ST950 Facilities Handbook

667/HB/46000/001

for

ST950

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Contents

1 INTRODUCTION

This document describes the Traffic Controller modes and facilities available in the ST950. An introduction to the ST950 and a list of related documents can be found in the ST950 General Handbook 667/HB/46000/000.

1.1 Contact Us

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

1.2 Abbreviations

AC	Alternating Current
CLF	Cableless Linking Facility
CLS	Central Light Source
CPU	Central Processing Unit
DC	Direct Current
DFM	Detector Fault Monitor
ELV	Extra Low Voltage
FT	Fixed Time
GSPI	Generic Serial Peripheral Interface
GPS	Global Positioning System
HPU	High Power Unit (for ELV Controllers)
I/O	Input/Output
IC4	Intersection Configurator version 4 (controller configuration application)
IRM	Integral Remote Monitoring
LED	Light Emitting Diode
LMF	Lamp Monitor Facility
LPU	Logic Power Unit
LRT	Light Rail Transit
LSLS	Lamp Switch Low-Voltage Serial
LV	Low Voltage (Mains)
mA	milliamps
MDU	Mains Distribution Unit (for Mains Controllers; not ELV)
MOVA	Microprocessor Optimised Vehicle Actuation
ms	milliseconds
MTCS	Master Time Clock System
NTP	Network Time Protocol
OMU	Outstation Monitor Unit
OTU	Outstation Transmission Unit
PCB	Printed Circuit Board
RAM	Random Access Memory
RFL	Reset Fault Log (Handset Command)
RLM	Red Lamp Monitoring
rms	Root Mean Square
ROW	Right Of Way
SDE	Speed Discrimination Equipment
SDE/SA	Speed Discrimination Equipment / Speed Assessment
SVD	Selective Vehicle Detector

UTC	Urban Traffic Control
VA	Vehicle Actuated
wrt	With Respect To
XML	Extensible Mark Up Language

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1.5 Document History

Version 1 - First release

Version 2 - Updates for firmware 46059 issue 5, Self-Test error messages removed (because they are present in the ICM handbooks), plus various minor corrections and formatting improvements.

Version 3 - Updates for firmware 46059 issue 6:

- Smooth CLF (section 28.10)
- Last Lamp Failed Monitoring (section 44.4)
- Self test changes (section 46)

Other significant changes to the document:

- Web page to download electronic copy of this document added.
- Added picture of the Alternate Manual Panel (Figure 97)

Version 4 - Updates for firmware 46059 issue 9:

- Extinguishing individual Phases (section 9.11)
- Operation of Max Green and Window Timers in UTC and MOVA modes (section 9)
- Various web page images updated

Other changes to the document:

- More details added on Plan Entry Times (section 28)
- Clarifications added for Hardware Fail Flash (section 41)

1.6 Electronic Document

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

2 DIFFERENCES BETWEEN ST900 AND ST950

2.1 Compatibility with Existing Controller Peripherals

The ST950 is compatible with the following peripherals:

- LSLS
- LSC
- Parallel interface manual panel
- ST900 MDU (LV) and LPU/HPU (ELV)
- GPS clock (RS232), although the communications cable needs to be changed
- SieCom (supported using existing scripts – no extension to cover new features)
- Semi-Integral Gemini UTMC-OTU and MOVA
- Semi-Integral Gemini RMS-OMU with MOVA and DUSC
- Freestanding TC12 OTU (UTC Control/Reply and Remote Handset)
- Freestanding Gemini DUSC and MOVA (NB: freestanding OMU requires a licence, see below)
- Freestanding Gemini UTMC-OTU and MOVA
- Freestanding OEM OTU

The ST950 is compatible with ***upgraded*** versions of the following peripherals:

- SIO 24/4
- SIO 24/16
- Intelligent detector backplane

The ST950 only supports the following peripherals when ***licensed***:

- Siemens Freestanding (non-serial) Gemini OMU
- Siemens 3U OMU and 5U OMU
- OEM OMU

The ST950 is ***NOT*** compatible with the following peripherals:

- SDE Card – facility provided by the integral SDE/SA facility
- TfL IMU / IRM – functionality may be incorporated in to the EFC in the future
- Integral TC12 OTU – use a free-standing TC12-OTU or integral UTMC-OTU (in the EFC)

2.2 Expansion – I/O Cards

2.2.1 Serial I/O Cards and Intelligent Detector Backplanes

For the ST950, the firmware in these I/O cards needs to be version 4.0 firmware (or later). Boards fitted with version 3.0 firmware and later can be upgraded to the version required by the controller through the Peripherals - Firmware Update web page. These upgraded cards will remain compatible with the ST900.

The updated firmware supports the new GSPI protocol so they can also be used directly by Gemini/EFC Applications such as UTMC OTU. The newer cards also include hardware inventory information (part numbers, issue states and serial numbers).

2.2.2 New optional 3U IO daughter card

The ST950 supports an optional 3U IO daughter card. This can be attached to CPU Card. The 3U IO daughter card uses the same technology and interface as the 24/4 Serial I/O Card and thus appears as a standard 24/4 Serial I/O Card.

It does not have a rotary switch to select the address; the card address is fixed at 1.

To request this card in the IC4 configuration, select the "Rack inc CPU I/O" option in the Cabinet/Rack field on the IC4 Administration page.

2.2.3 Maximum Number of Cards

There has had to be a slight reduction in the maximum number of serial I/O cards that can be powered by the ST950 compared to the ST900. Although in practice it is very unlikely any system gets anywhere near the maximum capabilities of either the ST900 or ST950.

The ST950 CPU Card consumes more from the 24V power supply because it uses this supply to generate all the logic supplies it needs, with the 5V power supply only being used to power the LV-LSCs. This leaves slightly less 24V power from the PSU available for use by the I/O cards.

The maximum number and combinations of I/O cards supported by the ST950 is documented in the General Handbook.

2.3 LSLS Cards

The ST950ELV controller is compatible with ST900ELV LSLS Cards. The LSLS Cards do not have to be changed as part of an upgrade and all LSLS card versions can be moved between the two types of controller. However, the hardware inventory information (part numbers, issue states and serial numbers etc) is only available from newer LSLS Cards.

Rack-fitted LSLS: When upgrading a controller where the LSLS cards mounted in the rack next to the Processor Card (rather than on separate backplanes distributed around the cabinet) a slightly longer ribbon cable is needed from Processor Card to first LSLS. No change is required if LSLS are mounted on backplane and connected via RJ45 cables.

2.4 User Interface

- The 25-way RS232C handset port remains and functions the same as on the ST900, with most handset commands working in the same way as before.
- Significant areas of change (covered elsewhere with section 2): configuration loading, fault log, real time clock.
- The WIZ handset command is also available over this RS232 link. This can be used for configuration loading and extract fault logs using a USB stick for example.
- Web page and virtual terminal interface via a USB cable to a PC or via USB/Wi-Fi dongle to a smart phone or tablet. Over this interface can also be run four MOVA Comms IP connections, one for each MOVA kernel.
- Multiple virtual terminal handset interfaces and the RS232 handset interface can be supported at the same time, although only one session can obtain level-2

write-access; the command displays “PME:0 (IN USE)” if another handset session currently has level-2 access.

- Web page access is permitted at the same time as handset mnemonic access.

