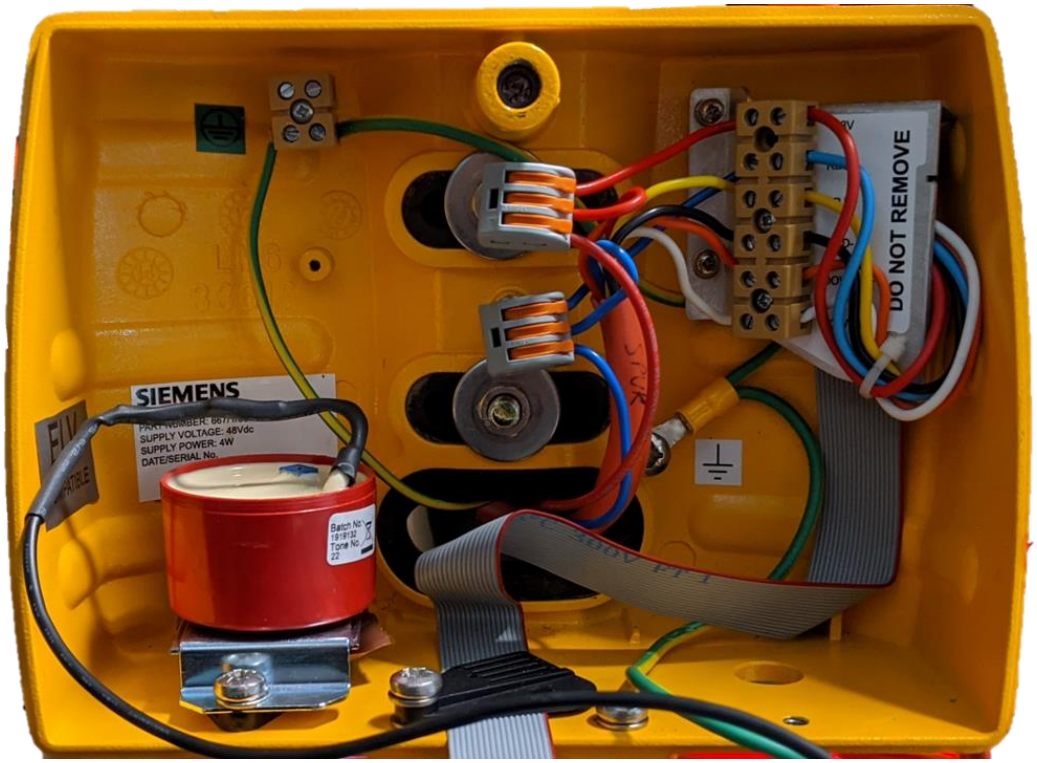


Figure 37 : Pedestrian Equipment: Showing Termination of Upstream and Downstream Cable arrangements

4.1.3 Parts

Plus+ Top Cap Assembly - GRY	667/1/53735/300
Plus+ Top Cap Assembly - BLK	667/1/53735/301

4.2 Plus+ Signal Head

The Plus+ signal head consists of a number of Plus+ Aspects (each containing a Plus+ LED plate), a ByPass module and RAG Node all housed within a standard Helios housing. The RAG Node is mounted behind the Green aspect door.

Instructions for mounting, replacing Helios signal heads and mounting items such as the Solar Cell can be found in the Helios Handbook 667/HB/30000/000.

Side Mounted Boxes

If there is a need for side or inline mounted boxes, the mounting is as standard, however the aspect for a Green Arrow will be connected to the GREEN2 connector (see section 4.2.3).
If there is a need for a further side mounted box (e.g. second Green Arrow optic), an additional RAG Node will be allocated and will be mounted within the second Green Arrow box.

4.2.1 RAG Node : Overview

The RAG Node is the interface between the CIC (power / communications distribution) and the Plus+ LED aspect.

The Plus+ LED plate contains pre-programmed asset data which, when interrogated by the associated Node, provides information about the colour of the LEDs on the plate. The Node then has a number of checks to ensure the correct aspect colours are connected to the correct output connectors. The Plus+ RAG node is able to confirm operation of the Plus+ LED aspect and will send appropriate diagnostic information about that as well as about itself back through the CIC to the controller.

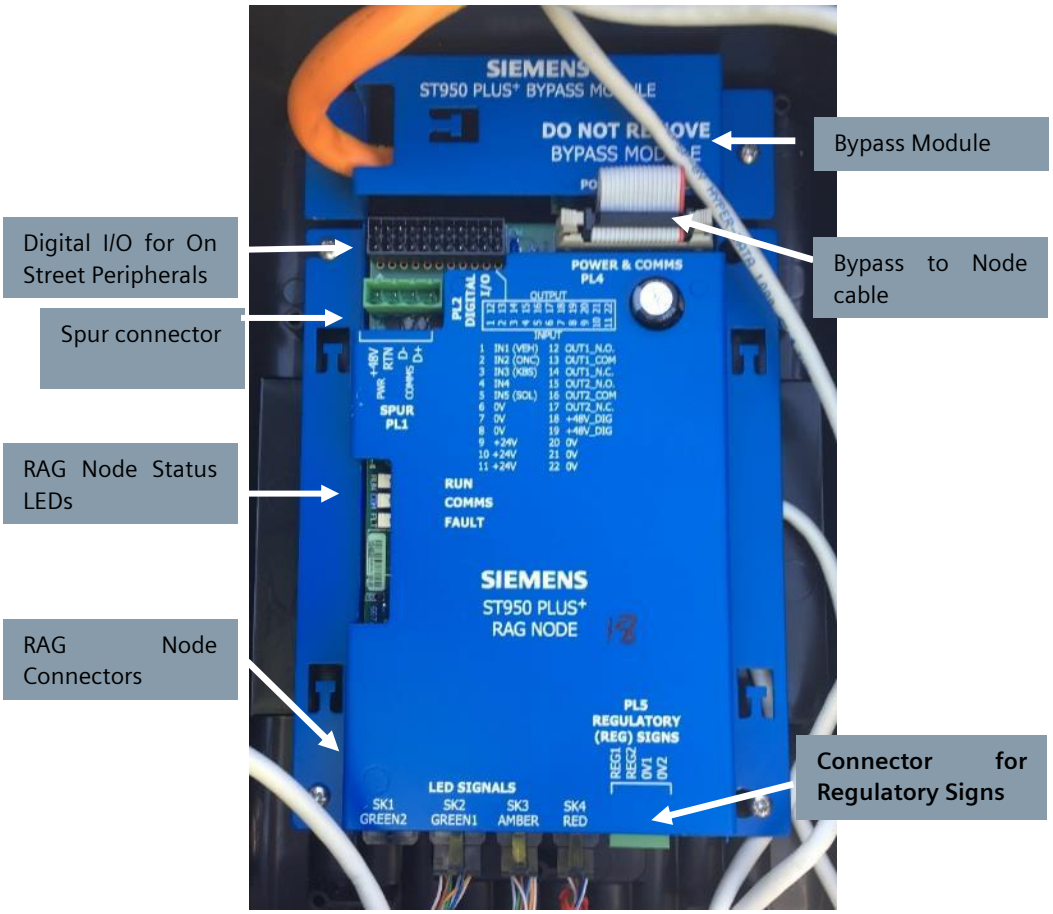


Figure 38 : Bypass Module and RAG Node

4.2.2 RAG Node Interfaces: Power and Comms (PL4)

The main physical interface to the RAG node is via the Bypass to Node ribbon cable. This cable can only be connected one way.

Assuming an operational system, once the Bypass cable is pushed into place, the Node will be provided with power and data.

Assuming correct configuration at the controller, the Node may begin operation immediately.

4.2.3 RAG Node Interfaces: LED signals

SK1 – 4 are used for the LED signal interfaces. For basic RAG installations;

- RED is connected to SK4
- Amber is connected to SK3
- Green is connected to SK2 (also referred to as Green1)

If there is a requirement for a second filter (Second Green);

- Extra Green must be connected to SK1 (also referred to as Green2).

If there is a requirement for a third filter signal (Third Green);

- An extra RAG node will be provided and is expected to be mounted within the aspect associated with the third filter (Third Green). In this case the Third Green is connected to SK2 of the additional RAG node.

Green Arrow : Green2

The Green-Arrow Optic in side-boxes always connects to the Green2 Output of a RAG Node. This is the case even when a second dedicated RAG Node is required for a second Green-Arrow side box, where Green2 is the only connection used on that RAG Node.

RAG Node Signal Connector Types

The connector for the Green signals (Green1 or Green2) cannot be mixed with the Amber or Red connector positions. However, The Red and Amber do have the same connector type. A small Red tag is added to the 'Red' signal cable to assist in identification. However, if the two connectors are reversed neither aspect will light and a fault will be registered at the controller.

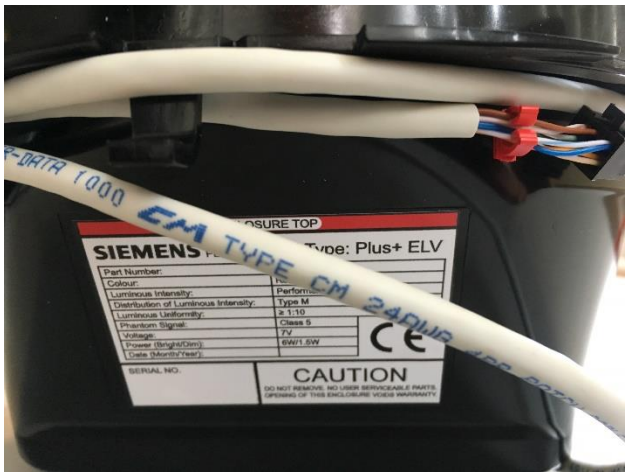


Figure 39 : RED Signal Aspect showing Red Tag.

4.2.4 Digital I/O (PL2)

The Digital I/O connector is used to interface to a number of peripherals:

- 4 TOPAS 2523 compliant inputs for above ground detectors along with the 0V returns
- 1 input for Solar Cell – to be used with the ELV Solar Cell
- 3 +24VDC outputs for powering the above ground detectors along with the respective 0V returns
- 6 pins for the 2 TOPAS 2523 compliant digital outputs (N.O., Common, N.C. on each of 2 outputs).
- The other pins are used for additional 0V returns and to provide an output for 48V unswitched (always on)

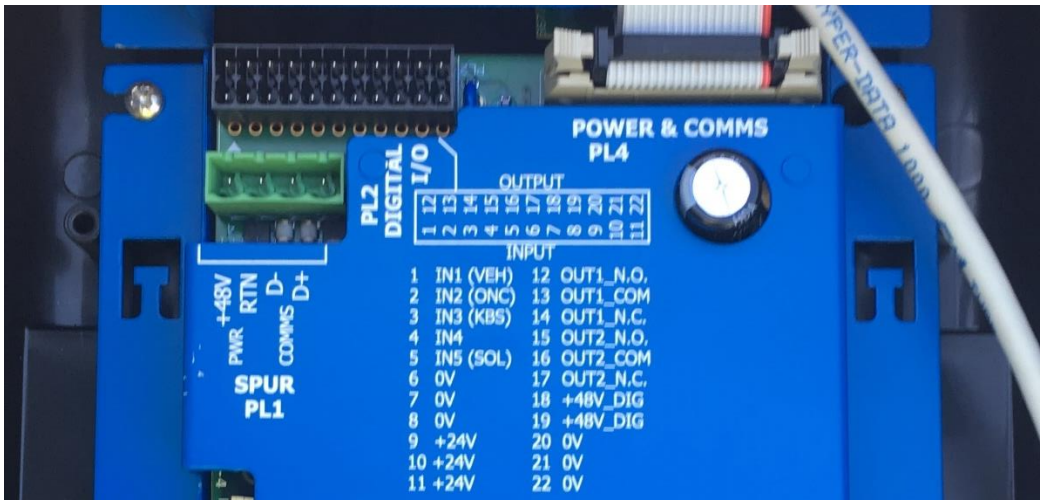
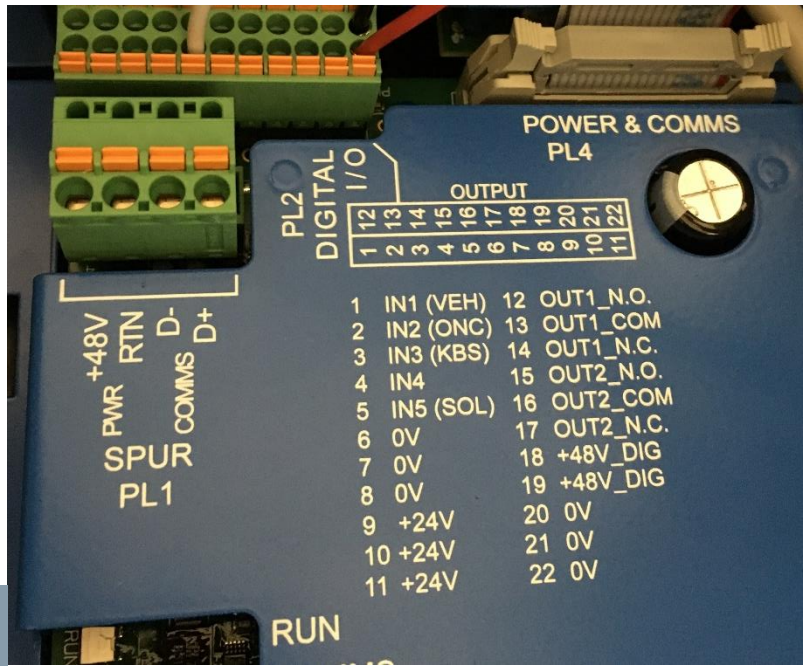


Figure 40 : RAG Node Digital I/O Connector

Supply Limits: RAG Node

The maximum combined current that can be provided by the three 24V supply pins, on the RAG Node, is **0.5A**.

4.2.5 Spur Connection (PL1)



Spur connector

Figure 41 : RAG Node Spur Connector

The spur connector is used to spur the Plus+ network from a node. For example, the Smartloop device is always spurred from a Node, usually via the terminal block located with the Pole Top Board (see section 4.1.1).

4.2.6 Status LEDS

LEDs provide an engineer with some status information on the correct operation of the RAG Node.

The RAG node has three LEDs which are used to indicate various conditions as follows. Conditions other than those identified should not occur and so can be treated as faults.

Figure 42 : RAG Node Status LEDs

LED	Illumination	Function
Run (Blue)	Slow Flash	Software is operating normally (typically flashing once per second)
	Off	The node has detected a persistent fatal error and has entered a non-operational state to prevent continual restarts (with Comms LED off and Fault LED illuminated).
Comms (Blue)	On (Flashing rapidly)	Indicates that normal communications to the CIC is occurring
	On (Flashing slowly)	Indicates abnormal communications e.g. one of the D+/D- pair is not connected. Please fix and power cycle the node.
	Off	No relevant messages received in the last second (implies loss of communications)
Fault (Red)	On	Fault is registered. The fault could be either internal or external e.g. from LED Aspect.
	Off	Normal and correct operation

Table 13 : RAG Node LED Indicators

4.2.7 Parts

Plus+ RAG Node PCB Assembly 667/1/53111/001

4.3 Pedestrian Demand Unit (PDU)

Pedestrian Demand Unit

Instructions for mounting, replacing Helios signal heads, pedestrian signalling and demand equipment and mounting items such as the Solar Cell can be found in the Helios Handbook 667/HB/30000/000.

Figure 43 : Pedestrian Demand unit (PDU)

Connection to the PDU is via the standard housing aperture on the rear – see

Figure 44 below. The signal and power cable will normally be derived from the Pole Top Board (reference section 4.1 for details). This is the case when the PDU is used in combination with Farside pedestrian signalling configuration or with a localised Nearside signalling unit. The cable will be the six-way dropper cable with all ways being used.

PDU and Wait Indicator Earthing Requirements

The PDU and Wait Indicator require a separate Earth wire to be fed from the Pole Top Earth Terminal or other Pole Earth points (sometimes derived from the CET gland on the armoured cable termination) and connected to the earth terminal on the PDU or Wait Indicator equipment.

Figure 44 : PDU Internal Connections (highlighted)

4.3.1 Audible and Tactile Connections

With reference to

Figure 44, the connections for the tactile and audible devices can be found along the top edge (bottom edge when door open).

Audibles are connected to ‘Loud’ as standard, unless specified otherwise.

4.3.2 Parts

Plus+ Wait/PDU PCB Assembly 667/1/53150/001

4.4 Wait Indicator

Wait Indicator

Instructions for mounting, replacing Helios signal heads, pedestrian signalling and demand equipment and mounting items such as the Solar Cell can be found in the Helios Handbook 667/HB/30000/000.

Figure 45 : Wait Indicator

Connection to the Wait Indicator is via the standard housing aperture on the rear. The signal and power cable will be derived from the Pole Top Board (reference section 4.1 for details), using the six-way dropper cable.

PDU and Wait Indicator Earthing Requirements

The PDU and Wait Indicator require a separate Earth wire to be fed from the Pole Top Earth Terminal or other Pole Earth points (sometimes derived from the CET gland on the armoured cable termination) and connected to the earth terminal on the PDU or Wait Indicator equipment.

4.4.1 Audible and Tactile Connections

The connections for the tactile and audible devices can be found along the top edge (bottom edge when door open).

Audibles are connected to 'Loud' as standard, unless specified otherwise.

4.4.2 Parts

Plus+ Wait/PDU PCB Assembly 667/1/53150/001

4.5 Nearside Display Unit and Nearside Combined Unit

Nearside Display Units and Nearside Combined Unit

Instructions for mounting, replacing Helios signal heads, pedestrian signalling and demand equipment and mounting items such as the Solar Cell can be found in the Helios Handbook 667/HB/30000/000.

Figure 46 : Nearside Indicator and Combined Unit

Connection to the Nearside Unit is via the standard housing aperture on the rear – see Figure 47below. The signal and power cable will be derived from the Pole Top Board (reference section 4.1 for details), using the six-way dropper cable.

Nearside Display Unit Earthing Requirements

The Nearside Unit requires a separate Earth wire to be fed from the Pole Top Earth Terminal or other Pole Earth points (sometimes derived from the CET gland on the armoured cable termination) and connected to the earth terminal on the Nearside equipment.

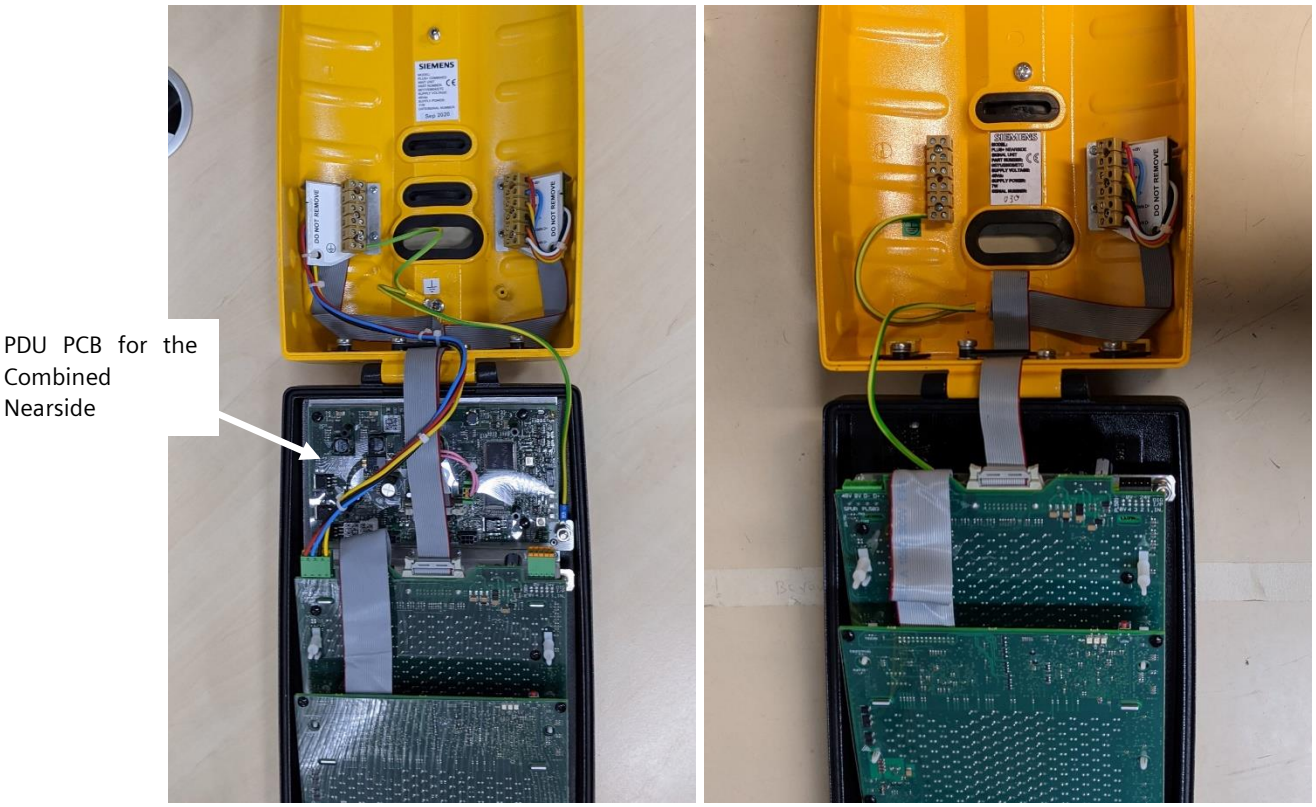


Figure 47 : Nearside and Nearside Combined

4.5.1 Audible and Tactile Connections

With reference to Figure 48 below, the connections for the tactile and audible devices can be found along the top edge (bottom edge when door open).

Audibles are connected to 'Loud' as standard, unless specified otherwise.

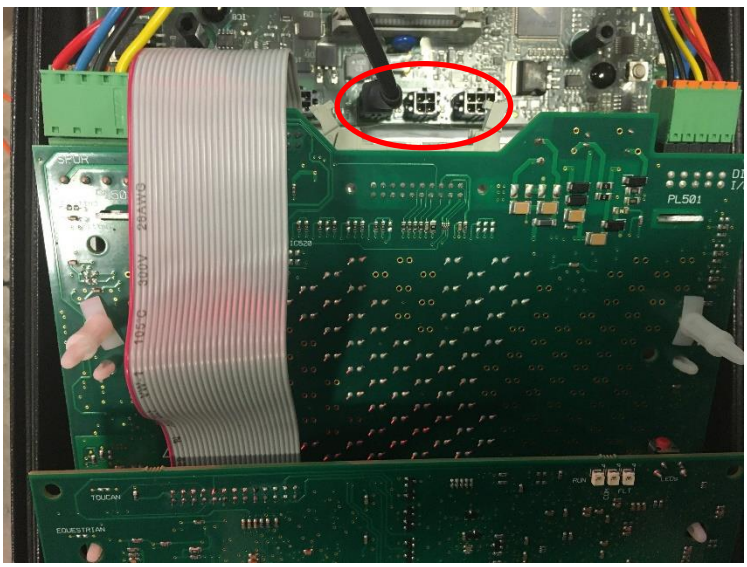


Figure 48 : Nearside Audible/Tactile Connection Location

4.5.2 Parts

Plus+ Wait/PDU PCB Assembly 667/1/53150/001
Plus+ Nearside PCB Assembly: Puffin 667/1/53121/001
Plus+ Nearside PCB Assembly: Toucan 667/1/53121/003
Plus+ Nearside PCB Assembly: Equestrian 667/1/53121/005

4.6 ELV Solar Cell

The ELV Solar Cell is mounted on and connects directly to the RAG node within signal head, as designated by the layout design. PL2 on the RAG node provides the appropriate interface, as shown in Figure 49 below.