2.5 Configuration

- No Config PROM. Load the IC4 configuration from a laptop via the web interface. The IC4 “Send Configuration” method is no longer used. Alternatively, you can use a USB mass storage device (memory stick) and standard handset terminal.
- The new controller cannot read an ST900 configuration file. The controller configuration information needs to be upgraded using IC4.
- The IC4 configuration files used by the ST950 controller have the 8ZP extension. Files with the 8BN extension are not used by the ST950. The source data / site data IC4 files still use the 8SD extension.
- Heart (SD Card) can be moved to a replacement Processor Card. This contains the IC4 configuration, including changes made by handset, learnt lamp loads, fault log, etc…
- Web pages with on-screen help to allow easier modifications of controller timings.
- Extraction of IC4 config files via web interface (Site Log), not IC4 “Retrieve Configuration”.
- The IC4 View Differences facility is supported and it use is recommended if only timing changes need to be made.
- An updated IC4 config can be loaded while the signals remain illuminated; we call it ‘Quiet Initialisation’.
- IC4 View Differences allows timings differences between the IC4 Configuration and the Controller to be viewed and either the IC4 Configuration or the Controller updated with the preferred values. A Quiet Initialisation replaces all the timing values in the controller with those from the IC4 Configuration.

2.6 Expansion – No Extended System Bus (ESB)

The ST950 does not provide the Extended System Bus used on previous generations of the controller. Therefore the following expansion cards are no longer supported:

- Integral TC12-OTU - use the internal UTMC-OTU application.
- IMU / IFC used by Transport for London
- External SDE/SA card – all ST950 controllers use internal SDE/SA

With no Integral TC12-OTU there is no support for the TC12 UPDL (Upload/Download) facility. However, the ST950 provides alternate mechanisms for many of the operations previously provided by TC12-UPDL so all the commonly used functions provided by UPDL are provided by an ST950 controller in different ways:

- Remote handset access: This can be achieved over the IP communications using a virtual terminal (*telnet* in 46059 version 5 and earlier, *ssh* from version 6). Also remember that the ST950 web pages can also be accessed remotely over the IP communications.
- Back-up of controller timings: The ST950 backs-up all its timings to its Heart so they can be re-instated if the CPU Card is changed.
- Updating timings: To update a number of timings consider the following alternate mechanisms:

- Use the web pages locally or remotely to view and modify timings.
- Use the IC4 View Differences facility to compare and update timing differences between an IC4 configuration and the controller.
- Use the Quiet Initialisation facility to update the IC4 configuration while the signals remain illuminated (limitations apply).

2.7 Controller and Gemini

- ST950 Processor Card essentially combines the ST900 Controller and Gemini CPU cards. Initially, only the UTMC-OTU and MOVA software of Gemini is included within the ST950.
- External Gemini can still be connected, e.g. for RMS OMU or to continue to use an existing UTMC-OTU/MOVA.
- The PCB includes Ethernet and USB connectivity, allowing local and remote access to controller web pages and the handset, whether or not UTMC-OTU functionality is required. Only one handset user can obtain Level-2 access (PME) and thus Level-3 access.
- A new MOVA mode exists in the controller that links more directly with the internal MOVA and is separate from UTC mode; both exist separately in the mode priority table.

2.8 Licensing

- Uses a ‘Licence Smart Card’ rather than an EPLD to enable certain software features. These Smart Cards use a similar technology to bank credit/debit cards but are physically the same size as mobile phone SIM card. Just like mobile phone SIM cards, Siemens may dispatch the Licence Smart Cards in their larger bank card size, with a cut-out to allow the smaller SIM sized card to be broken out and installed in the controller. Do not confuse the Licence Smart Card with the SIM card of a GPRS/3G modem for example – they both have the same form-factor but have completely different uses.
- A new licence can be moved from a new Licence Smart Card and added to the Licence Smart Card installed in a functioning controller, without needed to power down the controller or change the controller’s Licence Smart Card. Licences can be moved between the Licence Smart Card installed in the controller and a second Licence Smart Card. Fit the second Licence Smart Card in a standard USB Smart Card Reader and connect the reader to the front of the controller Processor Card. Facilities exist within the controller to move individual licences between the two Licence Smart Cards.

2.9 Real Time Clocks

- Daylight Saving and Time Zones – The ST950 must be configured with the daylight saving rules and time zone for the locality. The default settings are for the UK. These settings allow the ST950 to use NTP network and GPS time sources; allowing the ST950 to convert from the standard Coordinated Universal Time (aka UTC or GMT+0) provided by these systems and the local time.
- No week numbers – the handset command and Special Conditioning mnemonic to access the week number in the controller have been removed. Week numbers are no longer used to control daylight saving. Use the Holiday Clock facility if timetable events are required on different days through the year.

- Two Real Time Clocks exist in the ST950 to permit a Controller ‘Traffic Plan Time’ clock, which is mains synchronised with adjacent controllers for the timetable and CLF facilities, and a UTMC OTU network / crystal synchronised clock used by the rest of the ST950 system.
- The initial default for when no network or GPS clock has been set-up has the system clock following the Controller ‘Traffic Plan Time’ clock; use TOD to set/monitor the controller clock.
- Use the web interface to set up the clock system for other scenarios, e.g. the system clock is maintained by a GPS clock or NTP network connection, with the Controller ‘Traffic Plan Time’ clock either running independently or following the system clock.
- Optional Battery solely for the RTC. The ST950 holds configuration data and non-volatile working data in FLASH memory; the ST900 held these in battery-supported RAM. ‘Super caps’ provide significant support period (approx 48 hrs) for the Real Time Clock. Therefore, no battery needs to be fitted on the ST950 Processor Card. Where network or GPS clock synchronisation is used, the ST950 will set its RTC from those systems even if the RTC backup support had expired. If a longer support is needed, a standard coin-cell can be fitted.
- GPS Clock connector changed to a 10-way IDC connector that is compatible with a 9-way RS232 D-Type (ST900 has a Picoflex connector compatible with a 25-way RS232 D-Type).
- GPS Clock feeds in to GVP NTP (Network Time Protocol) facility as a clock timing source. The controller handset command CKM and CKS have been removed.

2.10 New and Improved Controller Features

- FTCM: If enabled, FTCM (Fixed Time to Current Maximums) completely replaces standard FT (fixed time) mode; it really does run as Mode 1 now! It can be requested from the Manual Panel or the mode priority table.
- Green Arrows improvement: Green Arrow phases will be delayed until their associated phase goes green (except for terminate type 1 ‘filter’ arrows). This should reduce the need to adjust intergreen times or add phase delays. This optional facility is disabled by default.
- Green Arrow improvement: The controller will automatically ignore stage moves that violate the appearance type rules when a green-arrow phase is at ROW. This should allow better stage selection with demand-dependant green arrows because the stage moves are only prevented when the green-arrow is actually at ROW. If the green-arrow does not appear, no stage restrictions are applied. This will still need Special Conditioning to insert artificial demands while the arrow is illuminated otherwise street demands could be ignored while there are no demands for the permitted stages. This will not overrule a configured alternate stage move – this feature has no effect if a stage movement rule is configured. This optional facility is disabled by default.
- Hardware Fail Flash automatically uses the software flash rate configured on the IC4 screen. There are no switches on the PCB to set up the time periods; just a single enable / disable switch.
- Intergreen Delays: This new facility is best described as a phase-based Extend All-Red facility. The existing Extend All-Red facility remains completed unchanged. The new facility is called ‘Intergreen Delays’ because it delays (extends) the intergreen between one losing phase and a specified set of

gaining phases while an input remains active. It includes a large number of ‘units’ where each ‘unit’ is configured with one losing phase, one or more gaining phases and a detector input (or scratch bit mnemonic). When the specified phase loses ROW, the unit delays the appearance of the specified gaining phases while the input remains active, up to a configurable maximum intergreen period, without affecting any other phases gaining ROW. When the input goes inactive (or the maximum period expires), the gaining phase appear at ROW. If the gaining phases normally have a staggered appearance controlled by phase delays and/or intergreen times (from the phase losing ROW), the stagger is maintained.

- Lamp Monitor Sensors increased from 48 to 96 (ELV only); 48 sensors would be restrictive with the additional number of Switch Signs and with ELV controllers configured with more than one sensor per phase (e.g. peds with waits or multiple RLM channels).
- Linked FT mode includes a smooth start algorithm. Rather than always starting with step 0, it starts with the LFT step that best matches the stages currently at ROW.
- LRT (Light Rail Transit) facility added to allow control of trams through the intersection. As the tram approaches the intersection, Prepare and Advance actions can be defined so the tram is given ROW through the intersection without delay. When the Stop Line is cleared by the tram, its ‘proceed’ signal can be terminated (as is typical for rail signals), but traffic phases are prevented from gaining ROW until the tram clears the intersection (cancel detector or cancel time-out). The controller also supports an LRT signal with multiple (diagonal) ‘proceed’ signals.
- Manual Panel stage LEDs now illuminate when door is opened and not when a handset is connected.
- MOVA can be configured as a separate mode from UTC mode; appearing separately in the mode priority table with separate configuration of stage force and confirm bits. (Only available if Internal MOVA is used; not available if an external Gemini is providing MOVA)
- MOVA Detectors can be shared by all the MOVA Kernels and the UTMC-OTU facility (as now), or (with internal MOVA mode) each MOVA Kernel can have its own detector set with a fifth detector set solely for use by the UTMC-OTU.
- RLM Cab Alarm only stops flashing when the FLF22 faults are cleared (it used to stop when the FLF55 fault was cleared)
- Special Conditioning Fault Clearance; if enabled, when special conditioning clears the faults, they now clear from the fault log; RFL=1 is not needed.
- Special Conditioning enhancements; the ST950 (from 46059 issue 5 onwards) provides up to 480 conditioning timers (CDT), 1024 conditioning facility flags (CFF) and space for twice as much Special Conditioning as the previous controller generations.
- Switch Signs increased from 8 to 32 to allow for more Wait indicators or LRT signals, etc.
- Type 3 Phases and Window Times – A window time for a stage can now be set to zero without worrying that the stage starts before the intergreens to the optional phases expire. This would previously prevent the optional phase gaining ROW in the stage. Now, a phase of appearance type 3 will gain ROW if the demand is received before its intergreens expire. This is similar to a phase of

appearance type 1, except that demands are also accepted during the inter-stage.

2.11 Fault Logs

- ST900 faults that are still applicable to the ST950 are still logged using the same FLF codes. Those FLF faults also appear in the new Fault Table, which includes text descriptions and help.
- New ST950 faults only appear in the Fault Table; a single new FLF 62 flag is set when there is one or more non-FLF fault in the Fault Table.
- The LOG handset command no longer exists. The ST950 includes a much larger 'System Log' in to which most of the same LOG-style entries are logged as well as new ST950 events. This System Log is preserved on the Heart; the log is not erased by firmware update, configuration update or change of Processor Card.
- In addition to the System Log is a Site Log in to which users can add notes and attach documents. The controller automatically adds a note and attaches the new IC4 configuration file in to the Site Log as part of the configuration loading procedure.
- The fault table, system log, important timings, lamp monitor trace records (KTR) and inventory information can all be captured in just a few clicks by exporting the Site Information as a ZIP file. For obvious reasons, this ZIP file is sometimes referred to as the PI Dump (PI = Periodic Inspection). The ZIP file can be obtained directly from the web page interface. Alternatively, it can be obtained using standard handset terminal and a USB mass storage device (memory stick).
- Remote Reboot – Where a controller has shutdown reporting a correspondence fault for example, it is now possible to restart that controller remotely. Therefore, if the fault is spurious, it gets the signals back on quickly and allows the fault to be investigated later. Of course, if the fault re-occurs, the controller will shutdown again. No configuration required. The feature is enabled/disabled by a physical link on the Processor Card (near the Heart SD Card).
- Fault Log Reset button (optional) can be fitted in the cabinet. Discrete wires to connector on back of Processor Card. No configuration required. It can only be used to reset the fault log when the controller has shutdown. If only minor faults (e.g. DFM faults) are logged, it is ignored. So if a controller has shutdown and you don't have a handset, you can still attempt to restart it.

2.12 Facilities Not Currently Available

- ST750ELV architecture and small cabinet – Note that the ST950ELV Controller can be used for stand-alone pedestrian crossings, although its larger architecture requires the larger standard-sized cabinet.
- ST750 architecture (the 'biscuit tin') – the new ST950 Processor Card is not compatible with this architecture
- Integral TC12-OTU – UTC communications are moving from TC12 to UTMC
- Integral TfL IMU / IRM Card – in discussions with TfL about the replacement facility probably using IP communications.
- SDE/SA Card and Sound Mark interface – ST950 controllers use internal SDE/SA (using its standard serial I/O cards and intelligent detector backplanes)

- On-Street Configuration (SAC/CFG) – this rarely used facility has been deleted because it is not compatible with the new controller architecture.
- IP/Web page interface over SieCom Bluetooth adaptor – use Wi-Fi instead.
- TYCO/SCATS serial interface

Note: Some facilities that were previously listed as ‘not currently available’ in earlier ST950 Controllers are now available – check the latest controller release documentation, e.g. 667/SU/46000/000.

3 GENERIC SPECIFICATIONS

3.1 Controller Operation

In common with previous controllers, the ST950 LV and ELV Controllers are phase oriented. Timings and demands are associated with phases and the control philosophy is designed to give right-of-way to phases in an optimum manner.

It is necessary to group phases into stages for Manual Control, operation in Urban Traffic Control Schemes, MOVA and in Cable-less Linking Schemes. The traffic requirements and safety constraints also condition the grouping of phases into stages.

The controller receives requests for ROW from the following:

- ‘On-street’ detection equipment and pedestrian push-buttons
- The UTC computer
- The Cable-less Linking Facility (CLF)
- Manual inputs
- Special requests, e.g. hurry calls

The controller then orders the appearance of phases in accordance with the controller strategy, the current mode operative and the demand requests for ROW. The controller will always change stage cyclically.

3.2 Phases

The controller supports up to 32 phases. These may be all real phases or a combination of real and software (known as dummy) phases.

3.3 Stages

The controller supports up 32 stages (Note: Stage 0 is normally ALL RED)

3.4 Timings

All controller timings are provided in the IC4 Configuration file. These timings are subsequently transferred to RAM and FLASH memory during controller initialisation; the FLASH memory preserves the values over power failures. Once in memory most controller timings can be varied by handset mnemonics or by using the web user interface. Once the data has been loaded from the IC4 Configuration this action cannot be repeated using the same IC4 Configuration file. This prevents the accidental overwriting of any configuration data that may have been set up using the handset.

In the UK some timings considered to be fixed timings cannot be changed by handset, these are typically the Amber and Red/Amber periods. These timings can, however, be specified as alterable at configuration time to suit other signal sequences, non UK requirements etc.