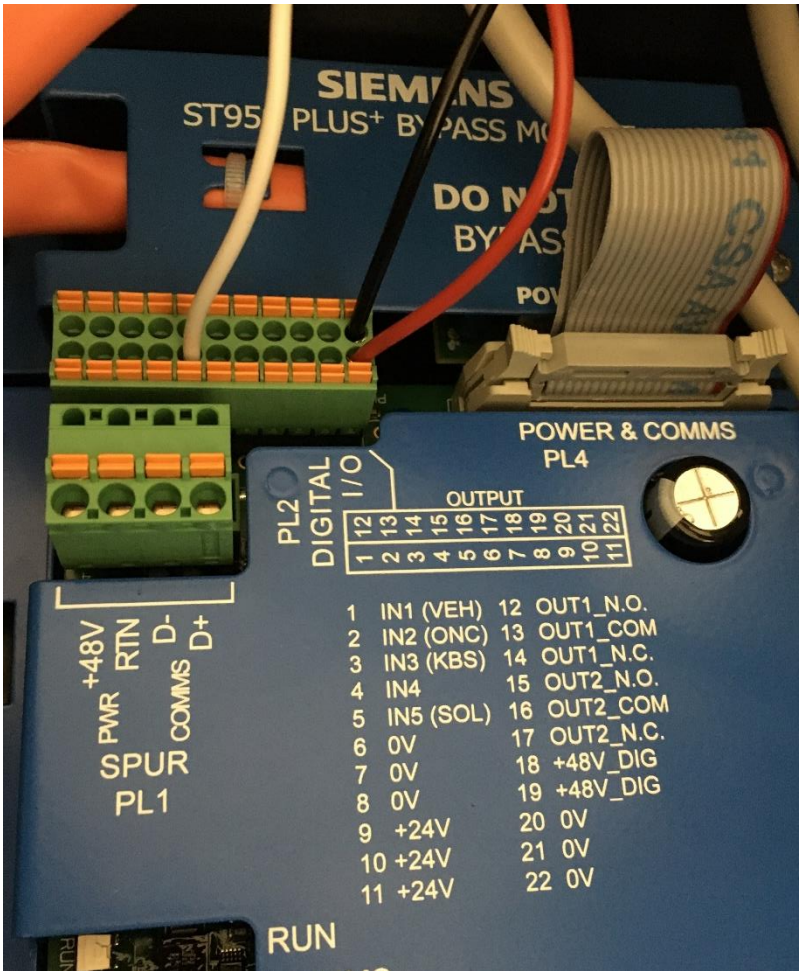


Figure 49 : Solar Cell Connection Detail

Solar Cell Wire	RAG Node Connection (PL2)
Solar Sense (white)	5 IN5 (SOL)
Supply (red)	9, 10 or 11 +24V
Neutral (black)	20,21 or 22 0V

4.6.1 Parts

ELV Solar Cell kit 667/1/10039/024

4.7 Above Ground Detectors

Above-ground detectors provide detection for pedestrians and vehicles. The power and detector connections, for the detector, are normally taken from the **PL2** interface on the RAG node, allocated as per the Plus+ design layout.

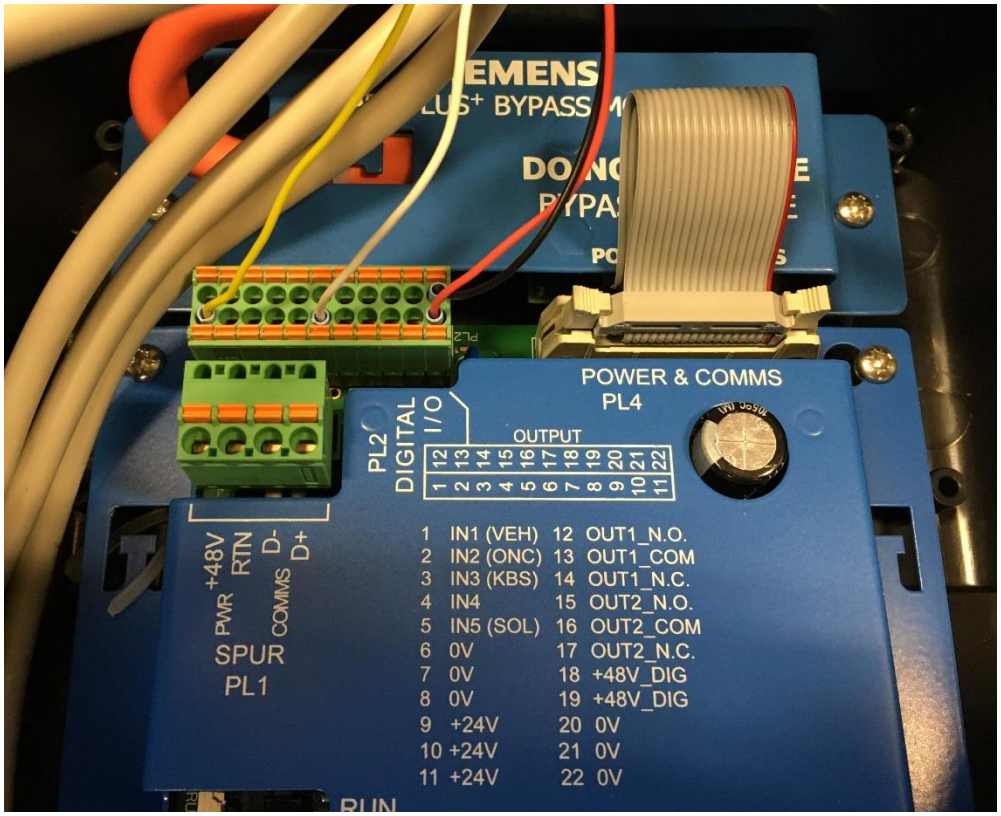


Figure 50 – Above-Ground Detector Connections

Heimdall Connection	RAG Node Connection (PL2)
Detection (yellow or blue)	1,2,or 3 IN1, IN2 or IN3 (XXX)[18]
Common (white)	6,7or 8 0V
+24V (red)	9, 10 or 11 +24V
OV (black)	20,21 or 22 0V

If appropriate, the Detector may also be connected to adjacent (nearby) Nearside Units. These detector connections can use the terminal block on the back of the PTB bracket. Armoured street

[18] Depending on application

cable must be used for the cable between poles. Note that this is not applicable to the PDU (which does not have any detector inputs).

For further information including mounting arrangements, please refer to the Heimdall Handbook (667/HB/31900/000).

4.7.1 Adding Above Ground Detectors to Poles without Signal Heads

If there is no head to connect the above ground detector, the AGD is to be connected to a RAG Node on a near-by pole.

Alternatively, if there is a Plus+ Near-Side or PDU/Wait on the same Pole as the AGD, these must be connected to the same Plus+ Cable as the RAG Node, i.e. be on the same Arm/Ring. (This ensures that the power consumption of the AGD is considered by the Design Tool)

Note that every AGD on a Pole without any Plus+ equipment will not be included in the power consumption calculations (on the assumption the Plus+ Cable naturally omits that Pole), so the installer will need to check there is spare capacity on the cable powering the adjacent RAG Node.

4.8 Regulatory Sign

The regulatory sign, which is a 12V system for Plus+, is connected directly to the node, located within the signal head to which the Regulatory Sign is mounted. An individual RAG node provides an interface for one or two Regulatory Signs. The connection(s) is made directly to PL5 on the RAG node, as per Figure 51 below.

If further Regulatory Signs are required then an addition RAG node will be required, which will be fitted in the Amber or Red Aspect chamber.

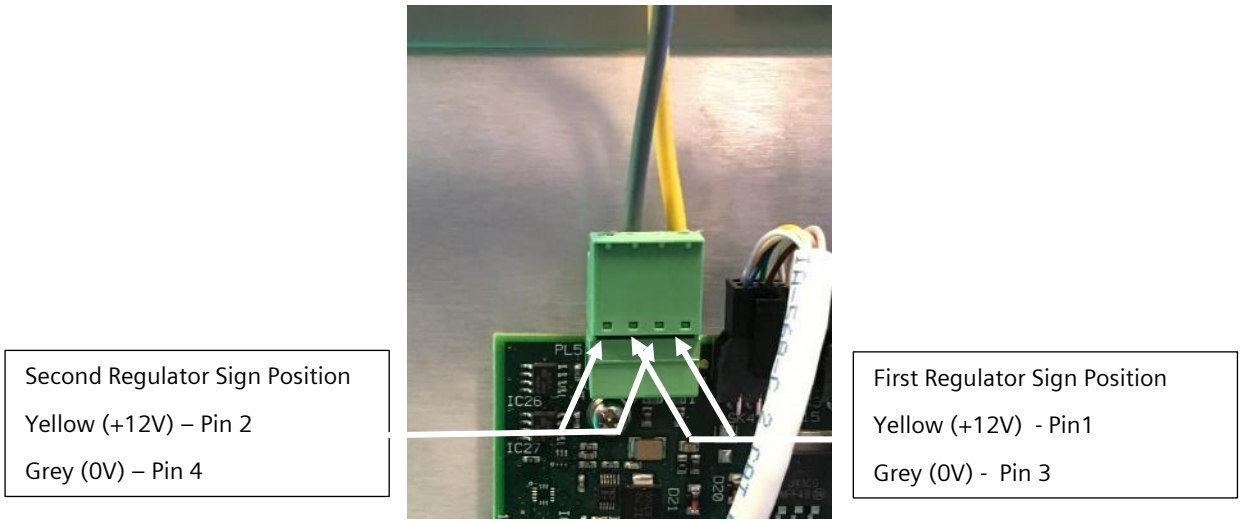


Figure 51 : Reg Sign Connected to RAG Node

4.8.1 Installing Three Regulatory Signs

If three Regulatory Signs are required to be mounted (powered) on/by a single Traffic Signal Head, an additional RAG node will be required. This second RAG node will need to be mounted behind the Amber aspect.

4.8.2 Parts

Plus+ HELIOS Side Mounted Regulatory Body 667/1/53500/807

Plus+ HELIOS In Line Mounted Regulatory Body 667/1/53500/808

HELIOS Regulatory Sign Door Assembly 667/1/30200/XXX

Plus+ HELIOS Regulatory Internal Illumination Assembly 667/1/53514/000

4.9 Smartloop

The Smartloop is normally fitted within 'access chambers' that are positioned in the most convenient positions, close to where the inductive loops are to be installed.

The Smartloop provides an interface that allows for further Smartloops to be installed downstream. The connection(s) is made to PL1on the RAG node, via the terminal block located with the PTB, see section 4.1.

There are three variants of the Smartloop, to reflect the main ranges of loop inductances that are normally encountered. However, in most situations it is expected that variant /001 will be the correct default variant to be selected.

Smartloop Variant Selection Table		
Variant	**Example Loop Type**	**Loop inductance**
/001	Low inductance values and/or short feeder lengths (this is the usual variant required for most site installations)	Approx. 20 – 150µH
/002	Medium inductance values and/or medium feeder lengths	Approx. 150 – 300µH
/003	High inductance values and/or high feeder lengths	Approx. 260 – 2000µH

Table 14 : Smartloop Variant Selection Table

Loop feeder length is normally in the range of 0 - 300M but is extendable up to 1000M where the recommended loop cable core size is 1.5 mm^2 or 2.5 mm^2.
The following provide a guide for users:

- Short feeder <100m
- Medium feeder 100-300m
- Long feeder >300m

The use of resin (torpedo) joints, or other cable connection methods, should ensure that any loop feeder/tails or Plus+ network connection can be achieved in a secure and waterproof manner. The use of other cable connections are also applicable, for example 'bottle' joints (but a bottle joint must be mounted vertically to ensure it remains waterproof).

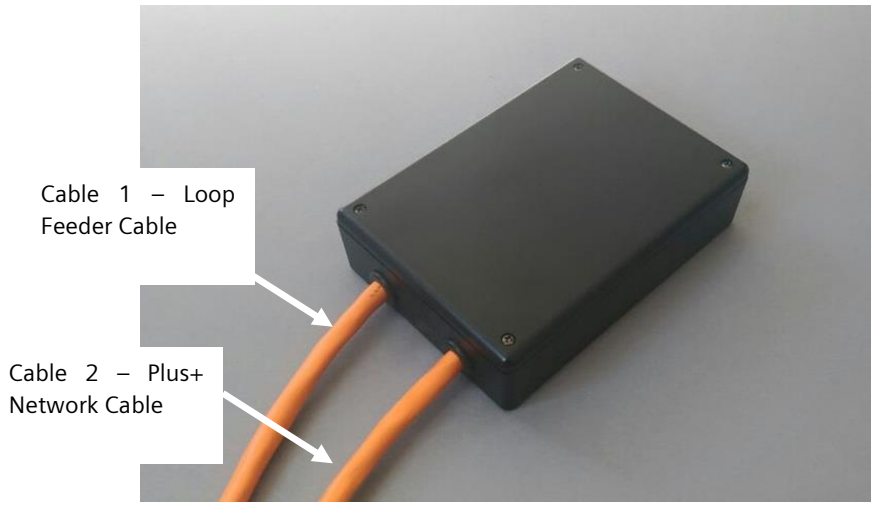


Figure 52 : Smartloop Cables (Loop Feeder and Plus+ Network)

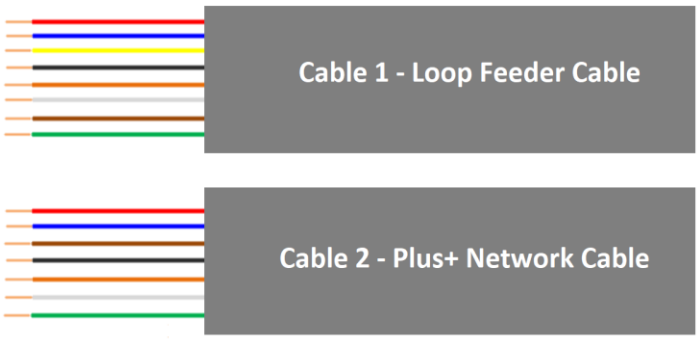


Figure 53 : Cable Interface Detail

Cable	Core	Function
1 – Loop Feeder/Tails Cable	Red	Loop 1
	Blue	Loop 1
	Yellow	Loop 2
	Black	Loop 2
	Orange	Loop 3
	White	Loop 3
	Brown	Loop 4
	Green	Loop 4
2 – Plus+ Network Cable	Brown	D+ (upstream)
	Black	D- (upstream)
	Red	+48V Plus+ Supply
	Blue	0V Plus+ Supply

Cable	Core	Function
	Orange	D+ (downstream)
	White	D- (downstream)
	Green	Earth (for terminating armouring)

Table 15 : Smartloop Interface Detail

Figure 54: 'Torpedo' Resin Joint

4.9.1 Installing Smartloop

The Smartloop device is normally installed in access chambers that are located near to the location where the inductive loops are to be cut.

Smartloop Installation Location

Instructions for the installation location of the Smartloop(s) is found in the issued STS drawing, as generated by the Plus+ design tool.

The two cables that are attached to the Smartloop box are the Plus+ network cable and the loop feeder/tails cable.

Loop feeder/tails are connected, using torpedo resin joints or other appropriate cable connection methods, as per the Table 15.

The Plus+ network cable will be jointed to either an upstream Smartloop or to the Plus+ street cable. The Plus+ street cable is expected to be a spur from the nearest Traffic Signal node. Spur connection details can be found in section 4.2.5.

4.9.2 Smartloop Cable Connections

The following descriptions relate to the connections made within the Torpedo resin joints. Other cable jointing methods are also available.

The Plus+ street cables are to be fitted with CET gland and jubilee glands. This is the case for both upstream (to/from the RAG Node) and downstream to subsequent Smartloops.

Figure 55 : Termination of Street Cable Armouring

If there is only one Smartloop linked to the upstream node, the earth cable available from the Smartloop Plus+ Network cable is terminated at the CET gland.

If multiple Smartloops to be linked together then an additional earth wire will be required to bridge the two CET glands.

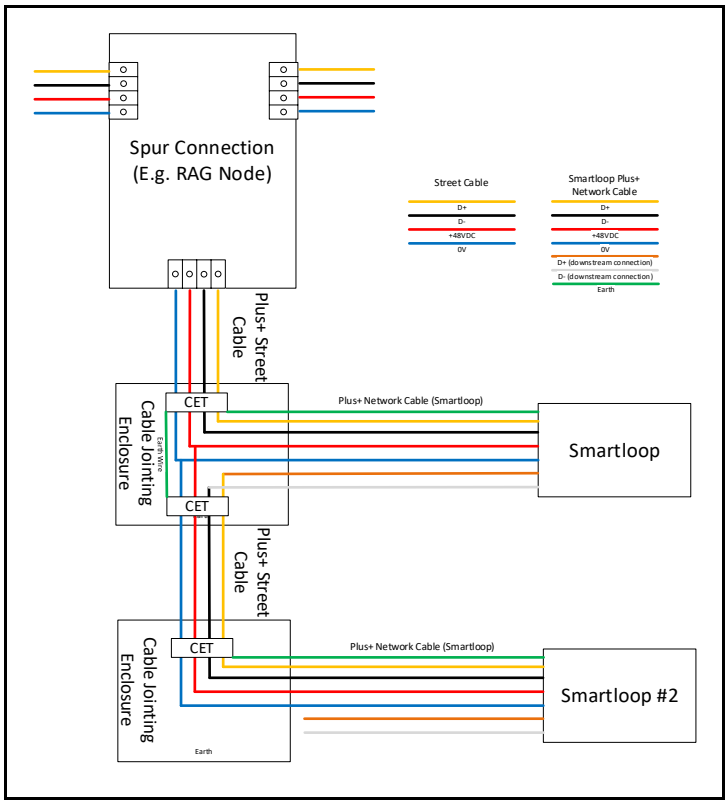


Figure 56 : Smartloop Plus+ Network Connection Detail

4.9.3 Smartloop Installation Verification

The Inductive loops and the Smartloop device are normally installed prior to the installation of the controller cabinet. A battery box is available, which allows the installers to confirm the correct installation of the Smartloop device in combination with the loop. The battery box will energise the Smartloop device and allow the installers to monitor the detection LEDs thereby confirming correct loop connections.

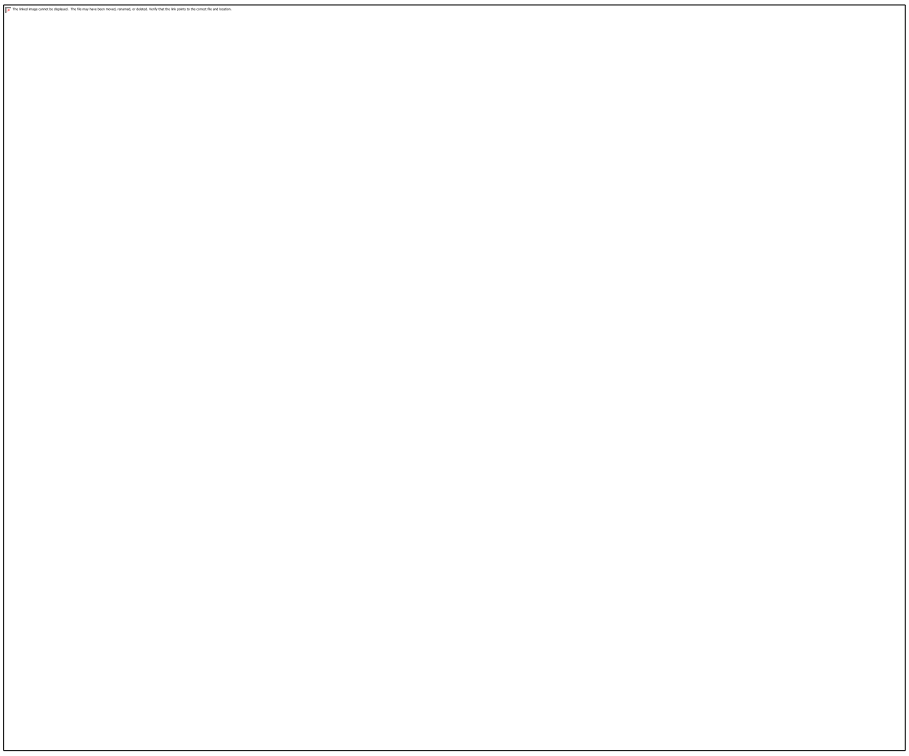


Figure 57: Smartloop Battery Box

4.9.4 Parts

SmartLoop 20-150uH – 667/1/53160/001

SmartLoop 150-300uH – 667/1/53160/002

Smartloop 260-2000uH – 667/1/53160/003

Torpedo Resin Joint (MPJ2 Resin Joint) – 915/4/03118/001

Smartloop Battery Box – 667/1/53295/001

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. Information related to Plus+ operations is provided in the relevant sections of this document.

5.1 Connection

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

- RS232 Handset Port
- USB Handset Port
- Wi-Fi
- Ethernet Port

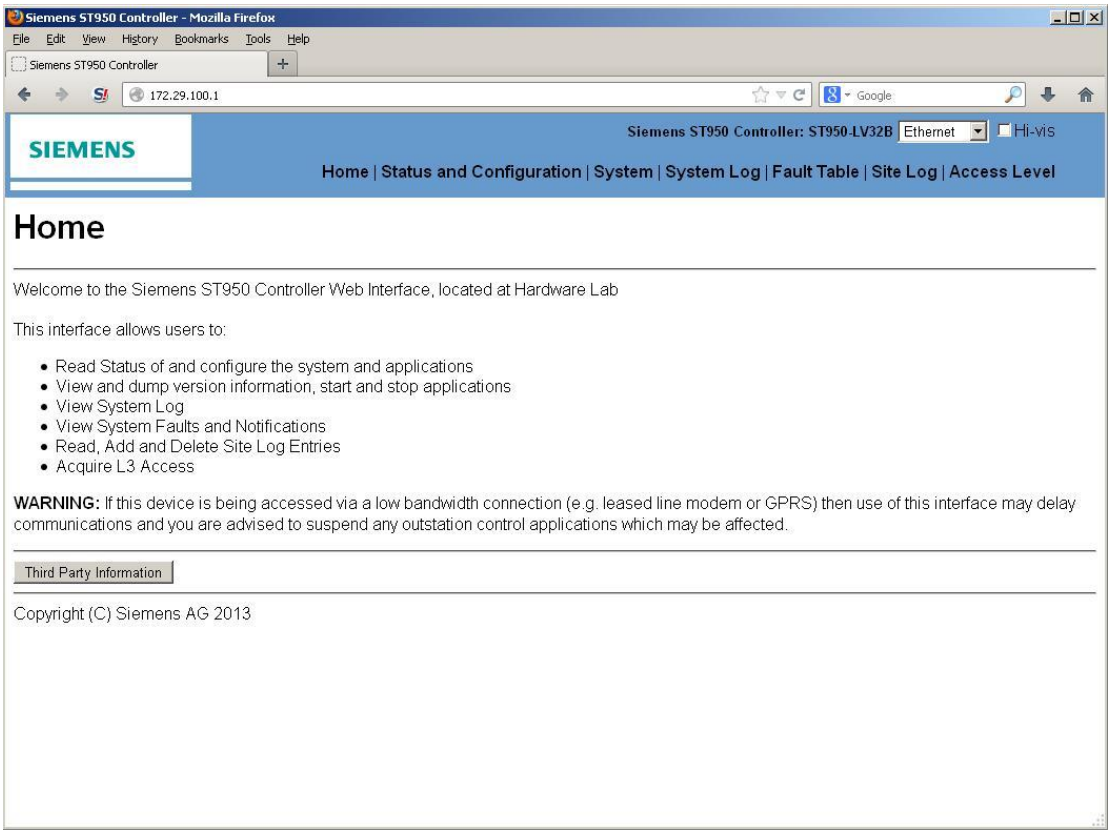
A driver needs to be installed in order to use the USB Handset port. A suitable driver for Windows is provided by the controller and can be installed on connection to the controller.