Some controller timings are considered to be safety timings and can only be changed by a person at the controller, e.g. minimum green, inter-greens and blackout timings. These require the operator to press the ‘level 3’ access button on the front of the main processor card before attempting to modify these timings. For non-UK markets, modification of level-3 timings can be performed remotely without needing to press this button. This requires the 'download to level 3' option to be specifically enabled in the IC4 Configuration.

Following is a summary of some of the timings available within the traffic controller. It also shows their upper and lower limit values and where applicable the configurable limits. All timings are in seconds unless otherwise marked.

	Lower Limit (sec)	Upper Limit (sec)	Resol'n (sec)	Config'ble Lower Limit	Config'ble Upper Limit
General Timing Periods					
Minimum green	0	255	1	1 per phase	1 per phase
Maximum green (8 sets)	0	255	1	1 value	1 value
Green extension	0.0	31.8	0.2	1 value	1 value
Conflicting phase change inter-green	0	199	1	1 per change (32x32)	1 value
RLM 1st Red extra inter-green	0	255	1	1 value	1 value
Starting inter-green	0	255	1	1 value	1 value
Red / Amber time*	0	255	1	1 value	1 value
Leaving Amber time† (8 sets)	0	31.8	0.2	1 value	1 value
All red extension	0	31.8	0.2	-	-
All red maximum	0	255	1	-	-
Phase delay	0	255	1	1 value	1 value
Pedestrian window	0	255	1	-	-
Pedestrian Clearance Periods					
Fixed Clearance Period	0	255	1	1 value	1 value
Extendable Clearance Period	0	255	1	1 value	1 value
Clearance Red Period	0	255	1	1 value	1 value
Linking Timing Period					
Linked pedestrian controller release (conditioning timer)	0	255	1	1 per timer	1 per timer
C.L.F. group offset	0	255	1	1 value	1 value
Plan offsets	0	255	1	1 value	1 value
Hurry Call Timing Period					
Hurry call delay	0	255	1	1 value	1 value
Hurry call hold	0	255	1	1 value	1 value
Prevent hurry call	0	255	1	1 value	1 value
Hurry call watchdog (Requires Special Conditioning)	0	500	2	1 per timer	1 per timer
Hurry call request watchdog (Requires Special Conditioning)	0	255	1	1 per timer	1 per timer

* In the UK, the Red/Amber time is fixed at 2 seconds.
† In the UK, the Leaving Amber time is fixed at 3 seconds.

	Lower Limit (sec)	Upper Limit (sec)	Resol'n (sec)	Config'ble Lower Limit	Config'ble Upper Limit
Detector Timing Period					
Call delay period	0	255	1	-	-
Cancel delay period	0	255	1	-	-
Detector Fault Monitoring*	1	254	1	1 value	1 value
Priority Timing Period					
Monitor time	0	2550	10	-	-
Emergency gap	0	255	1	-	-
Priority extension (4 sets)	0	31.8	0.2	-	-
Priority maximum (4 sets)	0	255	1	-	-
Priority inhibit (4 sets)	0	255	1	-	-
Phase compensation (4 sets)	0	255	1	-	-
Priority 1st delay time	0	255	1	1 value	1 value
Priority 2nd delay time	0	255	1	1 value	1 value
Speed Discrimination Period					
SDE/SA extra clearance	0	50	1	-	-
Conditioning Timers					
For each timer, either:	0	255	1	1 per timer	1 per timer
or:	0	31.8	0.2	1 per timer	1 per timer

3.4.1 Tolerance

All timings, except CLF and Master Time Clock, are derived from the CPU crystal frequency. An additional error due to random signals not being synchronised to the clock pulse may add up to 200ms to the time. If the result of the above timings is required to change the signal lamps, a further error may occur, which may be up to a maximum of 21ms.

The set-up accuracy of the real time clock and offsets calculated from it will be 1 second.

3.5 Modes of Operation

- Vehicle actuated (SDE/SA can be added to VA)
- Timetable selected fixed time plans either Cableless linked or in isolation.
- Central computer controlled in a traffic control system.
- MOVA (using the integral application, free-standing I/O UTC interface or serial interface)
- Fixed time
- Hurry call

* Active DFM times are specified in minutes and inactive DFM times are specified in hours. The value of 0 gives a short DFM timeout period of less than a minute for test purposes. The value of 255 disables detector fault monitoring of that state for the associated group during the associated timeset.

- Manual
- Parallel stage streaming
- Priority
- Part time lamps off
- Part time lamps flashing, e.g. flashing vehicle ambers
- Stand-alone pedestrian stream 'VA' (with pre-timed maximum option)
- Stand-alone pedestrian stream 'Fixed Vehicle Period'

3.6 Master Time Clock Summary

- Master Time Clock Timing Sources -
  - 50Hz or 60Hz Mains (automatically detected)
  - NTP Server over IP communications
  - Option for GPS (Global Positioning System) unit.
- Full global time-zone and Day Light Saving support
- Option to maintain both an NTP (crystal) synchronised clock for UTC **and** a mains synchronous clock for fallback CLF operation.
- Standby Timing - On board crystal and optional non-rechargeable battery support programmable up to 31 days. Without the battery, support is 48 hours using 'super caps' and on power-up the time is automatically reset / updated by NTP or GPS (where fitted). Accuracy of standby crystal oscillator is 35 parts per million.
- Programmable changeover to mains synchronisation.
- Facilities for synchronising the real time clock and group timer from existing U.T.C.
- Number of time switch settings - 64
- Number of time switch functions - 3
  - Isolate controller
  - Introduce a CLF plan
  - Introduce events, such as alternative maximum greens

3.7 User Interface

3.7.1 Web Interface

The primary mechanism for the user to interact with the controller is through the web pages. The web pages are available over the following interfaces:

- USB handset port
- Ethernet

3.7.2 Handset Interface

Access is available to both the controller and GVP handset functionality as follows:

- Connection to RS232 port - controller handset & WIZ
- Virtual terminal to standard port - GVP handset, controller handset & WIZ
- Telnet to controller port - controller handset & WIZ

WIZ Command

The WIZ command gives easy access to commonly used operations through a textual menu system.

RS232 Port

The handset link runs at 1200, 9600 or 19200 baud and supports either 7 Data Bits with an Even Parity bit (7E) or 8 Data Bits and no parity (8N). It can produce anything from a 14 character single line display to a 80 character by 24 line full screen status display that displays the results of up to 10 handset commands simultaneously. The default display width is 20 characters.

The Controller Handset Handbook (/HH/) gives full information on handset operation and codes. This should be used when operating the handset.

3.8 USB Interface

3.8.1 USB Memory Sticks

USB memory sticks formatted with the FAT file system should be used. Encrypted USB memory sticks and those formatted with file systems other than FAT are not supported.

Files to be read by the controller should be placed at the top level of the directory structure and not within a subdirectory on the USB memory stick.

Files written by the controller will be to the top level of the directory structure on the USB memory stick.

4 QUIET INITIALISATION

4.1 Introduction

An IC4 configuration can be loaded into the controller using either the web interface or the WIZ command for example. In all sequences, the controller assesses the difference between the configuration currently running and that being loaded and will either perform a full initialisation or a Quiet Initialisation.

A Quiet Initialisation is the loading of an updated IC4 controller configuration, with the option of the traffic signals remaining illuminated – see 'Reserve State'.

If the changes made to the IC4 controller configuration are fundamental, e.g. the phases in stage arrangements are changed, then Quiet Initialisation is not possible and the full reprogramming and initialisation sequence will be followed.

IMPORTANT: The Quiet Initialisation sequence still performs a Controller Initialisation, so for example all handset timing changes in the controller are overwritten by the timing values in the IC4 configuration. In addition, if the lamp monitor configuration data is changed, the lamp monitor is reset and begins relearning the lamp loads; if the lamp monitor configuration data is not changed, the learnt loads and lamp faults persist.

To update only timing values, the use of IC4 View Differences is recommended. IC4 View Differences compares all the timings in the controller with those in the new IC4 configuration and allows differences to be moved from the IC4 configuration to the controller or vice versa.

4.2 What can and can't be changed by a Quiet Initialisation?

Below is a summary of all the changes that can be made to an IC4 configuration, and whether those changes are permitted by a Quiet Initialisation.

Tip! To determine whether a specific IC4 field can be changed by a Quiet Initialisation, simply open the ST950 configuration in the IC4 application and toggle the Quiet Initialisation lock using the menu item to see whether the field on the IC4 screen is disabled or remains enabled - see section 4.3 for more information.

Changes permitted (✓) and not permitted (✗) by a Quiet Initialisation:

- ✓ General: Intersection name and location text can be modified
- ✗ General: The EM-Number cannot be modified
- ✗ General: Controller type and firmware type cannot be modified
- ✓ Call/Cancel units can be added, deleted and modified
- ✓ CLF Plans can be added, deleted and modified
- ✗ Conflicting phase matrix cannot be changed
- ✗ Correspondence options cannot be changed
- ✓ DFM settings can be modified
- ✓ Download to Level 3 option can be enabled or disabled
- ✓ Extend All Red timings can be modified
- ✗ Extend All Red facility cannot be enabled/disabled
- ✗ Extend All Red stage definitions cannot be modified
- ✗ Fail to Hardware Flashing cannot be enabled, disabled or modified

- ✗ Fail to part-time facility cannot be enabled or disabled
- ✓ Fixed Time periods can be modified
- ✗ Fixed Time sequence cannot be changed
- ✓ FTCM (Fixed Time to Current Maximums) facility can be enabled, disable and modified
- ✓ Handset alterable timings can modified
- ✓ Handset range limits can be modified
- ✓ Holiday Clock facility can be enabled, disable and modified
- ✓ Hurry Call mode can be enabled, disable and modified
- ✓ Inputs/Outputs can be added, deleted and modified
- ✓ Intergreen Delays maximum periods can be modified
- ✗ Intergreen Delays cannot be added, deleted or modified (except for the max period)
- ✓ Lamp monitoring sensor 'Load Types' (KLT) can be modified
- ✓ Lamp monitoring 'Sensor Types' can be modified
- ✗ Lamp Sequences cannot be changed (although their Titles can be changed)
- ✓ Last Lamp Failed Monitoring can be enabled, disable and modified
- ✓ LFT (Linked Fixed Time) step times can be modified
- ✗ LFT (Linked Fixed Time) mode cannot be enabled or disabled
- ✗ LFT (Linked Fixed Time) sequence cannot be changed
- ✓ LRT (Light Rail Transit) mode can be enabled, disable and modified
- ✗ LRT (Light Rail Transit) Phase Groups cannot be changed
- ✗ LSLS lamp monitoring sensor allocation cannot be changed
- ✗ LSLS output drive allocation cannot be changed
- ✓ Manual mode can be enabled, disabled and modified
- ✓ Manual panel buttons and LEDs can be modified
- ✓ Mode priorities can be changed
- ✓ MOVA (serial and internal) can be enabled, disable and modified
- ✗ Opposing phase matrix cannot be changed (part of the conflict table)
- ✓ Part-Time mode can be enabled and disabled
- ✓ Pedestrian Kerbside detector allocations can be added, deleted and modified
- ✓ Pedestrian On-Crossing detector allocations can be added, deleted and modified
- ✓ Pedestrian timings can be modified (PAR, MIN, PBT, CMX, PIT, etc.)
- ✗ Phases cannot be added or deleted
- ✗ Phase Appearance and Termination types cannot be modified
- ✓ Phase Delays can be added, deleted and modified
- ✓ Phase Demand and Extend detector definitions can be changed
- ✓ Phase Timings can be modified (MIN, MAX, EXT, IGN, RAT, LAT, etc.)
- ✓ Phase Titles (descriptions) can be modified
- ✗ Phases in Stages allocation cannot be changed
- ✓ Priority / Emergency vehicle mode can be enabled, disable and modified
- ✗ Red Lamp Monitoring facility cannot be enabled, disabled or actions modified
- ✓ Reserve State options can be changed
- ✗ Ripple Change cannot be enabled or disabled
- ✓ SDE/SA assessor information can be modified
- ✓ SDE/SA clearance time periods (SCT) can be modified
- ✗ SDE/SA facility cannot be enabled or disabled
- ✗ SDE/SA / Gaining phase delay interaction cannot be modified

- ✓ Special Conditioning can be modified
- ✓ Special Conditioning Timers can be added, deleted and modified
- ✓ Special Instructions can be modified
- ✗ Stages cannot be added or deleted
- ✗ Stages for start-up and switch-off cannot be modified
- ✗ Stage prohibited, alternate and ignore moves cannot be changed
- ✗ Start-up demands cannot be modified
- ✗ Switched Signs cannot be added, deleted or modified
- ✓ Timetable changes can be made
- ✓ UTC mode and its various interfaces can be enabled, disable and modified

Please remember that the controller remains powered during a Quiet Initialisation so it may not be practical to modify the physical equipment in the cabinet even though Quiet Initialisation permits the configuration item to be changed. For example, the summary indicates that a detector input can be added to the configuration and a Quiet Initialisation performed, but it may not be practical to physically add the detector device while the controller remains powered.

4.3 How do I know what IC4 fields can be changed?

To assist the IC4 user, each ST950 IC4 configuration includes a Quiet Initialisation lock.

While an ST950 Configuration is open in IC4, the state of the Quiet Initialisation lock can be toggled by simply selecting the ‘Quiet Initialisation’ option under the IC4 ‘Edit’ menu.

With the Quiet Initialisation lock ON, all the fields that if modified would prevent a Quiet Initialisation are disabled (greyed). The fields that can be modified remain enabled.

With the Quiet Initialisation lock OFF, all the fields are enabled as normal.

When the IC4 configuration is up-issued having being formally approved for example, the Quiet Initialisation lock is switched ON automatically. So by default, any changes made after a configuration has been approved and installed can be loaded in to the controller using the Quiet Initialisation procedure.

If Quiet Initialisation lock is ON and more significant changes need to be made, i.e. a disabled IC4 field needs to be changed, the Quiet Initialisation lock can be switched OFF using the IC4 menu option.

4.4 How do I request a Quiet Initialisation?

When a new IC4 configuration is loaded in to the controller, the controller compares the new configuration with that currently active in the controller to determine whether or not a Quiet Initialisation is possible. The controller does not use the state of the Quiet Initialisation lock.

The verdict is displayed to the user, with more details provided in the System Log.

Even if a Quiet Initialisation is permitted, the user can still decide to perform the full reprogramming sequence.

Note that there is no separate controller option to request a Quiet Initialisation; the standard mechanisms to load the new IC4 Configuration in to the controller are used. During these sequences, the controller checks whether or not a Quiet Initialisation is possible. If a Quiet Initialisation is possible, the user can decide whether to perform a Quiet Initialisation or the full reprogramming sequence. If Quiet Initialisation is not possible, only the full reprogramming sequence is available.