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.



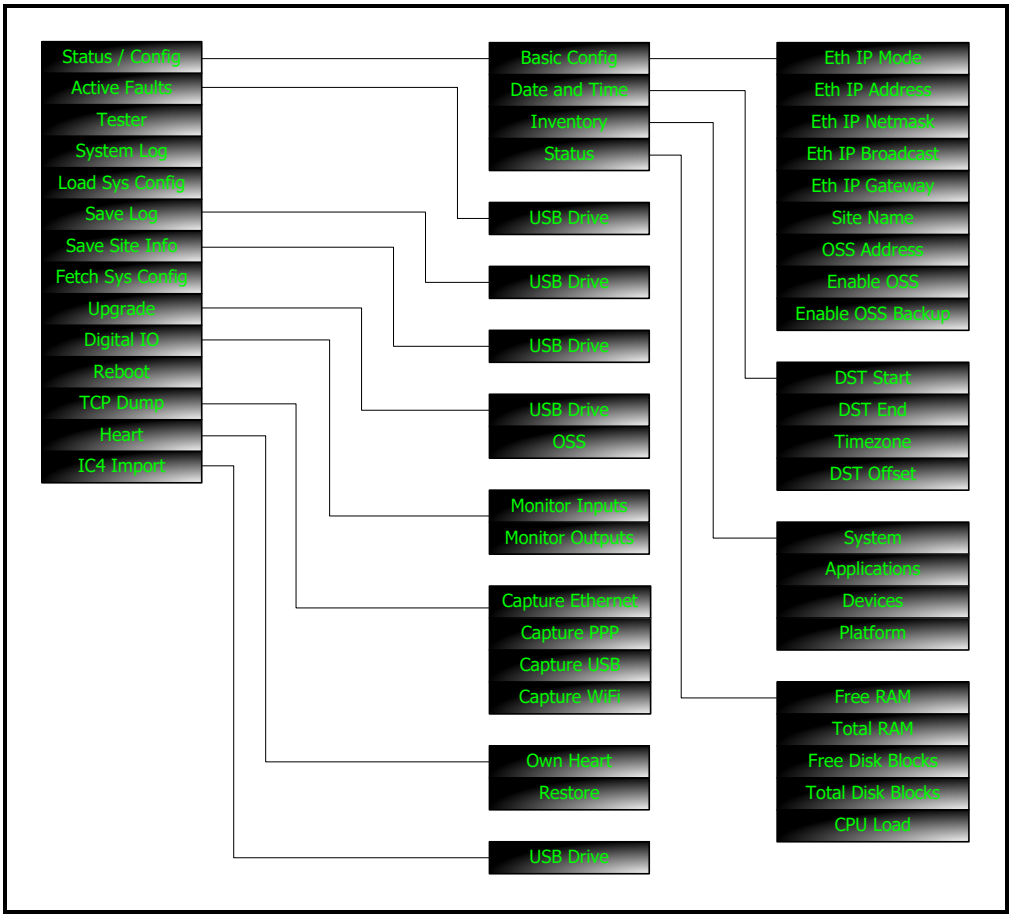
5.2.2 WIZ (Deprecated)

WIZ Commands

There are a number of WIZ commands are still supported for standard ST950 features. However, there is no real new functionality available to implement many of the Plus+ features.

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 (e.g. SSH).

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 (SSH) and are fully described in 667/HH/46000/000 (controller handset) and 667/HB/31760/000 (GVP handset).

6 INSTALLATION AND COMMISSIONING PROCEDURE

6.1 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 configurations are 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
- All plugs and sockets are securely mated
- All fixings are tight – especially those securing cards to side or back panels of the cabinet.

Power the cabinet on and run the self-test.

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

  Status and Configuration → Controller → IC4 Config

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

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.

Cabinet Key Lock

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.

6.2 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.

6.3 Cabinet Installation - Summary

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 for any significant period of time 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.

6.3.1 Order of Installation

- Remove the electronics from the controller, if required (see above and method in Section 6.3.2 below).
- Install the stool into the ground
- Run cables to the controller stool.
- Terminate the cable armouring to the SEB or CET bars
- Test the cables – if applicable.
- Fit the controller case to the stool
- In-fill the stool
- Seal the base
- Refit the electronics (if required)

6.3.2 Removal of Controller Electronics (Not normally Required)

Ensure the Master Switch is in the OFF position

Remove all PCBs from the rack. Swing the rack forward and unscrew the retaining bolts from the back plate of the rack. Tie this plate to a convenient point on the rear face of the cabinet.

The controller outer case is now ready for installation.

6.4 Installation of Stool

The Plus+ Controller can be mounted on one of three different stools.

For all relevant stool installation methods please refer to 667/CC/53060/000 – Siemens Mobility Controller Cabinet Stool Installation Method Statement.

6.5 Installation of Traffic Signal Poles.

The installation of the street infrastructure is outlined in the following documents;

667/HE/20662/000 Installation & Commissioning – Signals & Poles

6.6 Site Cable Installation

Site Cable Installation

For all site cabling to be installed, the installer is to refer to the Plus+ STS drawing, site layout design and configuration documentation. The STS drawing will contain all cable routes, connection details and street furniture locations.

The design tool and the Plus+ Site Layout design has been developed such that it meets the standards as set out in 667/DS/20664/048 - Traffic Signal Junction Cable Design & Certification for ELV Systems.

In addition, the installer should confirm that the Plus+ Site Layout version provided matches that identified on the Completion Certificate.

Traffic Signal Installation Completion Certificate (667/HE/20664/004)

Prior to installation please confirm that the junction design engineer has completed the first part and the second half as verification that the electrical design, including junction cabling, is as required in Junction Cabling Design Guide.

If the installers have deviated from the Plus+ Layout Design (see next point), the installers must sign off the second part to confirm the installation continues to meet regulations.

Additionally, ensure that the Site Layout Drawing Number and Revision are recorded on the certificate.

Significant differences in the actual ducting and that in the drawing

If there are significant differences in the actual ducting and that in the drawing, e.g. a duct had to be placed in a different position, then if any cable run is marked as Amber on the drawing raise the issue with the designer before installing any cables.

If the cable run is marked as Green on the drawing, then the Commissioning Engineer should review the percentage loading on the drawing and make a best judgement if the installation can continue without re-assessment.

If there is any doubt, please contact Siemens Mobility ITS Technical Support.

6.6.1 Cable Installation to Controller

Wiring runs should be made as neat as possible. The Plus+ Design Tool allows for several meters of spare cable which can be used for future possible changes and/or additions. If cable idents are required, these should be fitted to cores before termination.

All cables into the controller should be fed into the outer case, through the Sealing and Earthing Bar (SEB) when using the Plus+ Stool, or the CET glands, via CET bars, when using the Standard Controller Stool. Care must be taken not to obstruct the Electricity Supply Company cut out with any cabling.

6.6.2 Terminate the cable armouring (Plus+ Stool)

The components on the Sealed Base Kit are described in Figure 58.

1. Loosen nuts on the top clamps.
2. Remove top clamp.
3. Remove base plug from the base seal block.
4. Remove the stool door.
5. Feed cable up into cabinet through the base plate and compression seal.
6. If cable is loose in the compression seal, then select a suitable shim for the cable diameter.

Shims

Shims available are 667/2/53033/000 – 9mm, 667/2/53033/001 – 12mm, 667/2/53033/002 - 15mm.

7. Check length of cable required to reach its termination point.
8. Ensuring that the cable length is suitable for termination, cut through cable and armouring with a suitable tool.

9. The armouring must fan out to 90 degrees with a 30mm diameter to be clamped properly. See Figure 58. Strip back outer sheath of cable exposing the correct length of armouring to be bent down to achieve this.
10. Check the inner cable cores can pass through the holes in the top clamp. If the holes are too small, then replace the top clamp with the larger 22mm diameter option (667/2/53017/001).
11. Using pliers bend armouring out to 90 degrees. See Figure 58

Earth Connection

An earth connection is made by sandwiching the cable armouring between the top and bottom clamps. It is important that the clamping force is applied evenly across the clamp plates so please make sure that cable armouring does not overlap between cables.

12. Repeat for the next cable (up to 4 cables per compression seal).

Compression Seal Blocks

1 off compression seal block is provided directly under the master switch panel for mains, communications cable etc. In addition, there are another 3 seal blocks provided (12 cable entries for street cables), see Figure 44. If more cable entries are required use the Plus+ cabinet seal expansion kit – Extra 8 Cables - 667/1/53065/008.

13. Replace the top clamp and nuts.

Grease on studs

There should be some grease on each stud, please make sure it is there. If there is no grease then it is very likely that the nut could seize making it unremovable in the future. If there is no grease then please apply either carbon grease or copper grease to the stud.

14. Tighten down the nuts on the top clamp. Tighten each nut a little at a time so that the force is distributed evenly across the plate. This will minimise any side loads from being applied to the top clamp. Tighten until the bottom clamp touches the base plate.
15. Terminate the cables in the cabinet.
16. Replace the stool door.

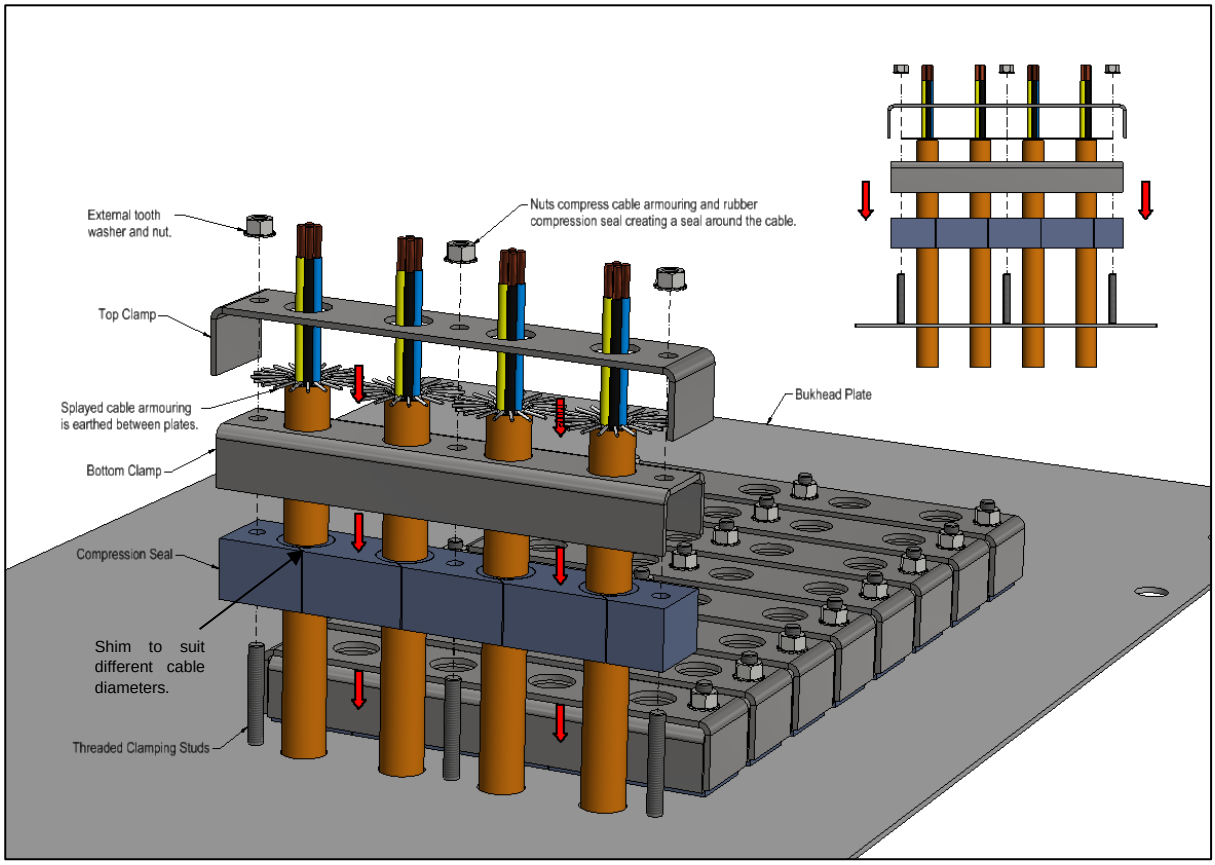


Figure 58 – Plus+ Sealed Base Kit Components and Earthing Mechanism

6.6.3 Terminate the cable armouring (Standard ST950 Stool)

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 CTB 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 outer cable sleeve must be stripped from the armouring approx. 0 to 2mm below the level of the CET ring. See Figure 50 for details.

The inner sheathing is removed to expose the individual leads, which are connected to associated terminals, leaving sufficient spare length for re-making off the ends should this become necessary.

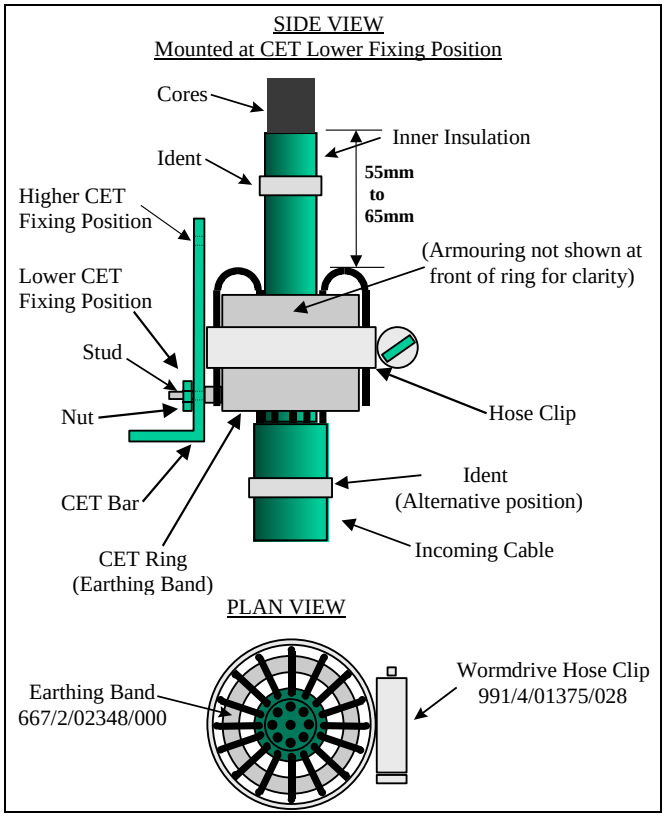


Figure 59 - Termination of Armoured Cable to CET bar

6.6.4 Terminate the cable armouring – General Items

If required and 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 can be identified as to their destinations and additional cable idents may be required on specific contracts.

After the site cabling has been terminated, additionally check:

- The cable connections to the SEBs or CET are tight
- The street cables are terminated correctly into the appropriate connectors.

Figure 60 : Termination of Cable in SEB

The Plus+ sealed base kit provides 4 cable entries for mains & data plus an additional 12 cable entries. See Figure 60. If additional cable entries are required then the Plus+ cable seal expansion kits must be used (667/1/53065/008), each kit provides 8 additional cable entry glands.

6.6.5 Terminate cables at the PTB (Pole Top Board)

Termination of the Feeder Cable at the Pole Top Board is recommended at this stage. This allows for the cable testing to proceed.

Reference section 4.1 for detailed information.

6.6.6 Cable Testing

If the site contains a ring cable arrangement the following test should be considered after the site has been commissioned and while the signals are bagged;

Identify a safe position where the ring can be broken.

A single break in the 48V power cabling will not result in the failure of any Nodes. However, if any nodes do fail it suggests that there is a break in the power part of the ring.

This test is not required for the data pair as this is a monitored function of the controller.

The electrical testing of the controller and cables are based on a PELV system, as defined in the IET Wiring Regulations (BS 7671). There may be specific or additional customer requirements for testing the cabling.

Site cabling must be tested against the requirements of the Installation and Commissioning Handbook – Installation Testing (General) (667/HE/20664/000).

Cable Testing

Do NOT test any site cabling without reference to this document (667/HE/20664/000). Additionally, with or without testing the Traffic Signal Installation Completion Certificate (667/HE/20664/001) needs to be completed as part of the completion of site commissioning (see Section 6.8).

Additionally, the cable testing should not be carried out once the Node are connected to the system.

6.6.7 Fitting the Cabinet to the Stool

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 SEB. Once the cabinet has been secured, moving of the cables could cause damage.

Back-Fill and Base Sealant

If the Plus+ Controller Cabinet is being mounted on a Standard Controller Stool, then there will also need to be a process of backfill and base sealant application.
Detailed information can be found in the Stool Installation Document (667/CC/53060/000).

6.7 Re-fit the Controller Electronics (if applicable)

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

- All cards are seated correctly in their sockets
- All plugs and sockets are securely mated
- All fixings are tight – especially those securing cards to side or back panels of the cabinet.

6.8 Installing the On Street Equipment

Following the installation of Stool, Controller Cabinet, Signal Poles and Cabling, the next installation activity is likely to be the remainder of the on-street equipment.

There are number of handbooks that cover these topics in detail;

667/HE/20662/000 Installation & Commissioning – Signals & Poles

667/HB/30000/000 Helios General Handbook

667/HB/31900/000 Heimdall Above Ground Detector Manual

In addition, Section 4 covers all the Plus+ specific equipment and the details with regards to interconnections.

If the equipment has not been pre-scanned, using the Installation App to allocate the serial numbers of the Nodes to the configuration file, then this is also a suitable point for this to occur.

The Plus+ Installation App Quick Start Guide (667/HQ/53000/300) provides details.

Confirmation of the Layout Design and Configuration

The Plus+ Design Layout will have a drawing number and revision. It is prudent to check the Plus+ Design Layout Configuration matches the Design Layout Drawing.

When using the Installation Application, the home screen will display the Drawing Number, Drawing Title and Revision. Further details can be found in Plus+ Installation App Quick Start Guide 667/HQ/53000/300

6.9 Controller Commissioning

In order to successfully commission a ST950 Plus+ controller, the use of a laptop and the USB handset port is highly recommended. Many of the traditional handset commands are supported but the user will find that the web interface provides a more detailed and appropriate view of the controller status to allow easier testing and commissioning.

FAT (Factory Acceptance Testing)

It is normally expected that the site design (Plus+ layout configuration, site drawing and IC4 Configuration) is reviewed with the customer.

Refer to MM-TS-CS-FM-026 which provides full details and a checklist. The commissioning processes detailed below assume the customer FAT has been completed.

6.9.1 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 6.9.2)
- Load the IC4 configuration (section 6.9.3)
- Load the Plus+ Site Layout Configuration (section 6.9.4)
- Add the required Licence(s) (section 6.9.7)
- If required, configure the communications systems (e.g. IP data) (section 6.9.8)
- If required, configure and start MOVA referring to the MOVA7 handbook - 667/HB/31601/000
- If required, configure and start UTC referring to the UTMC OTU handbook - 667/HB/46000/004
- If required, start the Controller Monitor application to report controller status to Stratos – the application control is found via the web page; Systems → Applications.
- Set the controller date and time (section 6.9.11)
- **Bag all signal heads**
- Perform Lamp tests to ensure correct configuration (section 6.9.12)
- Perform Solar Cell testing (section 6.9.13)
- Perform Junction Testing (section 6.9.14)
- Extract site information for review with customer (section 6.9.15)
- 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. See the ST950 User Interface Handbook (667/HU/46000/000) for further information.

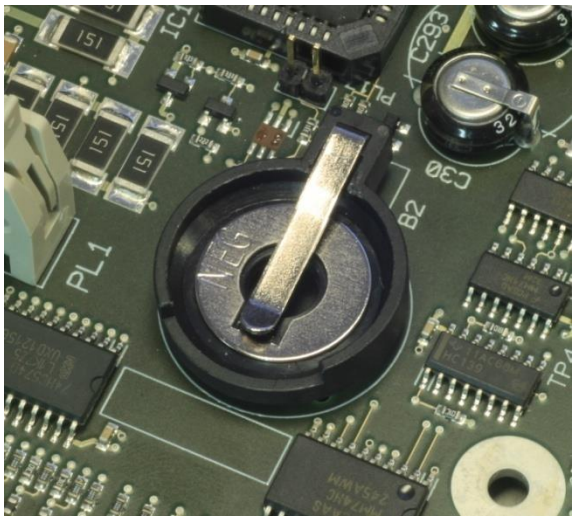
6.9.2 RTC battery backup kit

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:

RTC Battery Replacement

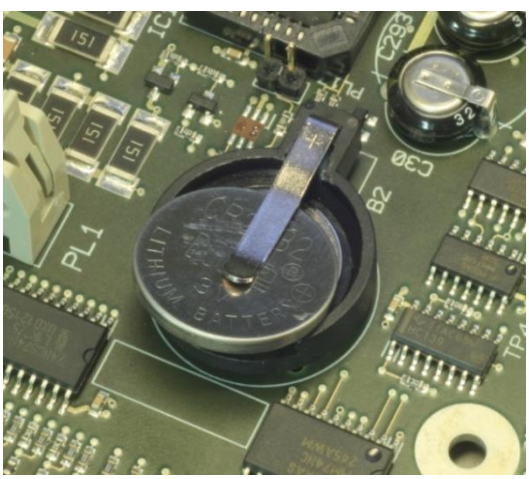
With the optional RTC battery backup in place the RTC backup period will be in excess of three years. The recommended battery replacement period is three years

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

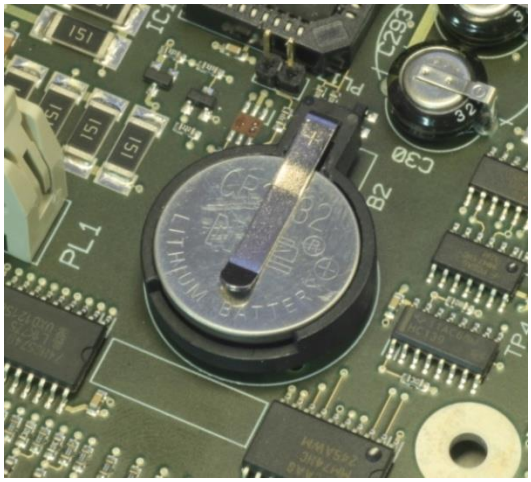


Empty holder

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

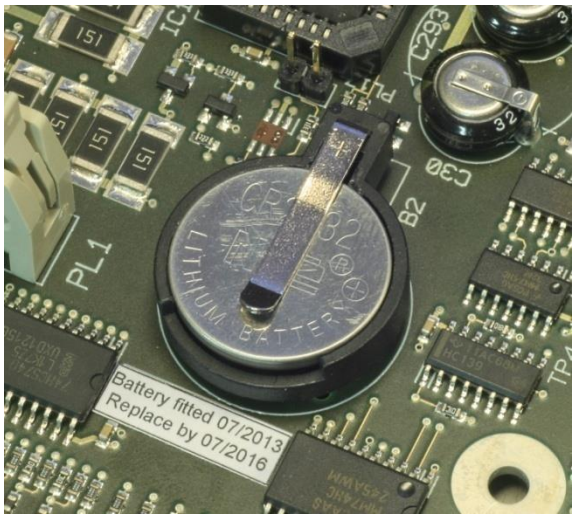


Cell partially in holder



Cell fully in holder

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



Cell and Label in fitted

RTC Battery

Ensure that during commissioning any battery isolation strip is removed.

Time Check

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

NTP Server

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.

6.9.3 Loading IC4 Configuration

The ST950 controller requires an IC4 configuration to be loaded for correct operation. Configurations can be loaded by using;

- Status and Configuration → Controller → IC4 Config → Import Config web page

Full details on how to load and confirm 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 by using;

- Status and Configuration → Controller → Heart → Ownership web page

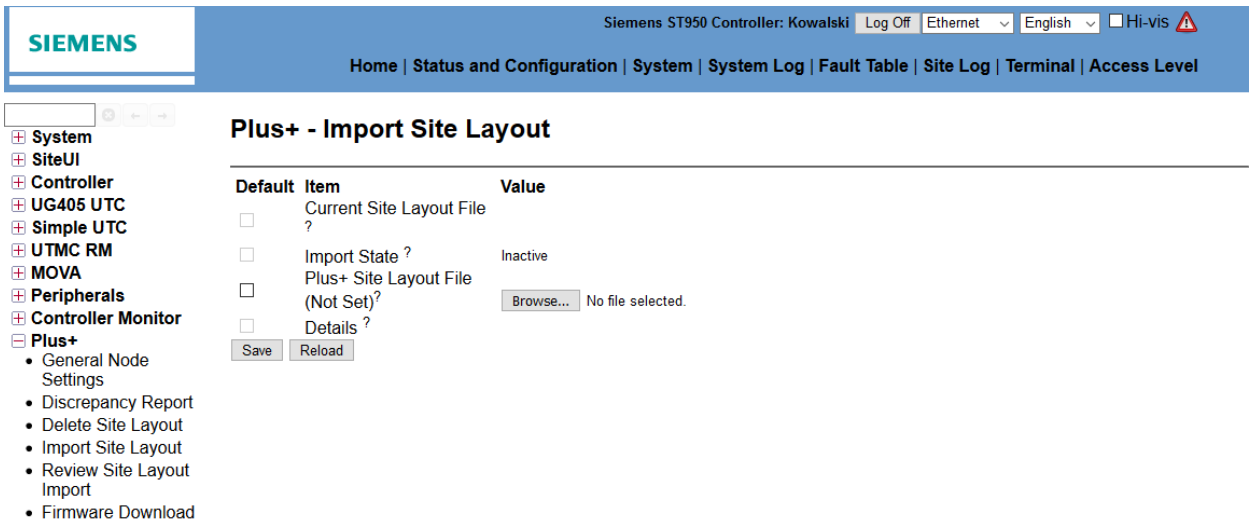
Full details of this process are given in the ST950 User Interface Handbook 667/HU/46000/000.

6.9.4 Loading Plus+ Site Layout Configuration

The ST950 Plus+ controller requires a Plus+ Site Layout configuration to be loaded for correct operation. The configuration is loaded as follows;

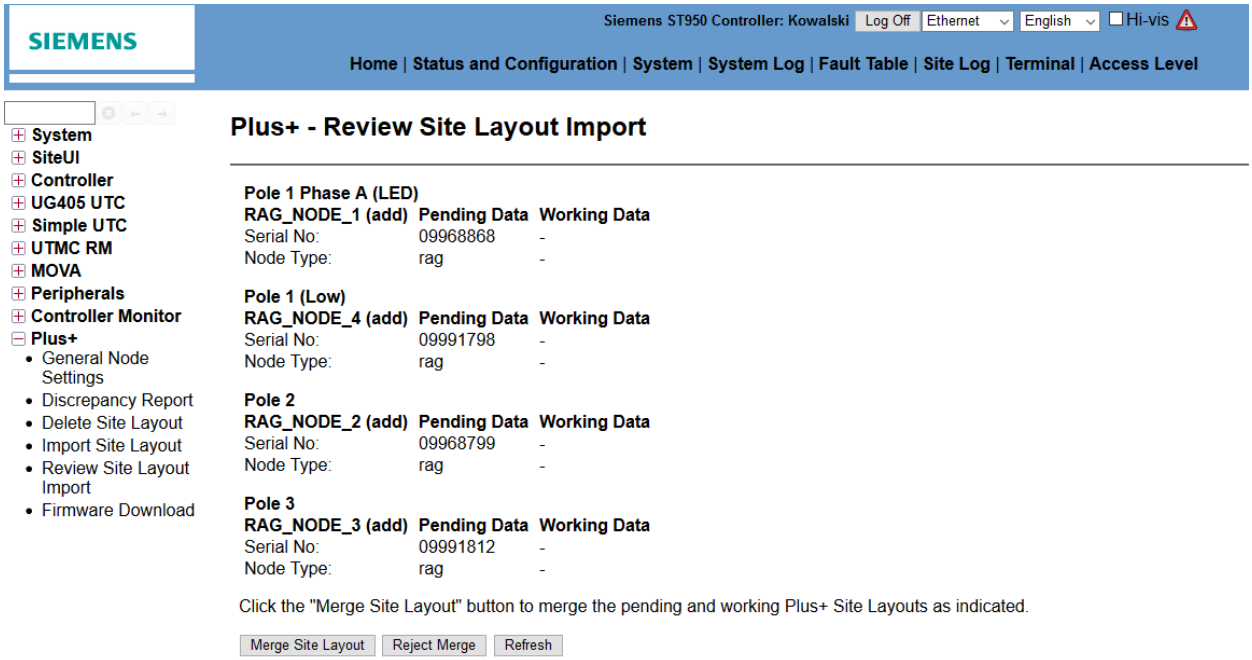
First select the configuration file using the Status and Configuration → Plus+ → Import Site Layout web page:

- Select the configuration to be imported using the *Browse* button.
- Press the *Save* button to load the configuration.

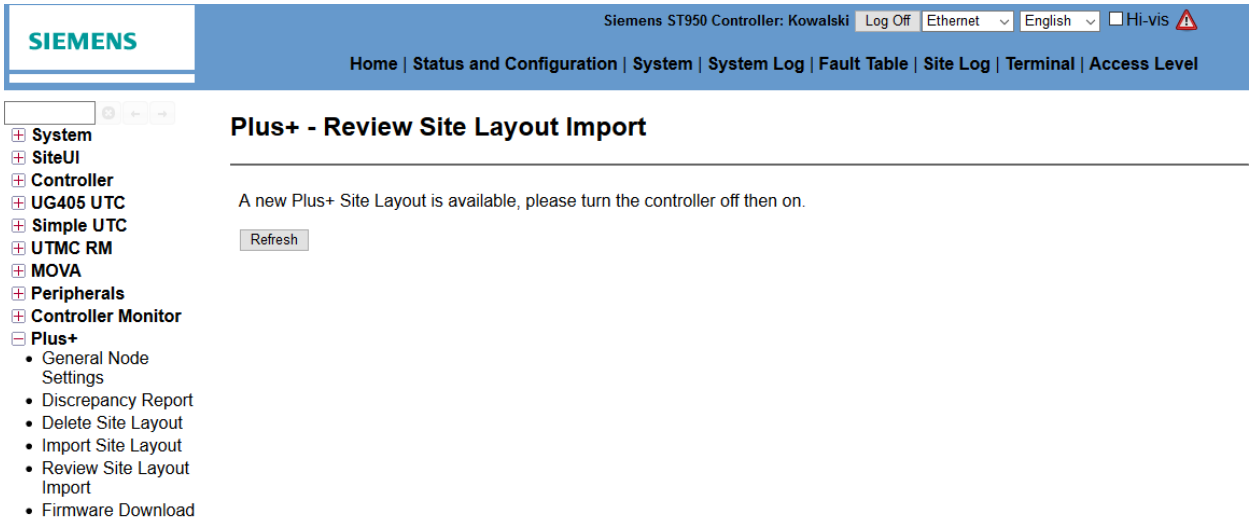


Review the changes which would be applied to the system by the new configuration using the Status and Configuration → Plus+ → Review Site Layout Import web page:

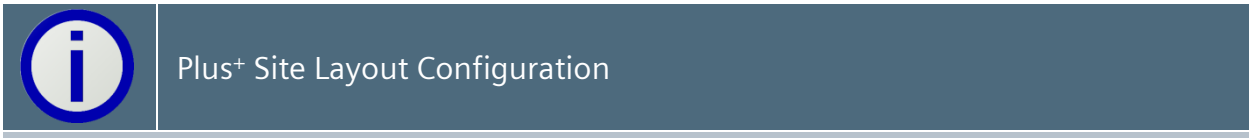
- Press the *Merge Site Layout* button to accept the changes.
- Press the *Reject Merge* button to reject the change.



The controller will need to be power cycled after pressing the *Merge Site Layout* button:



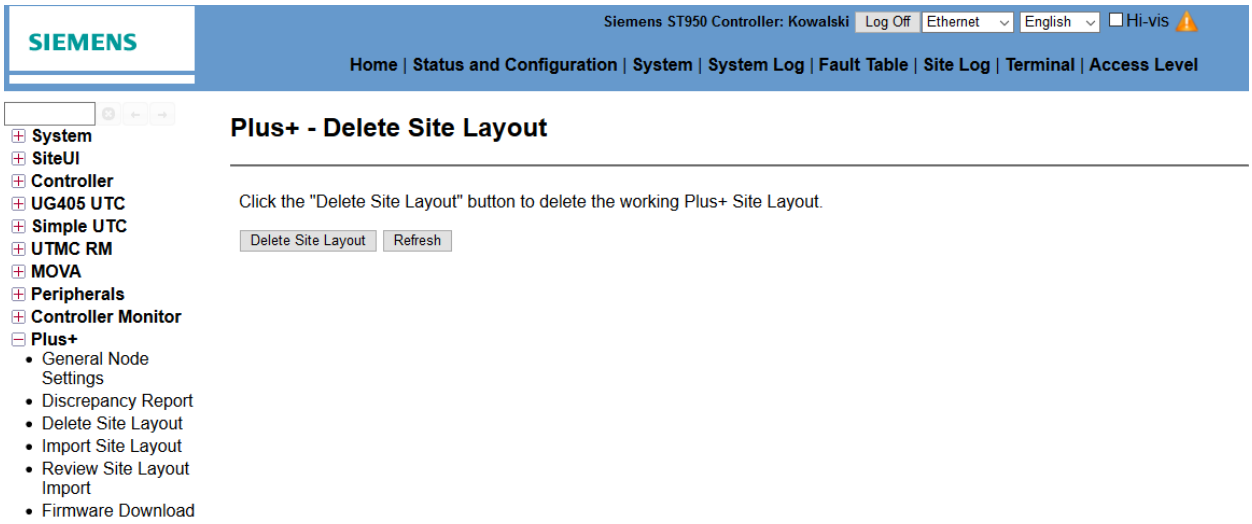
6.9.5 Reviewing Plus+ Site Layout Discrepancies



For the controller to be functional the site layout will need to be fully completed i.e. the Nodes' serial numbers will need to have been added to the configuration. It is recommended that this is completed before importing the Plus+ Site Layout, by using the 'Installation App'. Refer to the ST950 Plus+ Installation App Quick Start Guide (667/HQ/53000/300)

Discrepancies between the Plus+ Site Layout and the discovered Plus+ equipment can be reviewed using the Status and Configuration → Plus+ → Discrepancy Report web page.

If it is necessary to delete the Site Layout then this can be done using the Status and Configuration → Plus+ → Delete Site Layout web page.



6.9.6 Loading New Plus+ Firmware

If new firmware is required please refer to Appendix B.

6.9.7 Loading Licences

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

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

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

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

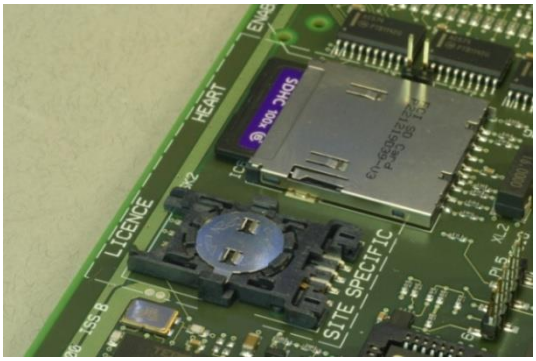
Distribution and Storage of Licences

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

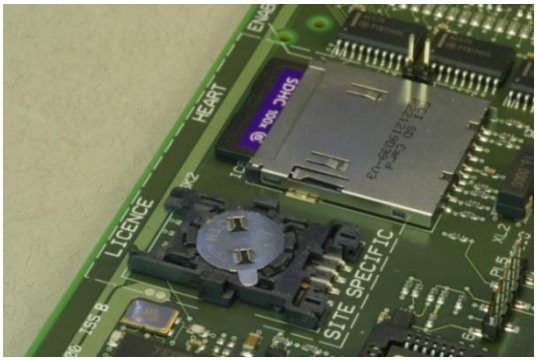
Installing Licences on the Controller

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

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

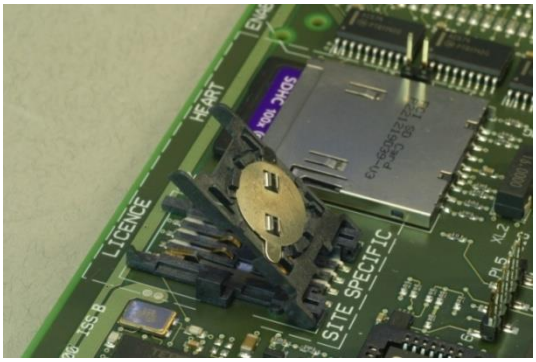


No Card – Locked



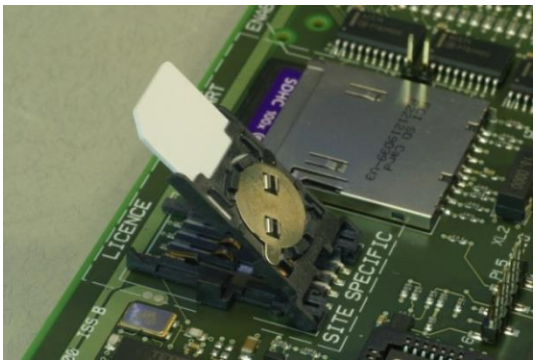
No card - Unlocked

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

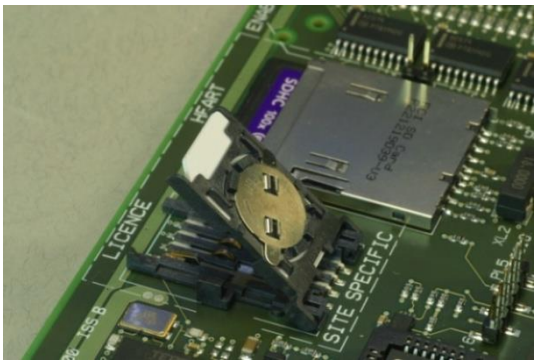


No Card, container Open

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

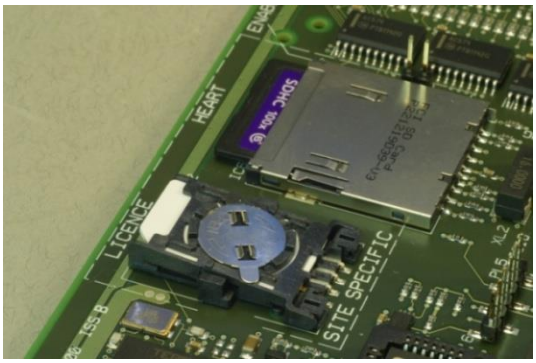


Card partially in container

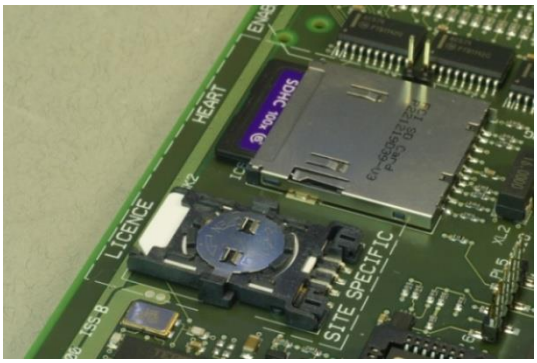


Card fully in container

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



× Card in container – unlocked



✓ Card in container - locked

- Re-connect connectors and power up the controller.

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

Licence Manager

The Licence Manager can be used to:

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

The Licence Manager is found on the web page:

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

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

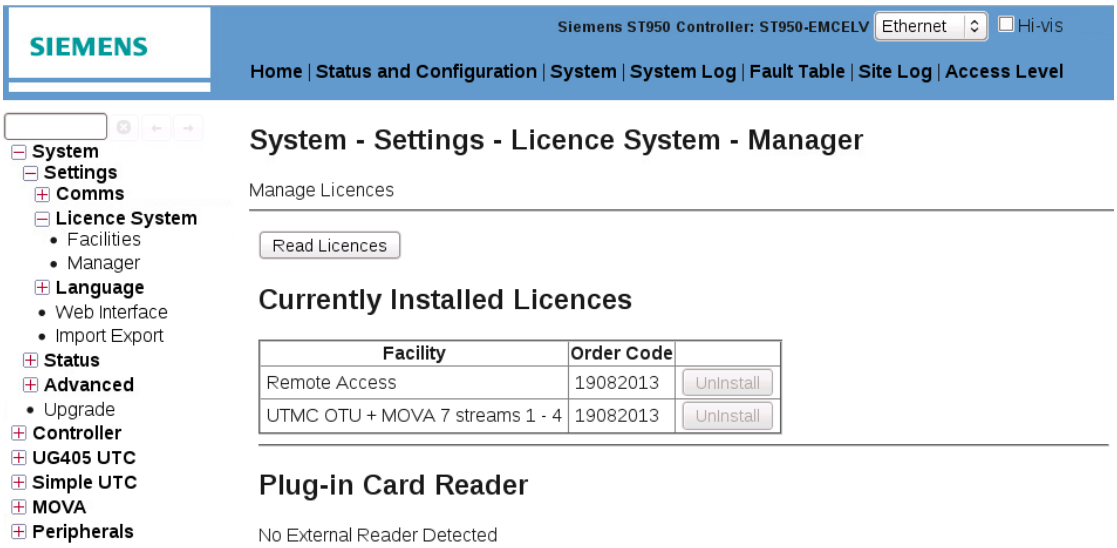


Figure 61 - Licence Manager web page with no external reader fitted

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.

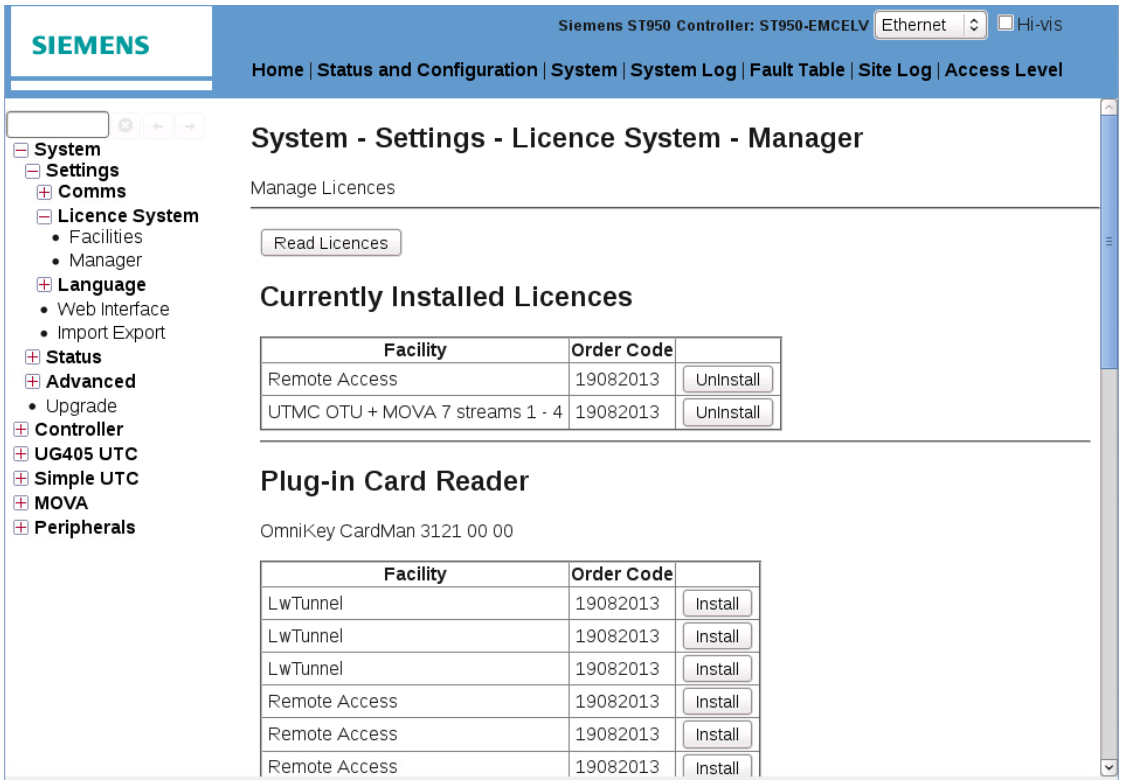


Figure 62 - Licence Manager web page with external reader fitted

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.

6.9.8 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 6.9.9) & a non-Stratos system e.g. UTC (section 6.9.10). 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.

6.9.9 Connection to Stratos

Network Configuration

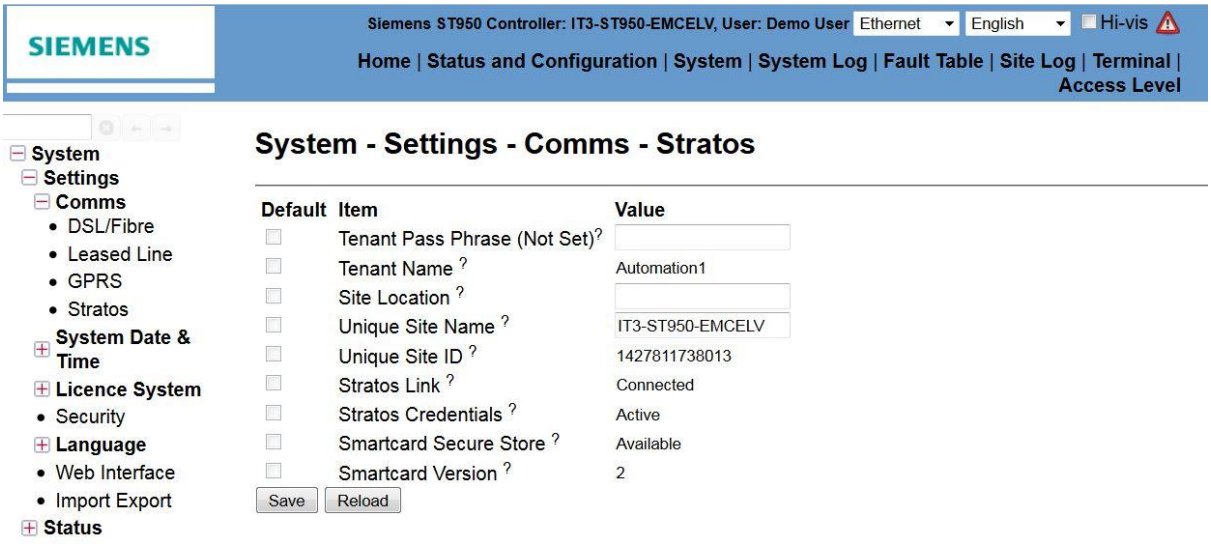
In order to connect to Stratos, the following internet services must be accessible to the equipment:

- 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 6.9.7.