5 RESERVE STATE

Firmware and configuration upgrades can be performed while the traffic signals remain illuminated. If the new firmware package only upgrades the application software or the configuration upgrade does not fundamentally change the arrangement of phases and stages (see Quiet Initialisation), the option is available to keep the traffic signals illuminated.

Alternatively, if the new firmware package includes an upgrade to one or more embedded microprocessors for example, or the configuration upgrade fundamentally changes the arrangement of phases and stages, the upgrade is put on hold until an engineer visits the site (and presses the PROGRAM pushbutton).

The Reserve State settings define how the embedded microprocessors react when the application processor reboots, to load new firmware or a new configuration for example.

The Reserve State settings define whether the signals extinguish, flash amber or cycle in fixed time for example. A time limit can also be configured so for example, the signals of a pedestrian crossing can be held at vehicle green / pedestrian red for a period of time while the application processor reboots, but if it does not return because of a problem, the signals can be extinguished rather than hold indefinitely.

During the Reserve State, the controller has no access to external I/O. This includes user interfaces, vehicle detection, pedestrian pushbuttons, UTC control and monitoring, etc. These are all facilities that are controlled by the application software and can be updated by the firmware or configuration update.

5.1 Options available for the Reserve State

Fundamentally, three options exist for each stream:

Fixed Time – typically used at busy traffic intersections. The standard FT (Fixed Time) sequence is followed. For controllers with more than one stream, LFT (Linked Fixed Time) mode is available. FTCM (Fixed Time to Current Maximums) mode is not available in the Reserve State; if FTCM mode is used normally, either FT or LFT must also be configured so it is available for the Reserve State.

Hold Stage – typically used at pedestrian crossings. The signals remain in the current stage, subject to the Timeout periods below. Normally, Reserve state would also be configured to move to the switch off stage and hold there – this is the default operation for stand-alone pedestrian crossings where it is expected that the switch off stage is configured as vehicle green / pedestrian red.

Part Time – is available where it is not practical to leave the signals operating. The configured part-time state of the signals is used, typically all-off or flashing ambers. Entry to this state follows the standard sequence for entry in to part-time mode – ROW moves to the configured switch off stage and when all the minimum green times have expired, the signals move to their part-time state. Part-time mode does not need to be configured for this option, only the part-time Lamp Sequence states which default to signals off.

In addition to these options, two time-out periods exist and can be adjusted:

Entry Timeout - If the entry sequence does not complete within a reasonable time, the Reserve State states are forced when this period expires. If for example restrictions are configured that deliberately delay the appearance of the switch-off stage, this time-out period may need to be increased. By default this period is 60 seconds.

Return Timeout - If the Controller Application does not regain control within this period, a different Reserve State option can be configured. For example, the default for a stand-alone pedestrian stream is to 'Hold' the switch off stage, but if the Controller Application does not regain control, the stream is extinguished using the 'Part-Time' option. By default this period is 4 minutes, but can be reduced if required. The signals (if still illuminated) are also forced Bright when this timeout occurs (see 'dimming' in section 5.8).

Two additional options exist:

Part Time on App Failure or Timeout - If selected, the phases for the stream are forced immediately to their defined part-time state if the Application stops unexpectedly or the Entry timeout expires. This can be enabled/disable independently on each stream. This is similar to the 'fail-to-part-time' facility, but neither part-time mode nor the fail-to-part-time facility needs to be enabled. When the Application restarts, normal operation resumes automatically (subject to the checks described in section 5.4).

Shutdown on App Failure or Timeout - Shutdown the controller to all signals off or Hardware Fail Flash when either the Application stops unexpectedly, Entry does not complete within its Timeout period or the Application fails to return within the Limited Time Timeout period. As this always requires a manual reset before normal operation can resume, consider using the 'Part-time on App Failure or Timeout' option instead as this allows normal operation to resume automatically.

5.2 Entry to the Reserve State

All software reboots of the Controller Application attempt a controlled entry in to the Reserve State. Such reboots include Quiet Initialisation, a software update and pressing the Reboot button on the System web page. The controlled entry sequence depends on the stream type, but only when all streams are ready will the Controller Application actually reboot.

Part-Time

Entry to the Reserve State forces the switch off stage to ROW in the same way as normal entry to part-time mode. When the shutdown stage is at ROW and all minimum green times have expired, this stream is deemed ready. When all streams are ready, the Controller Application is permitted to reboot and this stream enters its configured part-time state (off or flashing).

Fixed-Time

Entry to the Reserve State prevents any further stage movements*. If a stage move is in progress, it is allowed to complete. When not in an interstage and all minimum green times have expired, this stream is deemed ready. When all streams are ready, the Controller Application is permitted to reboot and this stream enters the configured fixed-time mode (independent standard FT or Linked FT), subject to RLM actions.

* This may hold the signals in stage that normally only runs for a short period (such as an all-red stage) until all streams are ready.

Hold Stage with the Go to Switch-Off Stage option

Entry to the Reserve State forces the switch off stage to ROW (in a similar way to 'part-time'). When the switch off stage is at ROW and all minimum green times have expired, this stream is deemed ready. When all streams are ready, the Controller Application is permitted to reboot and this stream remains in that switch off stage until the Controller Application regains control or the time-out period expires (when it is recommended that the 'part-time' option is selected to extinguish the crossing).

Hold Stage without the Go to Switch-Off Stage option

Entry to the Reserve State prevents any further stage movements in that same way as the Fixed-Time option. When all streams are ready, the Controller Application is permitted to reboot and this stream remains in the stage until the Controller Application regains control or the time-out period expires.

5.3 Exit from the Reserve State

While the Controller Application is waiting to regain control, it reports that start-up mode is in operation (regardless of the mode of the signals in Reserve State).

(If required, Special Conditioning can read the actual mode of operation and active stage while the Controller Application is waiting to regain control.)

With the Controller Primary still in control of the signals, the Controller Application monitors the state of the signals. It monitors the state to determine the best time to regain control. Unless Linked Fixed Time mode is active, the Controller Application regains control of each stream independently as follows:

If the signals are off/flashing in the Reserve State:

The Controller Application can regain control at any time and then resume normal operation via the configured start-up sequence.

If the signals are held in stage in the Reserve State:

The Controller Application can regain control at any time and naturally resume normal operation, e.g. service the pedestrian demand at the crossing.

If the Reserve State is cycling in Fixed Time mode:

The Controller Application regains control on the stream just as the fixed time sequence completes an interstage movement and begins a new stage. This allows the Controller Application to regain control of the stream as soon as practical. However, it does mean it may exit start-up mode and begin normal operation in a stage other than the start-up stage. If specifically required, the Controller Application can be prevented from regaining control while a specific stage is at ROW (see 'PRVSTn' below).

If the Reserve State is cycling in Linked Fixed Time mode:

The Controller Application regains control of all the streams at the same time in order to maintain the synchronisation between the streams. This occurs just as a new combination of stages gains ROW, i.e. just as the last stream performing an interstage movement completes that movement.

Reminder: If the Reserve State uses fixed time, ensure that the configuration can cater for start-up in to any stage, not just the configured start-up stage.

Whatever the mode of operation, the Controller Application does not regain control if the stage at ROW (or about to gain ROW) is prevented using the 'PRVSTn' Special Conditioning mnemonic. The Controller Application waits until the stage at ROW (or about to gain ROW) is not prevented.

When the Controller Application Software regains control, the configured start-up demands are inserted. In addition, any pedestrian phases with WAIT indicators illuminated are also demanded. This occurs whether the signals were extinguished or flashing, or whether fixed time or part-time mode was active. In all cases, drivers and pedestrians may be waiting to proceed but their demands through street detectors have been ignored by the controller during the Reserve State.