Ethernet Configuration

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

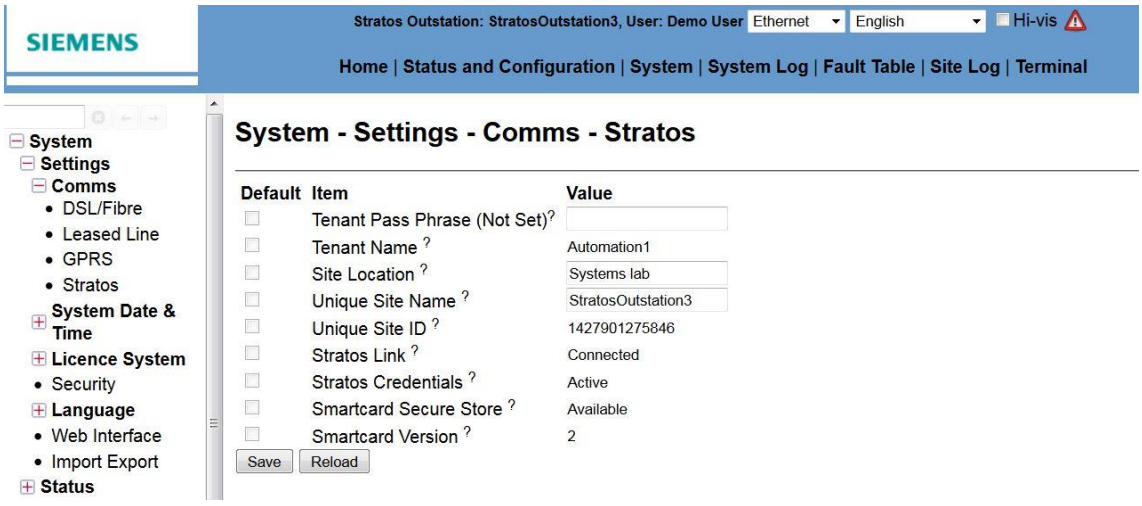
To connect the equipment to Stratos perform the following:

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:
    a. Set the Tenant Pass Phrase.
    b. Set the Site Location.
    c. 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

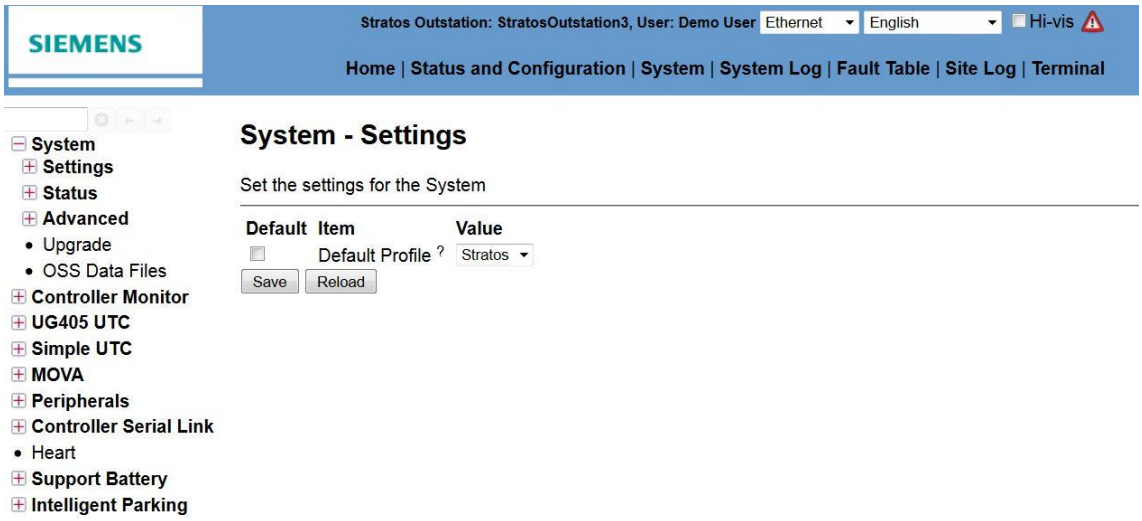
These items are set on the System – Settings – Comms – Stratos configuration web page.

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*.



6.9.10 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 document 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 is configured as follows;

- Status and Configuration → System → Comms → DSL / Fibre web page

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

6.9.11 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.

Time Zone Settings

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

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

Status and Configuration → Controller → Clocks

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

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

System Time : Stratos Connection

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

System Time : Stratos Connection

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

System Time : NTP

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

System Time : CLF Plans

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

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

'TOD=21AUG13' to set the Date and

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

6.9.12 Lamp Testing

The ability to test individual lamps is an important facility that allows faults to be identified easily and rectified.

At first commissioning or whenever major changes are made to the site signalling equipment a full lamps test must be performed to verify that all lamps are operating correctly.

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.

6.9.13 Solar Cell Testing

Solar Cell Testing

For this test to be performed the ambient light conditions must be appropriate 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

6.9.14 Junction System Testing

Using the detect lights on the above ground detectors, ensure that all above ground detectors (E.g. Kerbside, 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 or other Above Ground Detector, demand pushbuttons etc are correctly connected/configured.

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.

6.9.15 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.

6.10 Customer Acceptance

The installer is expected to 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. Full details and the SAT form are found in document reference QAFORM-TC-F-122.

7 LEAVING SITE

Before leaving site:

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

Cabinet Key Lock

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.

8 ROUTINE MAINTENANCE PROCEDURES

This section contains a list of checks that must be performed at an ST950 Plus+ 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.

Controller Cabinet Power During Maintenance

All power to the controller must be disconnected before any attempt is made to remove the internal components of the controller cabinet. The only exception would be when replacing a 48VDC PSU, which has redundancy and therefore allows for hot-swap.

8.1 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.

8.2 Routine Inspection of Pedestrian Signal and Demand Equipment

- Check all pedestrian signalling and demand units for damage and take any necessary corrective action.
- Open the pedestrian equipment and inspect no excessive pollution and for secure wiring and insulation.

8.3 Routine Inspection and Electrical Testing of Controller

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

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

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

Cabinet Key Lock

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

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

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

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

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

Ensure that no fault indications are showing.

Fuse Testing

The following tests will result in the signals extinguishing.

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

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

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

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

Inputs and Maintenance RCD Testing

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

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

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

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

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

If appropriate (when using a Standard Controller Stool) inspect the cabinet base seal. If damaged, the affected area should be filled with sand and re-sealed. For details see the Controller Stool Installation Method Statement (667/CC/53060/000).

8.4 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.

8.5 Other Maintenance Operations

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

- RTC battery replacement - see section 6.9.2
- Addition & removal of licences - see section 6.9.7
- Loading new IC4 configuration - see section 6.9.3
- Loading of new Plus+ Site Layout Design – see section 6.9.4
- Update of firmware - see section 6.9.6
- Export of site information - see section 6.9.15

9 FAULT FINDING

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

Equipment Replacement

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.

9.1 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 section 1.4.2.

9.1.1 On Receipt of a Fault Report

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

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

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

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

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

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

9.1.2 Before Going to a Site

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

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

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

9.1.3 On Arrival at the Site

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

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

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

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

Now proceed with the fault diagnosis.

9.2 Fault Finding using the Fault Log and Discrepancy Report

Controller Fault Log

A review of the controller fault log is the always the first step in resolving Plus+ issues.

If a large number of discrepancies are listed by the Controller at power-up – reporting that a number of nodes are in the wrong part of the network - check that the CIC address switches are set correctly.

9.3 Fault Finding Starting from the Fault Indications

The following is a list of switches and indicators in the ST950 Plus+ controller that assist in the location and diagnosis of a fault. The state of each of these switch indicators should be noted on arrival at a site before doing anything else.

9.3.1 Cabinet Alarm Indicator

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

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

9.3.2 Master Switch

This removes the mains supply from the entire controller when opened, i.e. switched off. This is mounted on a panel at the bottom right of the controller. If there is an adjacent expansion cabinet, the Master Switch in the main cabinet also removes mains 230V power to the expansion cabinet.

9.3.3 Controller Switch

This is included in the Master Switch panel and removes power from the equipment rack and equipment powered from it. This is a single pole switch so does not provide safety isolation. If there is an adjacent expansion cabinet, mains 230V power to the expansion cabinet is NOT

removed by the Controller Switch in the main cabinet. Also note that the maintenance socket is still powered when the controller switch is off, as is any equipment powered from Aux MCBs.

9.3.4 Main CPU Card LEDs

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

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

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

9.3.5 CIC Card LEDs

Refer to section 3.16.14 for information.

Each CIC card is equipped with 6 LEDs indicating the state of each CPU.

If a major fault is indicated (fault LED illuminated), check that the GSPI comms cable is correctly fitted and the card address is set correctly. Additionally, check that the data communications to the on-street equipment is functional (data comms or authentication issues) – ideally confirmed by reviewing the controller Fault Log.

If the issue persists after removing any reported faults then consider replacing the CIC PCB.

If all the comms LEDs on the card are out, then check that the GSPI and/or the SPB comms cables are correctly fitted.

If all lights are off, then suspect the +24V DC supply from the PSU has failed.

Check the +24V DC output from the PSU. 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 PSU and the CTB/CIC .

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

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

If the lights are out on only one CIC then the power supply on that card may have failed – replace the CIC then re-test. If the issue persists then CTB may require replacing.

9.3.6 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 PSU has failed.

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

9.3.7 Power Bank (Redundancy Module and 48V PSU)

If the fault log indicates an issue with 48V supplies or has raised any issues with the redundancy module, Table 16 below is a useful guide to diagnostics.

If the Green LEDs, which are indicators for up to three PSUs, are on then the supply is functional. Otherwise check the 48V PSUs to confirm performance.

Led Indicator	Function		Meaning
Green x 3	Presence	On	Energised PSU is connected.
Yellow 1	Imbalance LED	On[19]	Voltage Imbalance between PSU 1 and 2
Yellow 2	Imbalance LED	On[20]	Voltage Imbalance between PSU 2 and 3
Red x 3	Overload	On	Too much current is being drawn from a PSU

Table 16 – I/O Card LEDs

The 48V PSUs can easily be confirmed as operational as they have a 'DC_OK' LED indicator.

Also see additional details in section 3.7.4.

9.3.8 Intelligent Backplane Controller

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

[19] Solving an Imbalance issue involves the careful adjustment of the connected PSUs. Please contact Siemens Engineering in Poole for assistance before attempting any adjustment.

[20] Flickering - lightly loaded systems may show one or more flickering Imbalance LEDs this is not a fault.

9.3.9 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.

9.3.10 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.

9.4 Replacement of Cabinet Mounted Cards

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

9.4.1 Safety Requirements

Equipment Replacement

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.

The exception will be 48VDC PSU, if paired with redundancy units, and CIC units which are hot pluggable. Replacement of CIC is likely to cause signals off so appropriate mitigations should be put in place.

9.4.2 General Requirements

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

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

9.4.3 Access to Cards in ST950 Plus+ 19" Controller Rack

Most cards in the rack have connectors at their rear edge linked to various parts of the system. In order to gain access to the rear of the cards, first swing out the ST950 Rack Assembly. Release this by undoing the two screws at the right hand edge of the frame. Having done this there is room to reach the back of the cards to deal with the ribbon cables.

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

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

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

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

9.4.4 Replacement of 48V PSU

48V PSU Replacement

Note: The 48V PSU can be changed without the need to switch off the controller, assuming redundant configuration. The redundancy unit will manage the load sharing accordingly.

The 48V PSU should be disconnected at the mains voltage side using the 2-part in-line mains connector below the PSU. Thereafter the 48V cables can be unscrewed and removed from the PSU terminals.

The DIN rail latch can be released, by using a flat screwdriver to lever up the small protrusion at the top of the PSU, and then lifting the PSU upwards.

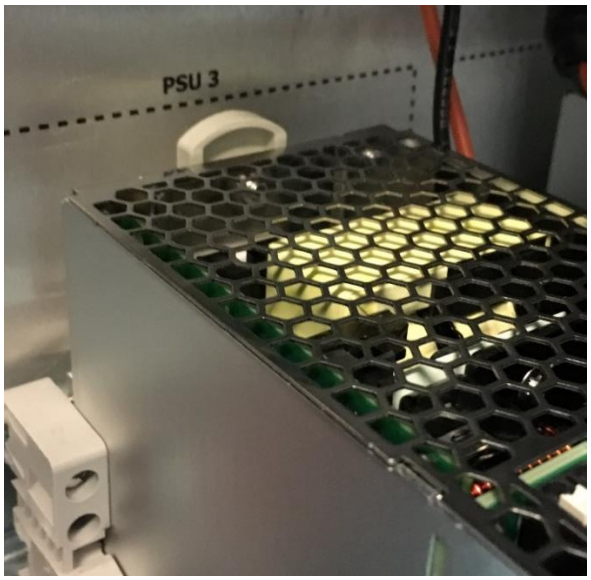


Figure 63 : 48V PSU DIN Rail Latch Release

The replacement PSU can then be clipped in place and the fitment of cables will be the reverse of the operation described above.

9.4.5 Replacement of 24V PSU.

24V PSU Replacement

Replacement of the 24V PSU – used to supply logic rails – will require the supply to the cabinet to be switched off at the double pole master switch.

Once the controller cabinet has been shut down, the cables can be removed from the PSU. The PSU will then need to be released from the DIN rail.

The replacement PSU can then be clicked into place, cables reinserted, and controller powered up.

9.4.6 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.

Replacement CPU Card

Only replace a CPU card with a compatible variant: 667/1/46010/101

Replacement CPU Card : IP Configuration

Before re-connecting the Ethernet connector ensure 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 running system, from 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.

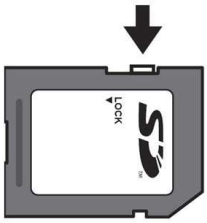
Cloning and Restoration of a CPU Heart

When restoration from Heart is being performed, to clone a system onto a replacement CPU card, 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 to avoid conflicting network issues due to prior and incompatible network configurations.

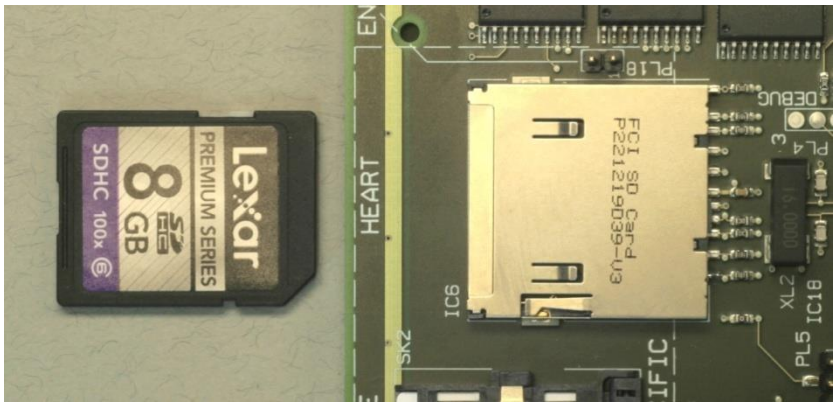
Move Heart to new CPU card

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

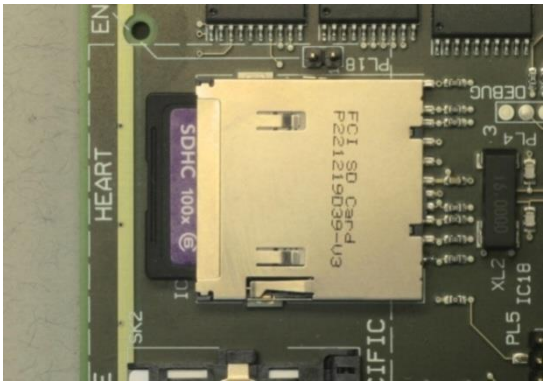
Note: It is important that the card is not write protected. The ‘lock’ switch must be in the position shown in the diagram below:



SD card Write Enable switch position



SD Card Orientation



✗ SD card partially inserted – incorrect ✓ SD card fully inserted – this is correct

Restore from Heart

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

Restoring from the Heart Using Web Pages

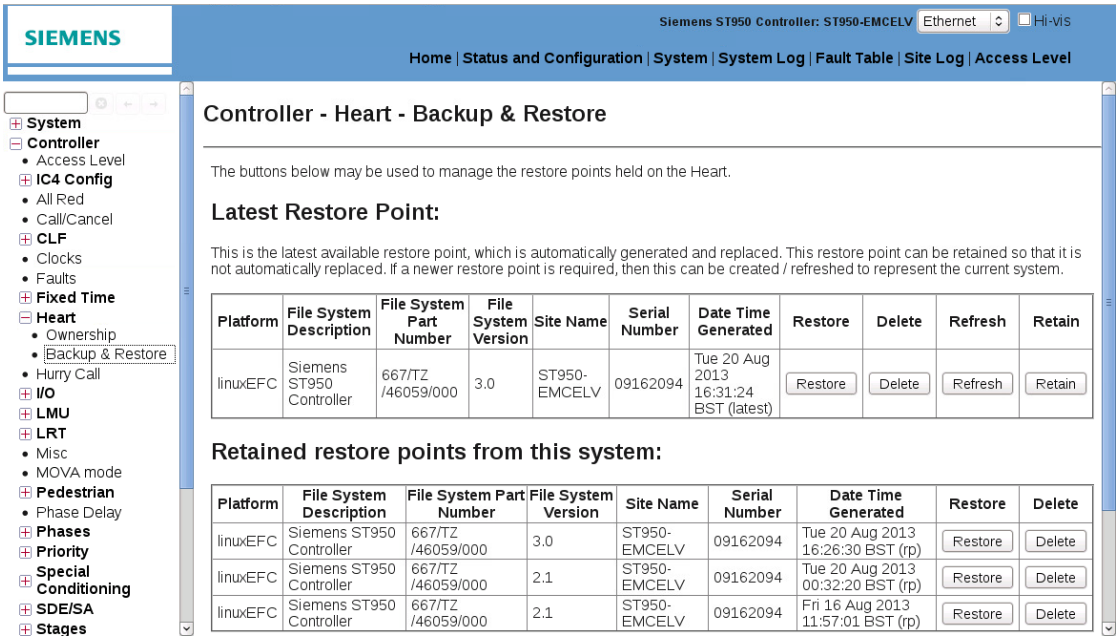


Figure 64 - Restore Points available for use

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.

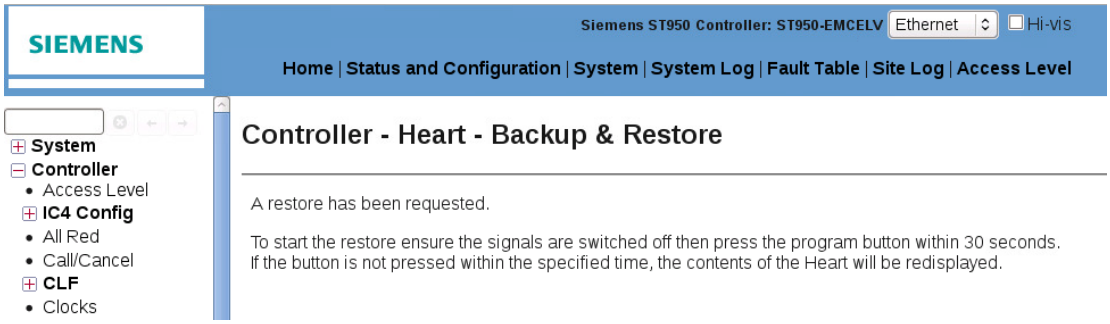


Figure 65 - Restoration instruction screen

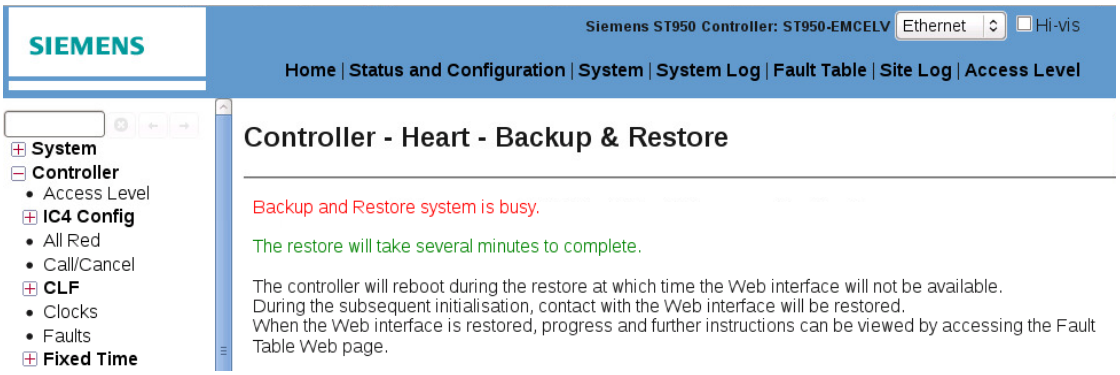


Figure 66 - Restoration progress screen

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.

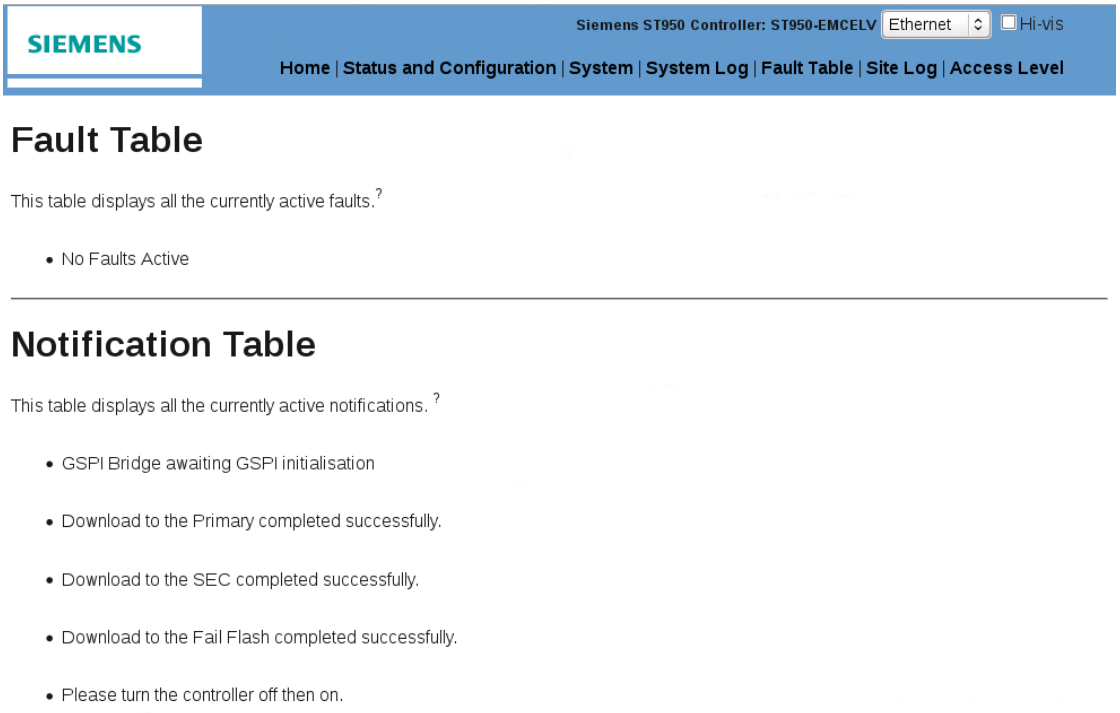


Figure 67 - Fault Table on completion of restoration from Heart

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.

9.4.7 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 9.4.6

Own Heart

Before using a new SD as a Heart it must be owned, as detailed below.

Owning the Heart Using Web Pages

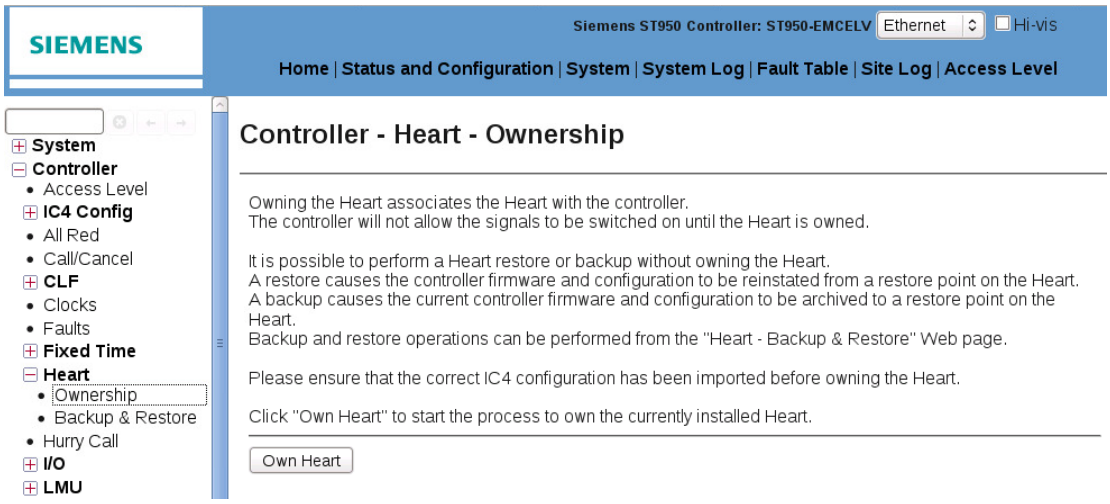


Figure 68 - Web page used to own the Heart

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.

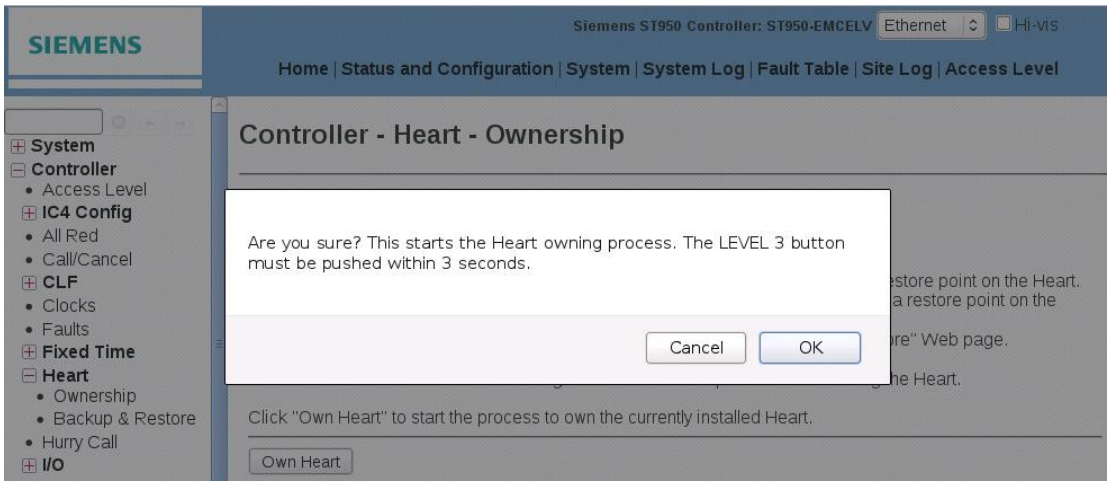


Figure 69 - Request to press Level 3 button during Heart ownership sequence

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

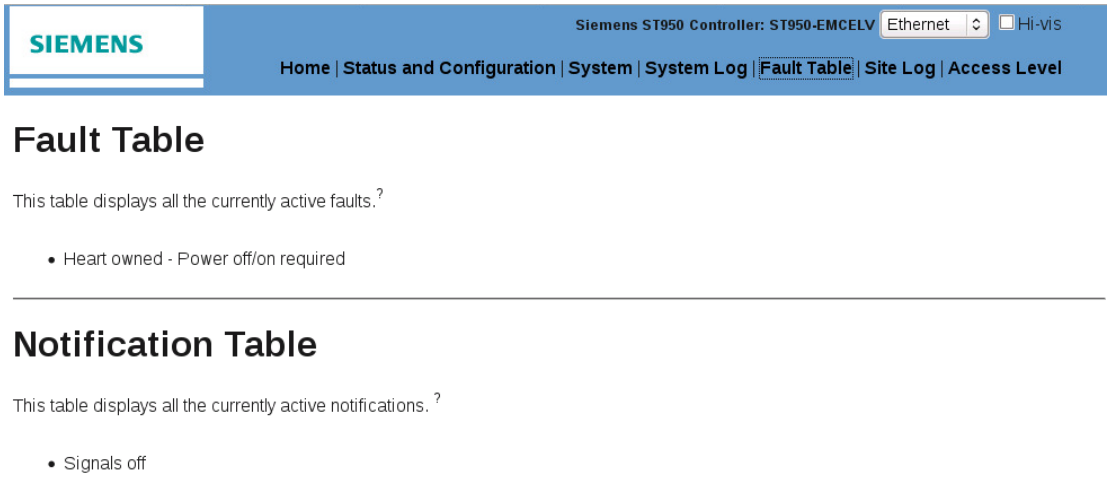


Figure 70 - Fault Table indication that the controller must be turned off then on to complete the Heart ownership

9.4.8 Replacement of CIC Card

Replacement CIC Card

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

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

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

CIC Card Address

Remember to set the CIC card address to be the same as was set on the faulty card.

CIC Card Position Three

CIC 3 is reverse orientation; the spring clip is on top.

If the backplane is also removed, ensure all street cables are reconnected in the same positions.

Ensure that the SPB and SIO cables are connected in the same orientation on the replacement backplane card.

9.4.9 Replacement of I/O Card

Replacement 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.

9.4.10 Replacement of Intelligent Detector Backplane Card

Replacement IDB Card

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

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

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

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

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

9.4.11 Replacement of the Manual Panel Card

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

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

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

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

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

9.5 Replacing On-Street Equipment for Maintenance

See Appendix A for details of approved spares.

Node Signals illuminate immediately following user action

As soon as certain user actions are accepted (e.g. 'Acknowledge' in the Fault Log), the Signals on the Node will illuminate in whatever state is required for the Phase. As field support the user should either:

- Trigger the action at a suitable point in the traffic sequence, e.g. Phase at Red with the traffic on that approach already stationary
- It is therefore expected that the Plus+ Signal is bagged when it is fitted to a Pole (whether it is new or existing) until it is checked. This applies to ALL signal included but not limited to RAG, Near-Sides and Waits.

Removing Faulty Node when there is no Replacement

If a failed Node cannot be replaced and is going to be left (e.g. no spare available), the Node should be disconnected (from its Bypass Module) to isolate the 48V supply from those Signals.

9.5.1 Replacement of a RAG Node.

The RAG (Red Amber Green) Node can be hot swapped, in most cases, as part of a maintenance procedure.

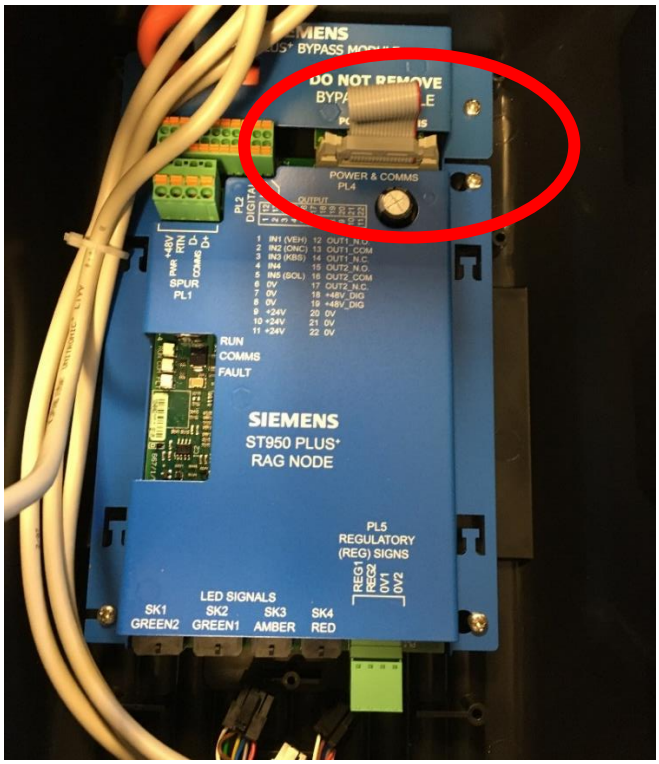
Take note of 'Last Lamp'

When replacing Nodes, the technician should consider the 'Last Lamp'. If the 'Last Lamp' of any phase will be extinguished due to the replacement of a Node, a compliance error will be registered by the controller and the site (or stream; depending on configuration) will be extinguished.

The process of removal is as follows;

1. Open the Green Aspect door, on the traffic head that contains the relevant Node.

2. Remove the ByPass ribbon cable connection PL4.



3. Remove any external connections. Include the Regulatory Sign connection if utilised.

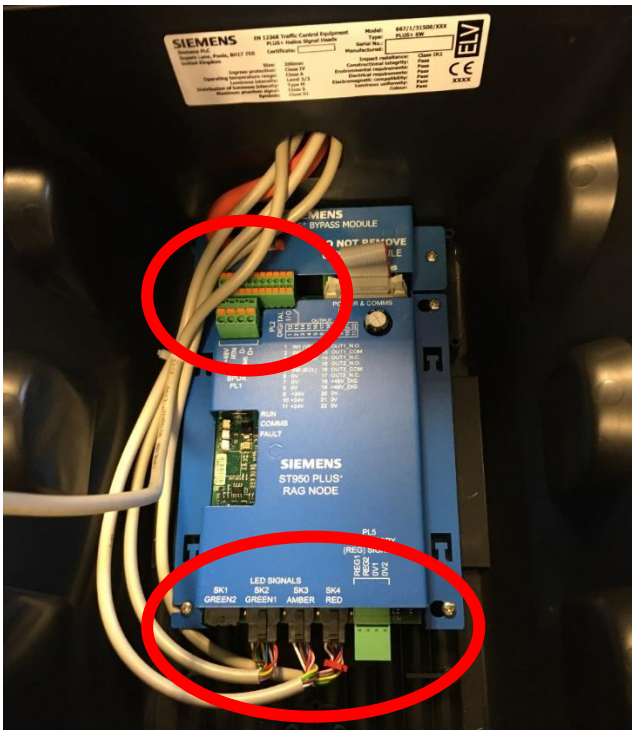
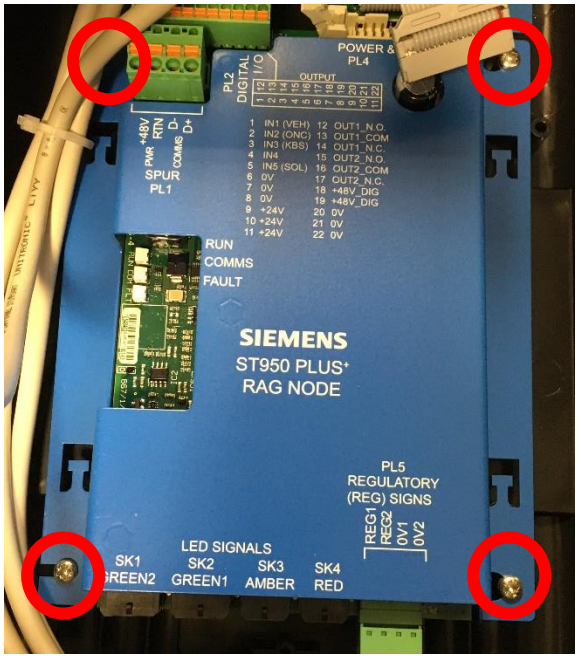


Figure 71 : RAG Node External Connection

4. Loosen the four retaining screws.



5. Remove the board by sliding the node to the right and lift on the right side.

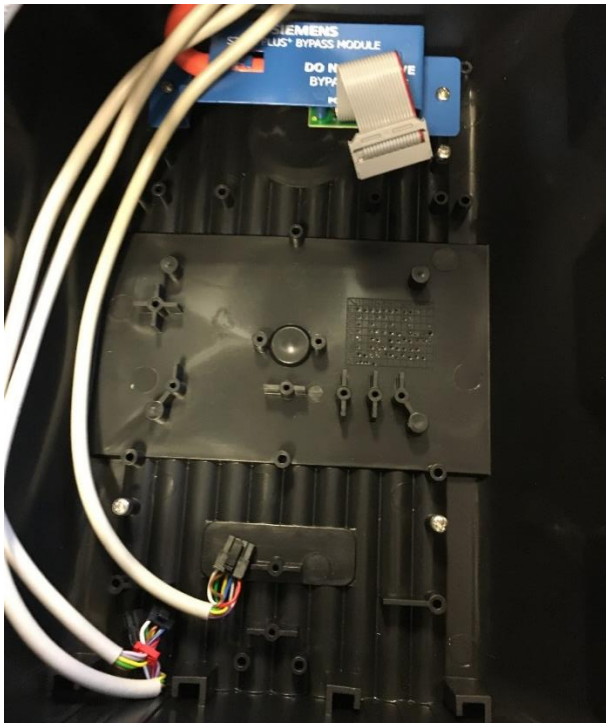


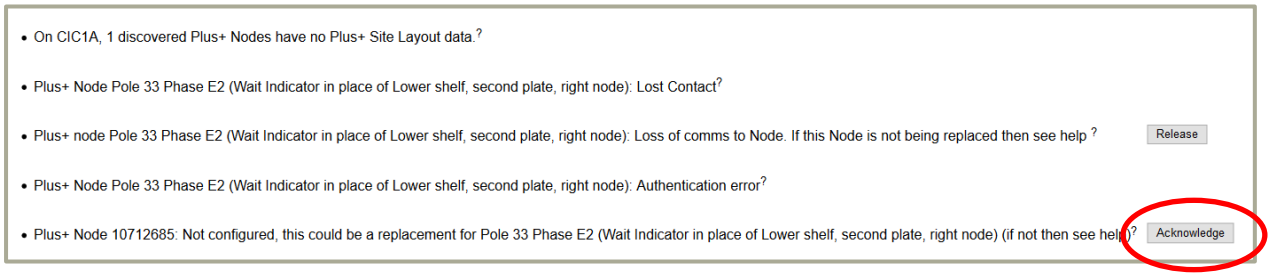
Figure 72 : Detail of RAG Node having been Removed

6. Replacement is the reversal of removal.

Take note of the New Serial Number

For a single Node, the process to acknowledge an update does not require prior knowledge of the Serial Number. However, it is good practice to note the New Serial Number and update any backups of the Design Layout (paper or Electronic). If multiple nodes are being replaced, then the Serial Number will need to be noted for configuration update.

7. At the controller, in the Fault Table, the User is expected to press the L3 button to remove the 'Authentications' issues listed.
8. The user is then offered to 'Acknowledge' the change in Node. Note: The use of the 'Release' Button, if seen, is not required.



Replacing a Signal Head

If the complete signal head is being replaced, disconnect the dropper cable from the pole top board and pull through before removing the complete signal head assembly.

The new signal head can be installed in its place.

The controller will recognise the ByPass having been changed and will require an 'Acknowledge'.

Confirm Signal Head Position and Orientation

When replacing a signal head, the orientation and location must be confirmed by using the Lamp Test facility, for example.

9.5.2 Replacement of Wait/PDU Board

The Wait/PDU board is used in three variations of Node, namely Wait Indicator, PDU (Pedestrian Demand Unit) and as part of the Nearside combined. In most cases, the Wait/PDU board can be hot swapped as part of a maintenance procedure.

The process of removal and replacement is similar in all three cases.

1. Remove power and communications by disconnecting the ByPass connector. In the case of a Combined Nearside there are two ByPass connections, one of which will be to the Nearside Indicator Board. In this case both connections will need to be un-made.

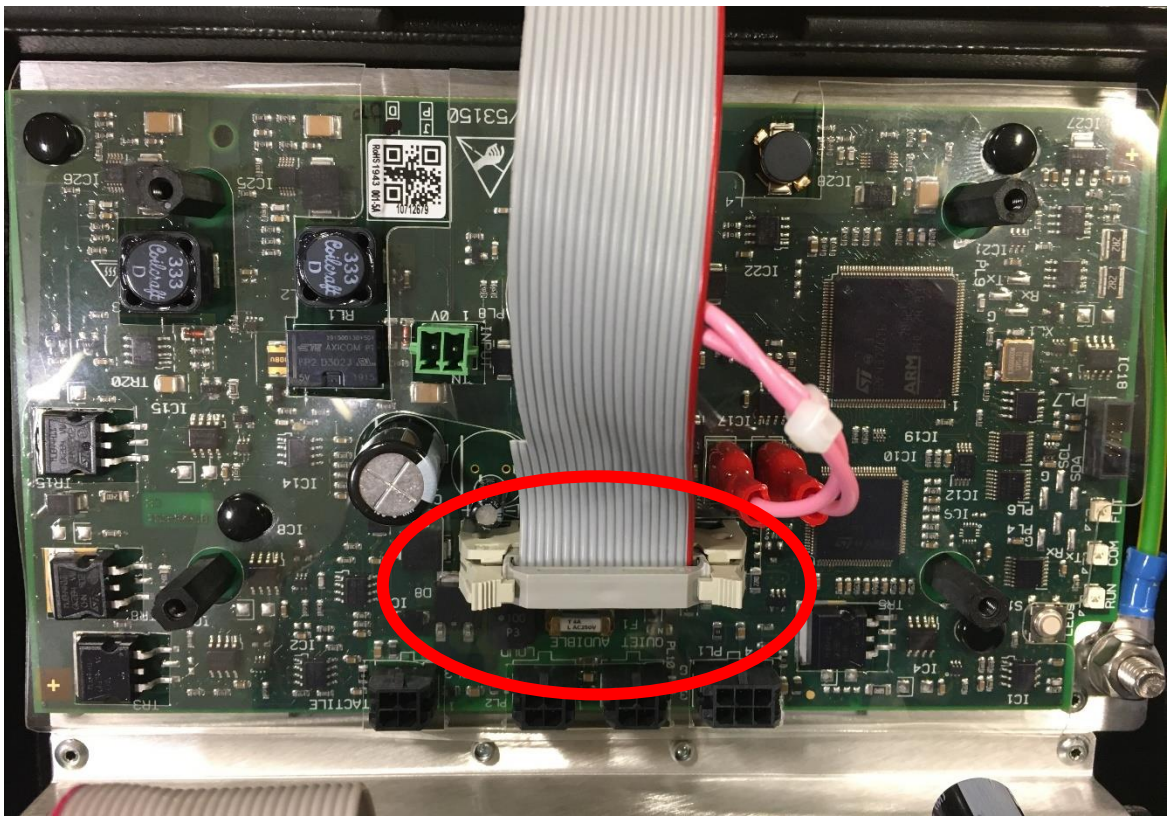


Figure 73 : Wait/PDU ByPass connection (needs update)

2. Remove connections from the Push Button

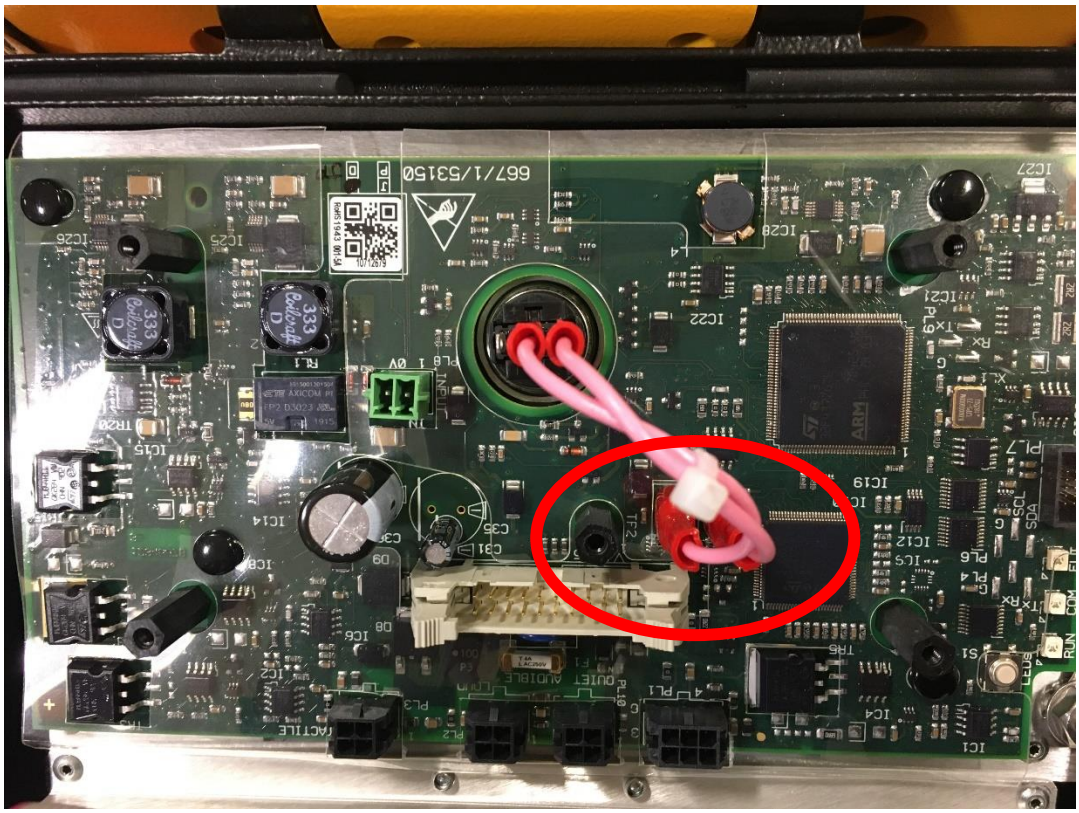


Figure 74 : Push Button Connection Detail (needs update)