5.4 Repeated entry to Reserve State

Having a controller repeatedly switching between normal operation and the Reserve State is undesirable. Therefore, the number of excursions within a time period is limited by two independent facilities:

The EFC software enters a 'restricted mode' of operation if it reboots a number of times in quick succession. In this 'restricted mode', no applications or plug-ins are loaded, but the user interfaces are available allowing the engineer to investigate the cause. This is similar to the 'safe mode' used by PCs for example.

Independently, the Primary CPU counts each entry in to the Reserve State. On the fourth entry in to the Reserve State within any 24 hour period, the Primary 'latches' the Reserve State and refuses to allow the Controller Application to regain control until the count is manually reset. More information on this feature is given below.

While the Primary has 'latched' the Reserve State, it informs the Application which places an entry on the Fault Table web page to clearly inform the user. This Fault Table entry includes a manual reset button allowing the user to manual reset the count in the Primary either locally or remotely. If the power is switched off or the Level-3 pushbutton is pressed this count is also reset.

Note that loading a new IC4 configuration requires the user to be on site and press the Level-3 pushbutton so this normally keeps the count reset and prevents latching of the Reserve State if the user needs to update the IC4 configuration a number of times.

5.5 Red Lamp Monitoring

Last Lamp Failed Monitoring (section 44.4) continues throughout the Reserve State sequence.

However, the Lamp Monitoring facility (section 44.1) is suspended during the Reserve State, including the detection of RLM (Red Lamp Monitoring) lamp faults. The Lamp Monitoring facility is provided by the Controller Application for various reasons, for example it allows configuration and firmware updates while the signals typically remain illuminated in the Reserve State, improved diagnostic information and in the future will allow improved algorithms to be added that make use of this more powerful microprocessor.

RLM actions include inhibiting pedestrian phases (UK intersections typically), blacking-out phases (part-time or stand-alone ped streams typically), and sending the stream to its ‘fail to part-time’ state (non-UK).

RLM faults confirmed prior to the Reserve State continue to be actioned. For example, if the intersection has already been extinguished by an RLM fault, it remains extinguished in the Reserve State.

Depending on the controller configuration, additional RLM actions may be forced should red signals illuminate while in the Reserve State.

For controllers configured with ‘fail to part-time’ facility disabled:

Once in the Reserve State, RLM actions are forced should a monitored red signal illuminate during the Reserve State. The default settings (section 5.6) for the Reserve State ensure the correct operation, e.g. an intersection cycles but with pedestrian phases inhibited, a part-time intersection switches to part-time (off/flashing) and a stand-alone pedestrian crossing remains at vehicle green / pedestrian red.

During the controlled entry to the Reserve State however, new RLM actions are not forced. This allows the streams to complete their required entry sequences. (If the RLM actions were forced, then as soon as the entry sequence begins certain types of stream would be extinguished, e.g. part-time intersection streams and pedestrian crossings at vehicle red.)

For controllers configured with ‘fail to part-time’ facility enabled (Non-UK):

The RLM actions are not forced. This allows the user to explicitly choose between continuing to operate in fixed-time operation without monitoring of the red signals, or switch to part-time (off / flashing) either immediately or after the time-out period. The default setting is to switch to the part-time state using the standard sequence for entry in to part-time mode.

5.6 Reserve State Default Options

For each controller stream, IC4 defaults the Reserve State options as follows:

For intersection streams with RLM configured to blackout phases (not ‘fail to part-time’):

Switch off in a controlled manor using the standard sequence for entry in to part-time mode.

For intersection streams with RLM configured to inhibit phases (not ‘fail to part-time’):

Fixed Time (or Linked Fixed Time if this mode is configured). Pedestrian phases are inhibited and pedestrian-only stages are omitted.

For intersection streams with ‘fail to part-time’ and RLM configured:

Switch to off/flashing in a controlled manor using the standard sequence for entry in to part-time mode.

For intersection streams with ‘fail to part-time’ configured but not RLM:

Fixed Time (or Linked Fixed Time if this mode is configured)

For all other intersection streams:

Fixed Time (or Linked Fixed Time if this mode is configured).

For stand-alone pedestrian streams (regardless of RLM settings):

Hold the switch-off stage for a period (expected to be vehicle green / pedestrian red), but switch off if the Controller Application fails to regain control.

NOTE: If a pedestrian crossing is not configured as a stand-alone pedestrian stream, IC4 will not select those default options causing the stream to switch off if RLM is configured. If the 'hold' option is required, it has to be selected manually. (If the pedestrian crossing is an additional stream on an intersection controller, it is sometimes configured as a small intersection stream so it can be controlled in a similar way to the main intersection stream.)