3. Remove any other connections e.g. Tactile, Audible, Amber Plate in the case of a Wait Indicator

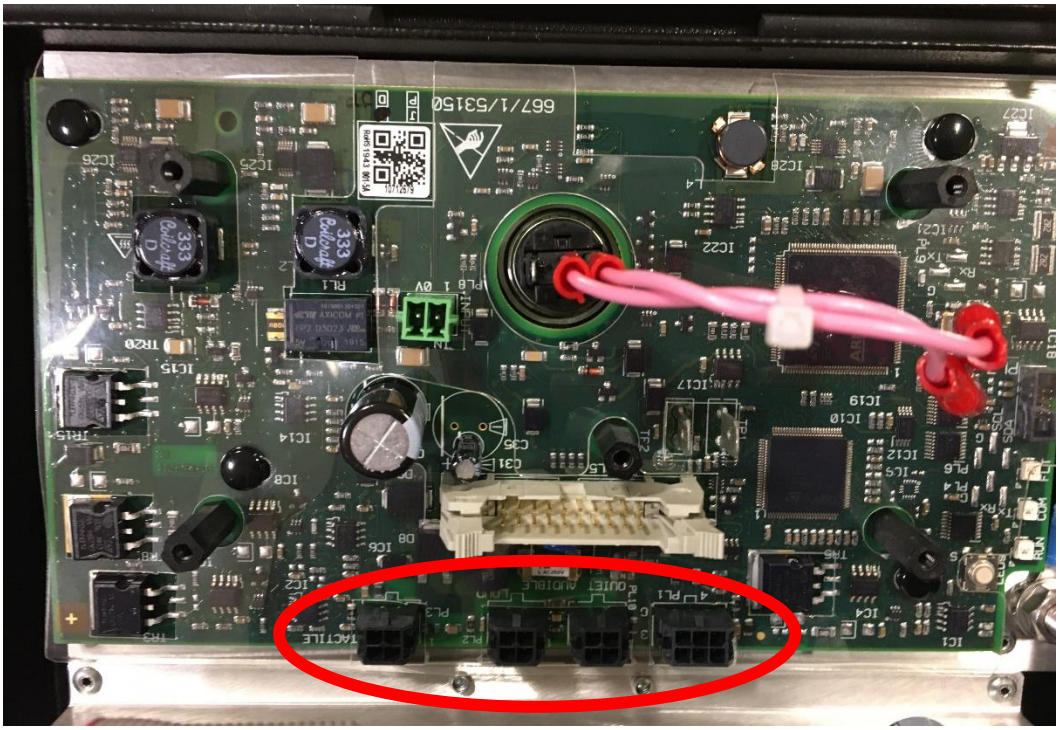


Figure 75 : Wait/PDU Connection Detail

4. Remove the Five Board Fixings

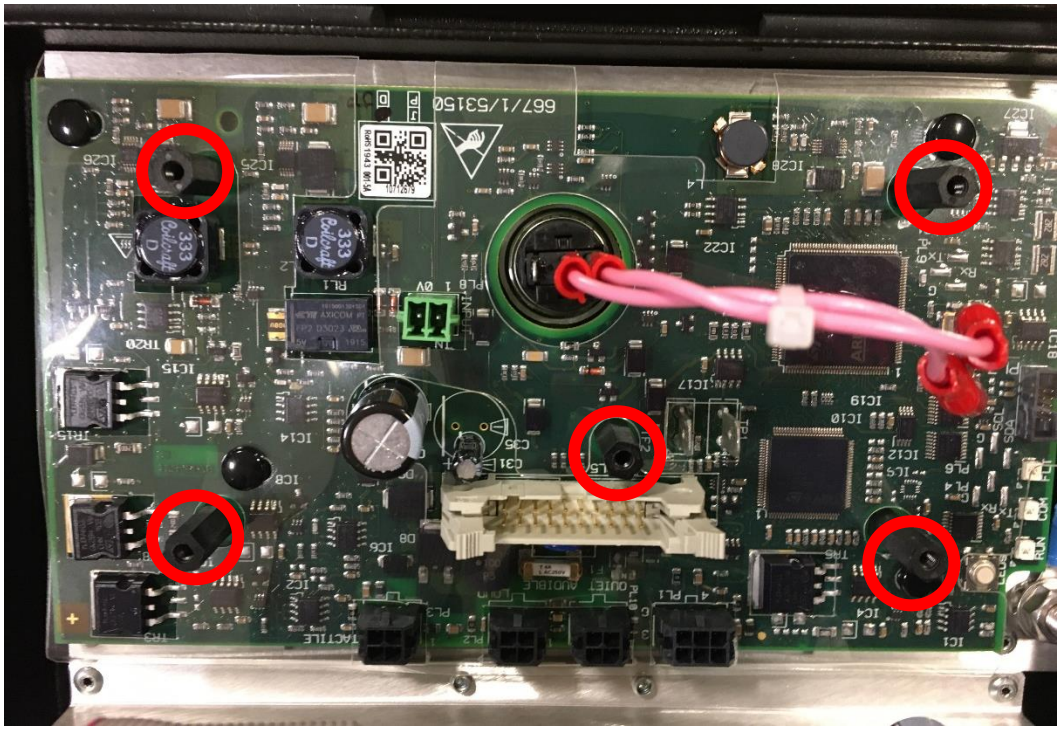


Figure 76 : Wait/PDU PCB Mounting Detail

5. Remove PCB

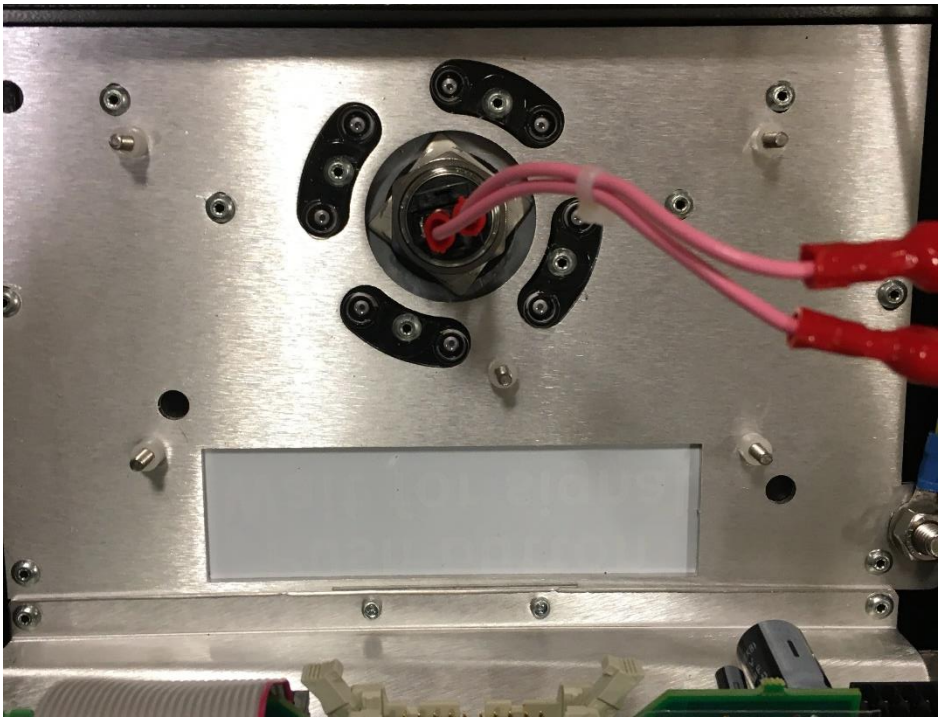


Figure 77 : Wait/PDU PCB Removed

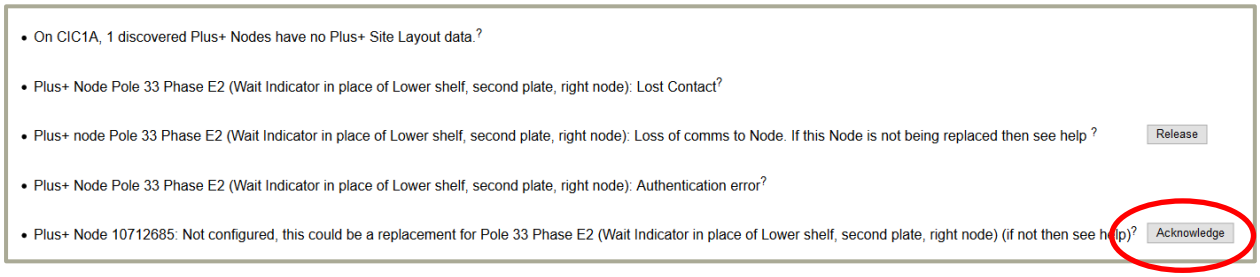
6. Fitting is the reversal of removal. In the case of a Combined Nearside with two ByPass connections, ensure the left-hand ByPass connection is to Wait/PDU and the right-hand ByPass connection is to Nearside (no crossover of ribbon cables).

Take note of the New Serial Number

For a single Node, the process to acknowledge an update does not require prior knowledge of the Serial Number. However, it is good practice to note the New Serial Number and update any backups of the Design Layout (paper or Electronic).

If multiple nodes are being replaced, then the Serial Number will need to be noted for configuration update.

7. At the controller, in the Fault Table, the User is expected to 'Acknowledge' the change in Node and then press the L3 button to confirm. Note: The use of the 'Release' Button is not required.

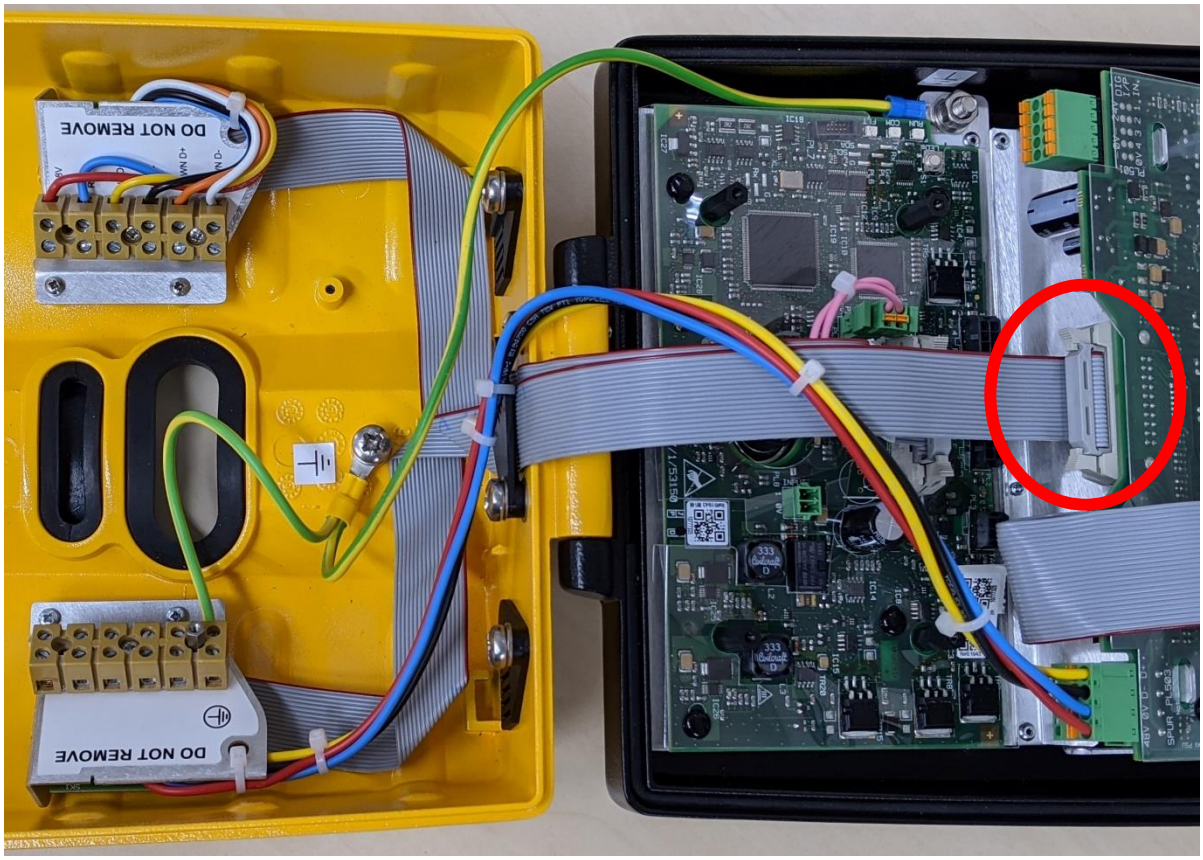


9.5.3 Replacement of Nearside Indicator Board

The Nearside Indicator board is used in two variations of Node, namely Nearside Indicator and the Nearside Combined. In most cases, the Nearside Indicator Board can be hot swapped as part of a maintenance procedure.

The process of removal and replacement is similar in both cases.

1. Remove power and communications by disconnecting the ByPass connector. In the case of a Combined Nearside there are two ByPass connections, one of which will be to the Wait/PDU Board. In this case both connections will need to be un-made.



2. Remove any other additional connections (e.g. Spur or Digital IO)

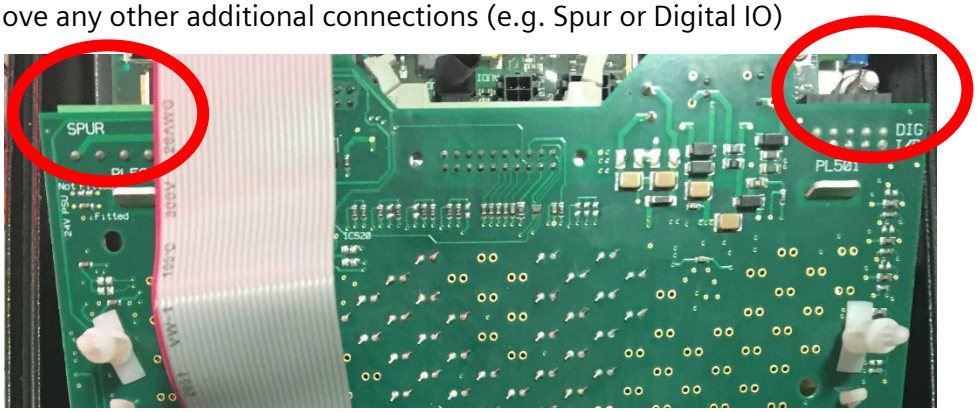


Figure 78 : Nearside Indicator PCB with connector detail

3. Release the Double stacked PCB by releasing the 4 fittings identified below. The top fixings indicated have small release levers, the bottom fixings are friction only. Remove the Red indicator PCB section first (bottom half of picture in Figure 79 below) and then remove the Green section which lies partially underneath the Red section.

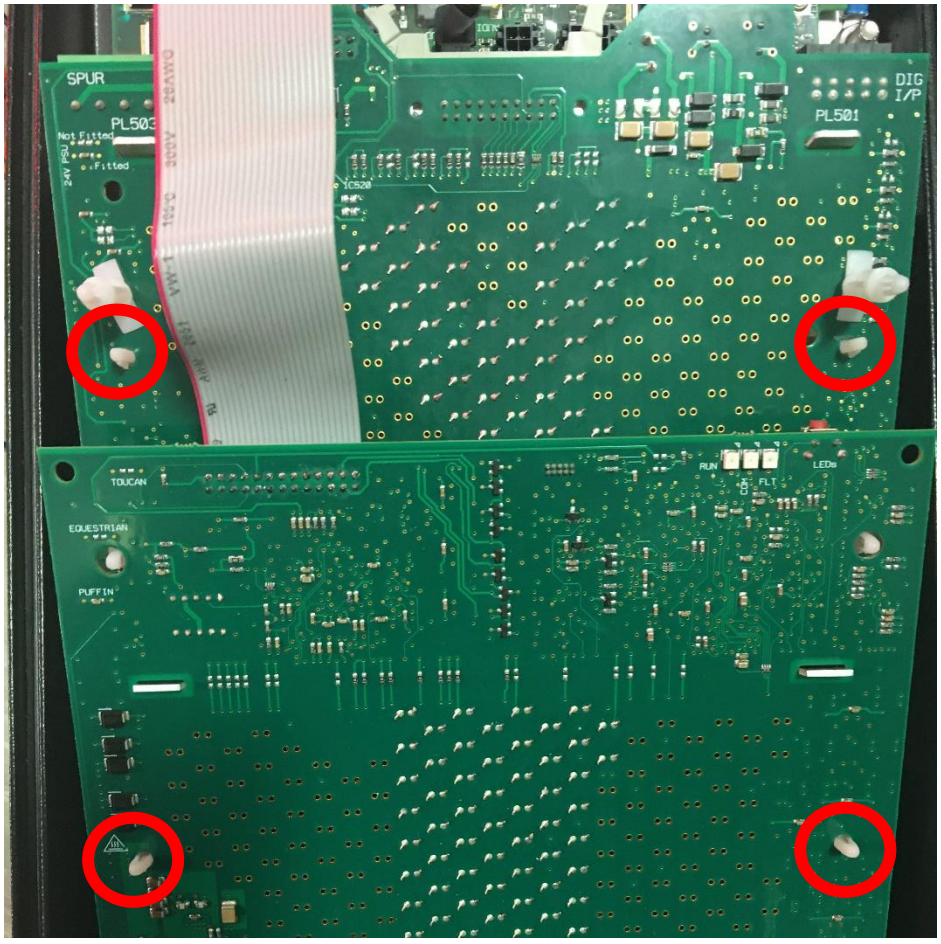


Figure 79 : Nearside Indicator with Fixings Identified.

Note the Nearside Green and Red sections are held together with a permanent ribbon cable connection and cannot be separated. The two parts are fixed together using plastic friction-lock fixings for secure shipment.

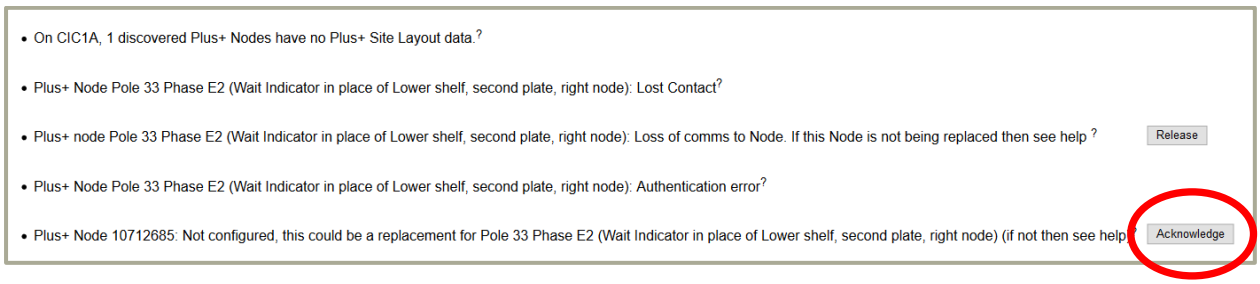
4. Remove the PCB and replace. Replacement is the reversal of removal.

	Take note of the New Serial Number

For a single Node, the process to acknowledge an update does not require prior knowledge of the Serial Number. However, it is good practice to note the New Serial Number and update any backups of the Design Layout (paper or Electronic).

If multiple nodes are being replaced, then the Serial Number will need to be noted for configuration update.

5. At the controller, in the Fault Table, the User is expected to 'Acknowledge' the change in Node and then press the L3 button to confirm. Note: The use of the 'Release' Button is not required.



9.5.4 Replacement of a Smartloop.

To replace a Smartloop, disconnect the unit from the RAG Node from which it is spurred by disconnection at the PTB (see section 4.1).

Disconnecting a Smartloop affects all Smarloop nodes connected downstream

Smartloops are not connected to the Plus+ network via a Bypass module. During replacement of a Smartloop, communications to any Smartloops connected via the replaced Smartloop will be disrupted.

Once disconnected at the PTB, the Smartloop connections to the Plus+ network cable and the loop feeder/tails cable can be cut as near to the respective torpedo resin joints as is practicable.

Take note of the New Serial Number

For a single Node, the process to acknowledge an update does not require prior knowledge of the Serial Number. However, it is good practice to note the New Serial Number and update any backups of the Design Layout (paper or Electronic). i.e. tack a photo of the QR code serial number

If multiple nodes are being replaced, then the Serial Number will need to be noted for configuration update. i.e. tack a photo of the QR code serial numbers and note their respective locations

Connect the replacement Smartloop to the loop feeder/tails cable. See section 4.9.1 and 4.9.2 for details.

See section 4.9.3 for instructions on confirming the correct installation and configuration of the replacement Smartloop device in combination with the loop.

Connect the replacement Smartloop to the Plus+ network cable. See section 4.9.1 and 4.9.2 for details.

Reconnect the Smartloop connection to the RAG Node from which it is to be spurred at the PTB.

At the controller, in the Fault Table, the User is expected to 'Acknowledge' the change in Node and then press the L3 button to confirm. Note: The use of the 'Release' Button is not required.

9.5.5 Replacement of Multiple Nodes

If there is reason to replace multiple nodes, the process is as described above with one exception. The 'Acknowledge' button is no longer available.

In order to amend the serial numbers the user is directed to the 'General Node Settings' Page.

Status and Configuration -> Plus+ -> General Node Settings

On this page the old serial numbers can be deleted and the replacement serial numbers written in. On completion ensure that the 'Save' button is pressed.

Replacing Serial Number Across Pages

If the serial numbers to be replaced span several pages, each page with amended serial numbers needs to be saved before moving on. Failure to do so will mean the original serial numbers are not removed.

9.6 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.

Appendix A Part Numbers and Spares List

Replacement Parts

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 many of the currently available main parts common to all ST950 Plus+ Controllers. For an up to date list please refer to the ITS Sales team.

A.1 Spares Parts List: Cabinet Mounted Equipment

In addition to the spares listed below, many of the parts listed in section 3 and section 4 may be ordered as replacement items. Contact Siemens Poole for details.

Description	Part Number
ST950 CPU Card assembly (128M EFC)	667/1/46010/101
ST950 CIC Card Assembly	667/1/53090/000
ST950 CTB Replacement Assembly	667/1/53170/001
ST950 CTB Assembly[21]	667/1/53050/000
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
Detector 6U Rack Expansion kit (Divider kit)	667/1/33002/000
Manual Panel RS232 kit	667/1/27110/000
300mA RCD kit	667/1/27117/000
Mains Isolator Locking kit	667/1/33073/000
CET Bar Kit (if using standard base)	667/1/27063/000
SEB Expansion Kit (Plus+ Cabinet Base)	667/1/53065/008
Screw Lock Key	667/2/20234/000
Manual Panel Assembly (Intersection Controller)	667/1/27056/001
Mains lightning protection kit	667/1/53037/000
Additional inrush relay kit	667/1/53058/000
Inrush Relay (replacement)	507/4/39687/000

[21] Used when additional CIC is being added to a controller (includes Redundancy Module)

Description	Part Number
CTB cable kits for CIC position 2	667/1/53051/002
CTB cable kits for CIC position 3	667/1/53051/003
Additional Rear DIN Rail kit	667/1/53046/000

A.2 Spares Parts List: Traffic Signalling Equipment

Description	Part Number
Plus+ HELIOS RAG with no Hoods or Backing board	667/1/53500/850
Plus+ HELIOS Pedestrian Farside with no Hoods or Backing board	667/1/53500/852
Plus+ HELIOS RAG variants	667/1/53500/XXX
Plus+ HELIOS Red LED Aspect	667/1/53200/100
Plus+ HELIOS Amber LED Aspect	667/1/53200/101
Plus+ HELIOS Green LED Aspect	667/1/53200/102

A.3 Spares Parts List: Regulatory Traffic Sign Equipment

Description	Part Number
Plus+ HELIOS Side Mounted Regulatory Body	667/1/53500/807
Plus+ HELIOS In Line Mounted Regulatory Body	667/1/53500/808
HELIOS Regulatory Sign Door Assembly	667/1/30200/XXX
Plus+ HELIOS Regulatory Internal Illumination Assembly	667/1/53514/000

A.4 Spares Parts List: Signal Mounted Equipment

Description	Part Number
ELV Solar Cell kit	667/1/10039/024
Plus+ Top Cap Assembly - GRY	667/1/53735/300
Plus+ Top Cap Assembly - BLK	667/1/53735/301

A.5 Spares Parts List: Pedestrian Signalling and Demand Equipment[22]

Description	Part Number
Plus+ Wait Indicator Assemblies	667/1/53602/xxx
Plus+ Combined Nearside Indicator Assemblies	667/1/53604/xxx
Plus+ Pedestrian Demand Units	667/1/53606/xxx
Plus+ Nearside Indicator Assemblies	667/1/53608/xxx
Nearside Bypass Module RH	667/1/53135/000
Nearside Bypass Module LH	667/1/53135/001
DFM Lens kit	667/1/27104/000
Plus+ Tactile Unit Assembly	667/6/53124/000
Plus+ Audio Unit Assembly	667/6/53123/000

A.6 Spares Parts List: Replacement Smartloop Items

Description	Part Number
SmartLoop 20-150uH	667/1/53160/001
SmartLoop 150uH – 300uH	667/1/53160/002
SmartLoop 300uH- 2000uH	667/1/53160/003
Torpedo Resin Joint (MPJ2 Resin Joint)	915/4/03118/001
Smartloop Battery Box	667/1/53295/001

A.7 Spares Parts List: Replacement PCB Module Assemblies

Description	Part Number
Plus+ RAG Node PCB Assembly	667/1/53111/001
Plus+ Wait/PDU PCB Assembly	667/1/53150/001
Plus+ Nearside PCB Assembly: Puffin	667/1/53121/001
Plus+ Nearside PCB Assembly: Toucan	667/1/53121/003
Plus+ Nearside PCB Assembly: Equestrian	667/1/53121/005

[22] Refer to the pricing workbook, or contact Siemens for detailed inventory breakdown of parts.

A.8 UK Standard Controller Types

Description	Part Number
ST950 Plus+ Controller Cabinet UK Single CIC Grey	667/1/53950/020
ST950 Plus+ Controller Cabinet UK Single CIC Black	667/1/45950/021
ST950 Plus+ CABINET STOOL + Base Seal Assy Grey	667/1/53060/000
ST950 Plus+ CABINET STOOL + Base Seal Assy Black	667/1/53060/100
NAL Gas Plinth Grey	667/7/46690/010
NAL Gas Plinth Grey Black	667/7/46690/011

A.9 Non-UK Standard Types

Description	Part Number
Not currently available	

A.10 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 Wi-Fi Dongle	667/1/45966/000
Lightning Protection Kit – Ethernet	667/1/45972/001

A.11 Other Spares

Description	Part Number
27C Yale Door Lock Kit	667/1/21384/000
Yale Lock Barrel Protector kit	667/1/21498/000
Mains Isolator Locking Kit	667/1/33073/000
Manual Panel Gasket	667/7/27129/000
Sealant strip self adhesive PVC 20mm x 6mm per m	667/4/04026/023
Base sealant - Robnorganic PX212ZF (or similar)	992/4/00216/000
Intelligent Detector Backplane with Control PCB Assy	667/1/32910/950
Loop Detector Termination Board Assy	667/1/32915/000
IDB Ribbon Cable Assy (IDB to Loop Termination Board)	667/1/32917/000
CPU Card Power Cableform	667/1/45960/000
RJ45 cable for I/O card 0.2m length	998/4/88351/002
RJ45 cable for I/O card 0.5m length	998/4/88351/005
RJ45 cable for I/O card 1.0m length	998/4/88351/010
RJ45 cable for I/O card 2.0m length	998/4/88351/020
RJ45 cable for I/O card 3.0m length	998/4/88351/030
Manual Panel On/Off Only	667/1/27056/010
48V 480W PSU KIT (includes mains side connector)	667/1/53057/000
24V PSU	605/4/08717/000
HIGH LOAD UPGRADE KIT	667/1/53030/001
REDUNDANCY MODULE – NO CABLE	667/1/53185/000
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.12 Controller Fuses[23]

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 – **High Load** ST950 Plus+ The Max size of this fuse should not exceed 100A (without reference to Siemens Poole). Maximum prospective short circuit current must not exceed	N/A

[23] The Plus+ Layout Design tool will evaluate whether the design is 'standard' or 'high load'.

Description	Part Number
16,000A. Rating depends on application but 45A minimum is recommended up to 24A load	
Master Switch Fuse – **Standard** ST950 Plus+ 16A HRC cartridge fuse to BS88-3 on Master Switch panel	518/4/90637/007
Master Switch Fuse – **High Load** ST950 Plus+ 30A HRC cartridge fuse to BS88-3 on Master Switch panel (or 32A HRC cartridge fuse to BS88-3)	518/4/90637/001
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
Torroid Incoming Fuse 2A	518/4/97093/012
Torroid Out going Fuse 160mA	518/4/90285/020

Appendix B Firmware Upgrade Process

Most of the firmware within the ST950 controller is stored in non-removal devices. This firmware can be updated using the mechanisms described in this section;

- CPU card
    - EFC firmware
    - Primary firmware
    - SEC firmware
    - Fail Flash firmware
- Non-Plus+ GSPI peripheral card (e.g. Serial I/O Cards)
    - GSPI peripheral firmware
- CIC
- Remote Nodes

B.1 Updating CPU Card Firmware

There are four devices on the CPU card which can be updated using this process:

- EFC
- Primary
- SEC
- Fail Flash (But not used on the Plus+ controller)

An update may change the firmware in either the EFC alone or in all four devices. During an upgrade the controller detects which devices are affected and performs varies the procedure accordingly.

B.1.1 Delivery of Updates

An update is contained in a single file and may be delivered either directly to the user or through OSS. Where the file is delivered directly to the user it may be transported by any means appropriate for a file of several megabytes in size e.g. file transfer, memory stick.

B.1.2 Compatibility of Updates

Any important information regarding an update is displayed to the user before the upgrade proceeds, giving the user the option to cancel the upgrade. Such important information may indicate a change in functionality and / or interfaces or may indicate a change would be made to the system. Account can then be taken of the change and the update applied later.

It may not be possible to update from the version for firmware running to the version desired. This is only likely if the upgrade skips many intermediate firmware versions. In such cases it will be necessary to perform the upgrade in two or more steps, first going to intermediate version before going to the final desired version.

B.1.3 Immediate Implementation

For most "EFC-only" updates the update is implemented immediately and the EFC restarted. This will cause the controller to enter Reserve State. The controller will leave Reserve State and the signals return to their normal operation once the restart of the EFC is complete.

B.1.4 Delayed Implementation

Update of the Primary, SEC and Fail Flash always results in the signals going off so is not implemented immediately but held until an appropriate time is determined by somebody on site. Some EFC only changes might be considered extensive enough to also warrant an on-site presence. That an update is pending in this manner is indicated by the following:

- A status of "Update on Hold" reported on the System – Upgrade web page.
- Entries in the Notification Table indicating how to proceed with or cancel the update.
- The blue LED on the CPU board flashing with a double beat.

Power Cycling a Controller

Power cycling the controller does not abort the upgrade as the upgrade is held pending across a power cycle.

To proceed with this update, perform the following:

- When safe to do so, turn off the signals using the signals on / off switch.
    - Press the programming button on the CPU board.

This action causes the EFC to reboot then program the Primary, SEC and Fail Flash (although if the Fail Flash switch is in the ON position, the Fail Flash CPU will not be reprogrammed but continue to flash the signals). On completion of this programming operation the blue LED on the CPU board stops flashes quickly and remains on solid. At this point the update is completed by powering the controller off then on.

Firmware Upgrade Time

Firmware upgrade and programming will take several minutes. Do not power off/on until the programming operation has completed and the blue LED remains on.

B.1.5 Initiating an Update

An update can be initiated through the web interface as follows.

- Visit the System – Upgrade web page.

- Under the title “File Upgrade”, browse to the location of the file and select the file.
    - Click on “Start Upgrade”.

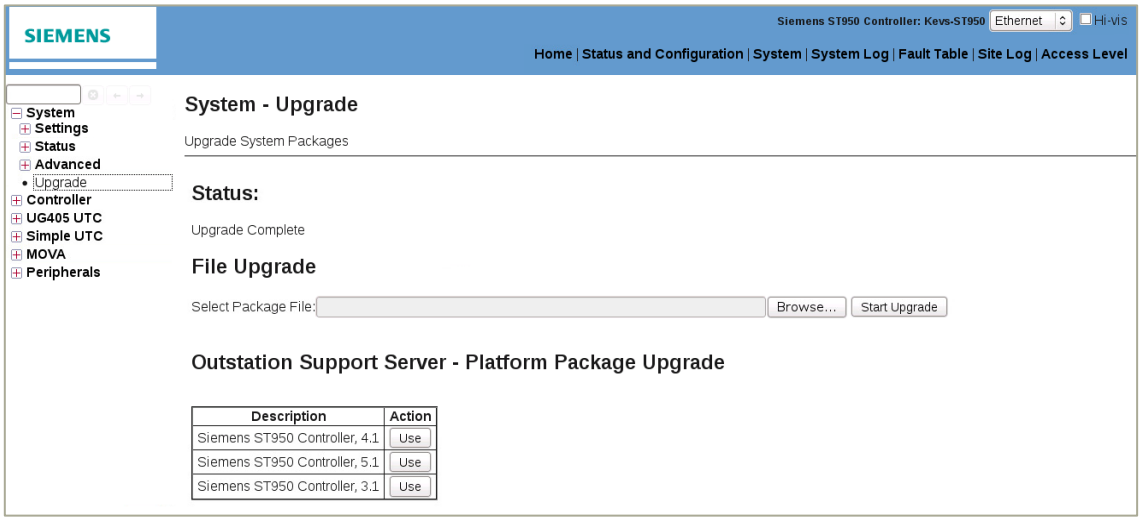


Figure 80 : System - Upgrade web page

B.2 Updating GSPI Peripheral Firmware (Not Including CIC)

It is possible to update the firmware running in the peripherals connected to the CPU card via the Generic Serial Peripheral Interface. Time taken to update a peripheral varies depending on peripheral type, but it is typically less than one minute per peripheral. **With the exception of the CIC devices**, the operation of the peripherals is stopped during this process so are unavailable to the unit and its applications for the duration of the upgrade process.

B.2.1 Delivery of Updates

The firmware for the GSPI peripherals is held within the EFC file system and so any update of unit firmware could contain an update to the firmware for one or more types of GSPI peripheral. Consult the release information for the firmware update for details of the changes it contains and the actions which should be taken.

The following procedure can be used if at any time it is necessary to compare the version of the GSPI peripheral firmware held within the EFC file system with that currently running in the GSPI peripherals.

- Determine the version of firmware running in the GSPI peripherals using the System – Status – Inventory – Firmware web page. The screen shot below shows one GSPI peripheral running 667/TZ/32998/000 issue 4.0 and one GSPI peripheral running 667/TZ/45350/000 issue 3.8.

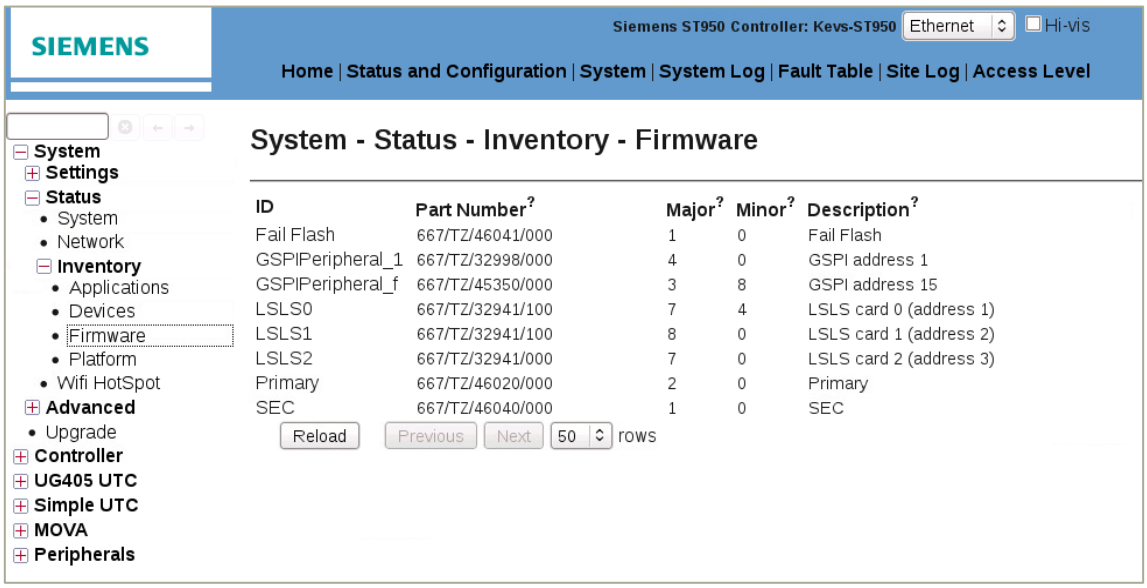


Figure 81 : System - Status - inventory - Firmware web page

- Determine the version of firmware available as an upgrade using the Peripherals – F/W Update web page. The following screen shot shows that firmware upgrade is available for two types of firmware: 667/TZ/32998/000 and 667/TZ/45350/000 at 4.0 and 3.8 respectively.

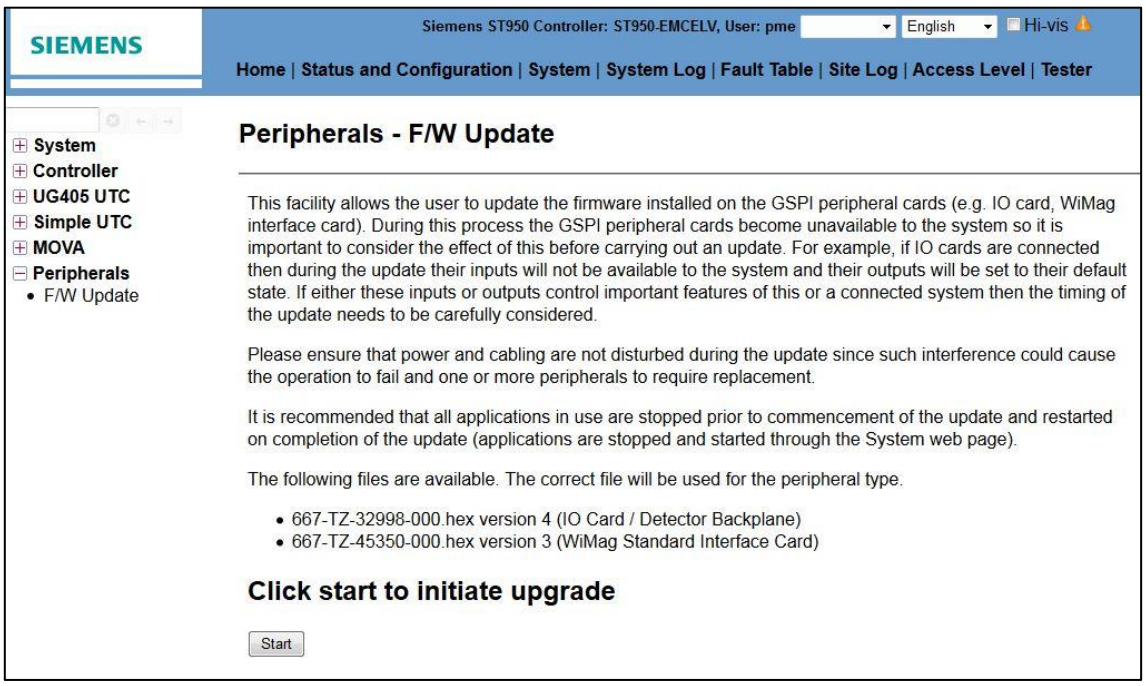


Figure 82 : Peripherals - F/W Update web page

B.2.2 Performing an Update

If it is determined that an update is required, then the following should be considered before performing the update:

- Is the unit connecting such that loss of the GSPI peripherals for a few minutes could cause a problem? An example of what might cause a problem is if IO outputs from the unit are used to control the state of another controller. In such a case it may be that the loss of IO on this unit might cause one or more connected controllers to turn off their signals.
- Is the current state of the junction such that the loss of the GSPI peripherals for a few minutes will cause a problem? An example of what might cause a problem is if loss of detector inputs connected to the unit IO makes the controller operation unsuitable for the prevailing traffic conditions.
- Is the local power supply currently stable and unlikely to be interrupted? An interruption to the power during a GSPI peripheral update may result in one or more of the GSPI peripherals requiring repair.

When a suitable time for the upgrade has been determined and reached then the upgrade can be initiated by pressing the “Start” button on the Peripherals – F/W Update web page. Progress information will be displayed during the upgrade with the page returning to its initial state a little while after the upgrade completes.

On successful upgrade, the Peripherals – F/W Update web page will be refreshed.

B.3 Updating Remote Node Peripheral Firmware (RAG, Wait Indicator, PDU, Nearside Indicator, Smartloop) and CIC Firmware

It is possible to update the firmware running in the Nodes and CIC. Time taken to update a peripheral varies depending on peripheral type, but it is typically less than one minute per peripheral. The operation of the Nodes and CIC are not stopped during this process so the junction is able to operate during the download stage.

B.3.1 Delivery of Updates

The firmware for the Nodes and CIC peripherals is held within the EFC file system and so any update of unit firmware could contain an update to the firmware for one or more types of GSPI peripheral as well (see above). Consult the release information for the firmware update for details of the changes it contains and the actions which should be taken.

B.3.2 Indication of Upgrade being Required

After upgrading the EFC, if the new firmware contains updated firmware for the Nodes or CIC then this will be indicated by a fault in the Fault Table.

B.3.3 Performing an Update

If it is determined that an update is required, then the following should be considered before performing the update:

- Is the unit connecting such that loss of the CIC for a few minutes could cause a problem?
- Is the local power supply currently stable and unlikely to be interrupted? An interruption to the power during a CIC or Node update may result in one or more of the devices requiring repair.

When a suitable time for the upgrade has been determined and reached then the upgrade can be initiated by pressing the appropriate “Start Download” button on the Plus+ F/W Download web page. Progress information will be displayed during the upgrade with the page returning to its initial state a little while after the upgrade completes.

Status and Configuration → Plus+ → Plus+ Firmware Download

Firmware Upgrade

Ensure the L3 button is pressed before pressing the two firmware upgrade buttons.

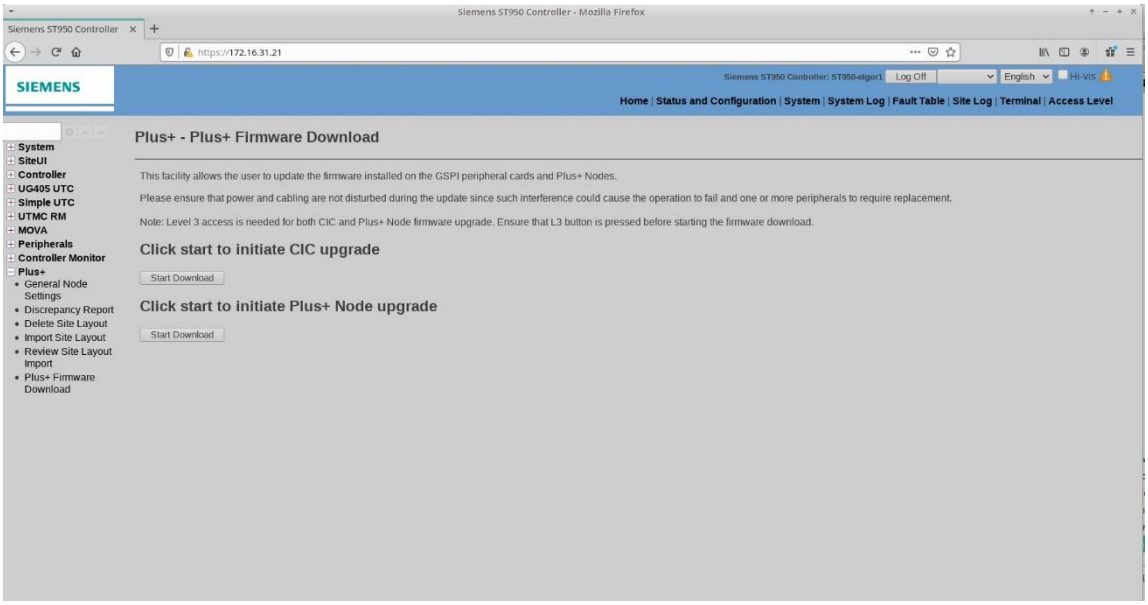


Figure 83 : Plus+ Firmware Download Tab.

Press the appropriate button to start the download process.

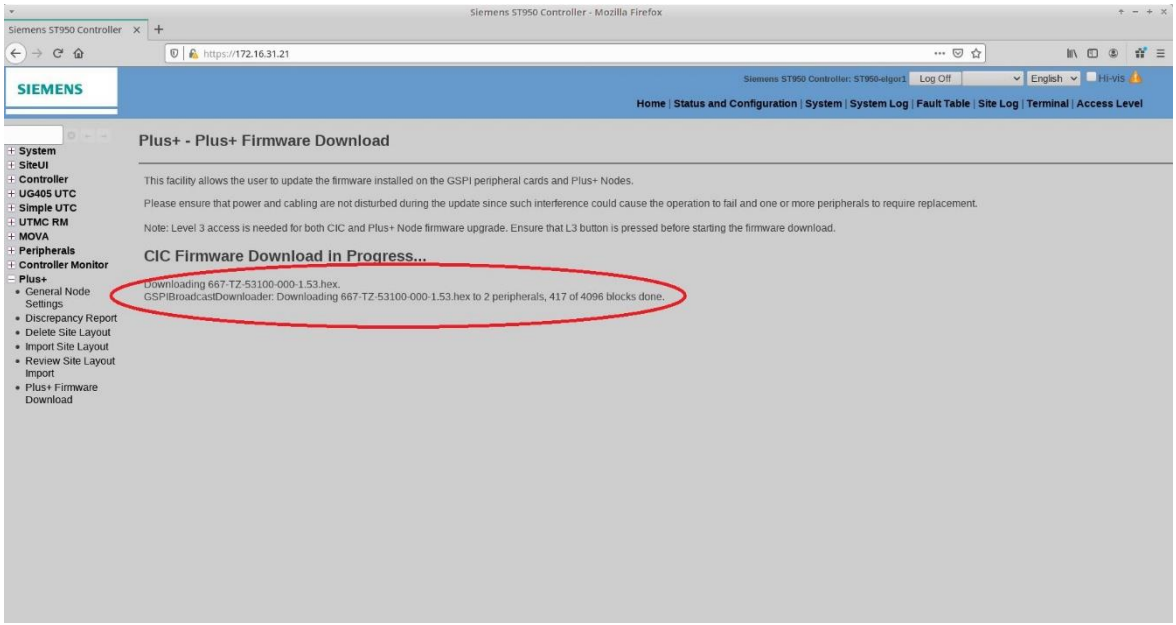


Figure 84 : CIC Firmware Download Progress

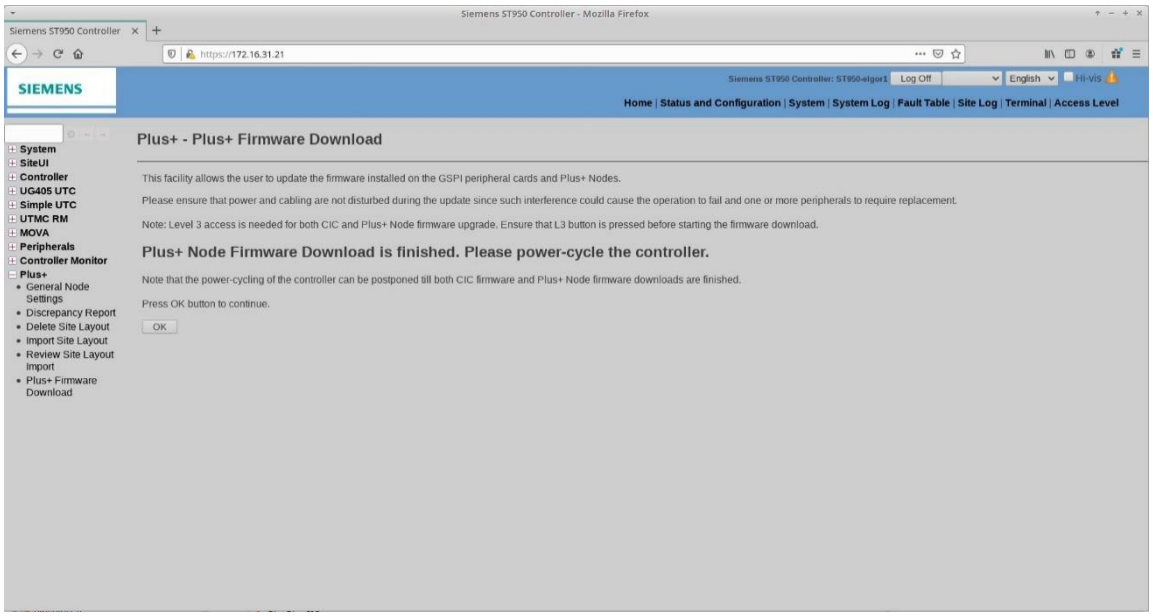


Figure 85 : Node Download Completed

On completion of the firmware download, the user is directed to the fault table in order to review any further actions.

Plus+ Peripheral Download Completion

If the CIC and the Nodes are both being upgraded, the user should only power cycle the controller on completion of both download phases. In some cases that may also be part of the primary/secondary update procedure. Please refer to the Fault Table for specific instructions.

667/HE/53000/000ore information

Siemens Traffic
www.siemens.co.uk/traffic

Siemens Mobility
http://www.mobility.siemens.com/mobility

Siemens Mobility Limited
Sopers Lane
Poole
BH17 7ER
United Kingdom

Order No. 667/HE/53000/000

For more information on Plus+ scan the QR code

www.siemens.co.uk/traffic