5.7 Diagram of the Reserve State Options

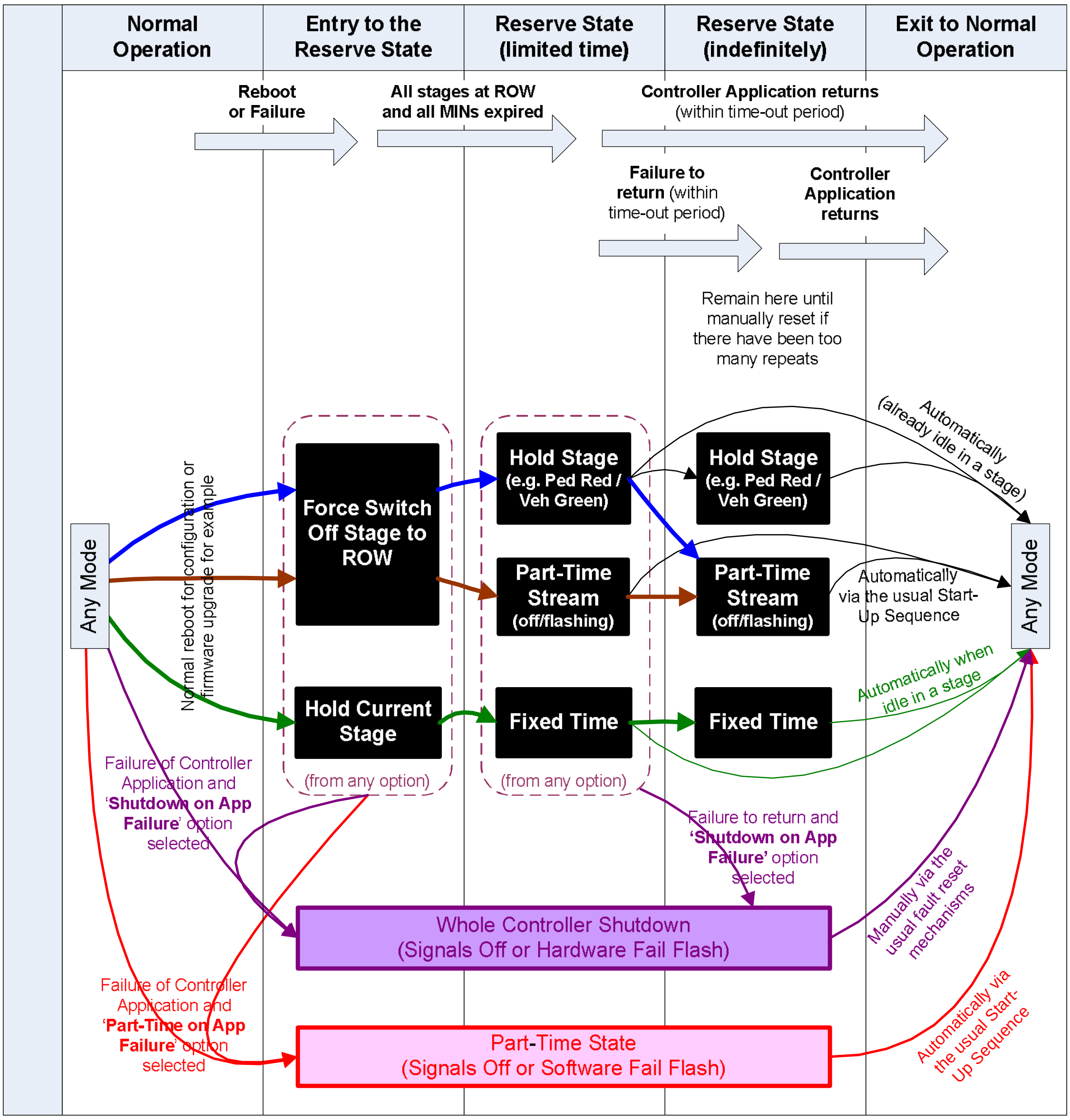


Figure 1 Reserve State Options

Only the combinations likely to be required are shown; other combinations are possible but these are omitted from the diagram. For example, it is possible to configure the controller to enter fixed-time initially and then switch off (part-time) on the time-out.

The defaults are:

- Blue: Stand-alone Pedestrian stream
- Brown: Intersection where RLM extinguishes the stream
- Green: Any other Intersection stream
- Red/Purple: Not selected by default

5.8 Reserve State and other facilities

While the Reserve State is active, the configuration and firmware of the Controller Application can be updated. Since the Controller Application is not operating in the Reserve State, a number of facilities are not available.

Always remember that the controller can be configured to extinguish (or flash) the signals in the Reserve State. Allowing the signals to remain illuminated in fixed time mode should be carefully considered.

- **Dimming:** The signals remain in their current dim/bright state, until the time-out period expires, when the signals are forced to the bright state.
- **Extend All Red** extends to its configured maximum period.
- **External I/O:** The Controller Application no longer scan inputs or set outputs. All outputs default to their de-energised / power-down state. Modes such as VA and UTC are not available.
- **Intergreen Delays** extend to their configured maximum intergreen period.
- **Manual Panel:** All the Manual Panel LED's extinguish and it is not possible to change the mode of operation. However, the signals on/off switch is operates.
- **Optional / Demand-Dependant Phases:** As is normal for the fixed time modes, optional and demand-dependant phases always gain ROW when their stage is called.
- **Part-Time Operation:** To minimise the impact on the traffic, if the signals are already in their part-time state when Reserve State begins, the signals remain in that state during the Reserve State (even if fixed-time is configured as the Reserve State option). When the Controller Application regains control, it handles the entry to or exit from part-time mode in the usual way.
- **Pedestrian All Red (PAR)** period runs for the configured FVP (Fixed Vehicle Period) period, or for three seconds if this value is set lower.
- **Pedestrian Clearance periods (CMX)** are extended to their configured maximum periods, although in practice it is likely that the pedestrian phases will be inhibited from gaining ROW.
- **Pedestrian Wait Indicators** for phases inhibited by RLM or configured with start-up demands are illuminated. Indicators already illuminated are not extinguished (unless the phase gains ROW).
- **Phase Delays** run as normal. Phase Delays disabled by Special Conditioning remain disabled during the Reserve State.
- **Priority Events:** Modes such as Hurry Call, LRT, Priority and Emergency Vehicles do not operate. If these facilities normally call a specific stage that

does not normally gain ROW, it is recommended that the stage is always included in the fixed time sequence to allow those vehicles to pass through the intersection albeit without their usual priority.

- **Red Lamp Monitoring:** Refer to section 5.5.
- **SDE/SA clearance periods (SCT)** are applied, extending the intergreen period as required.
- **Special Conditioning** does not run: If for example Special Conditioning supports the normal operation of the traffic signals, e.g. preventing stages unless specific demands are present, then the defined fixed time (FT or LFT) sequence must ensure safe operation of the intersection.
- **Switched Signs** are all extinguished.
- **UTC Instation** receives the G1/G2 lamps off condition because the controller’s external I/O interfaces are suspended. If the internal UTMC-OTU facility is being used then that is likely to reboot at the same time as the Controller Application.

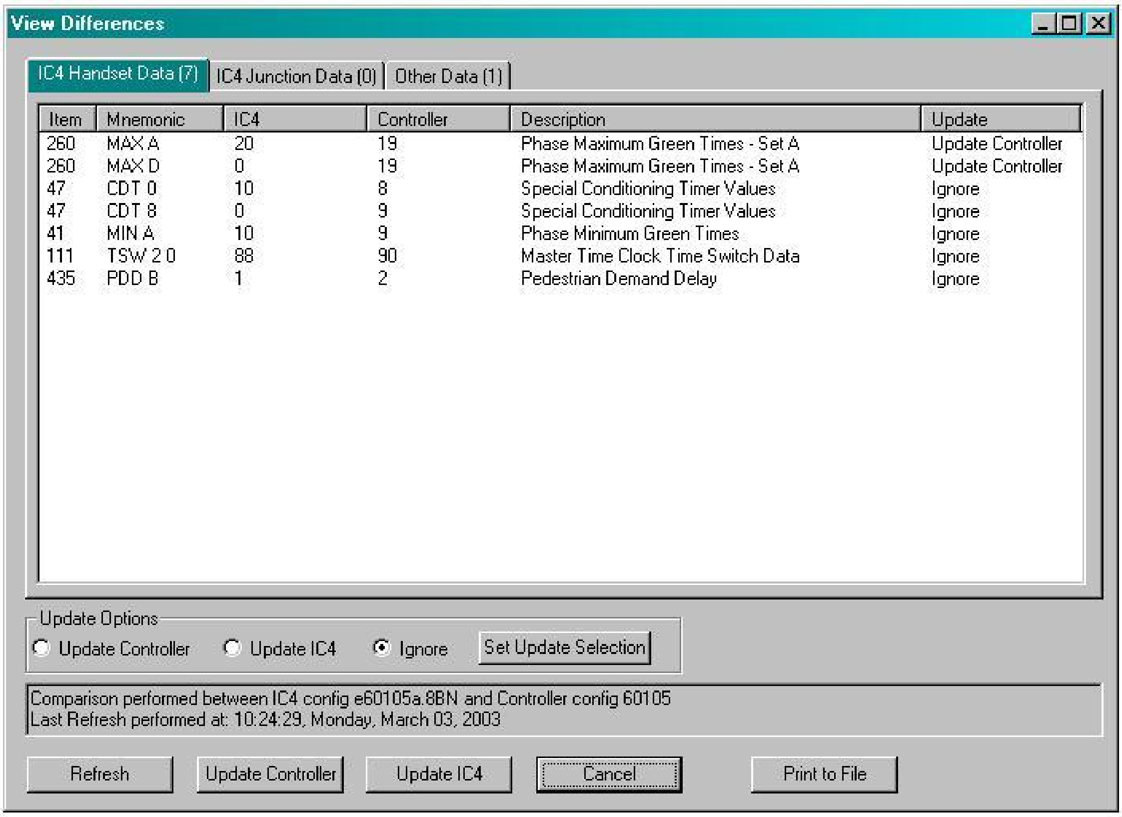
6 IC4 VIEW DIFFERENCES

6.1 Introduction

Once a controller has been configured by IC4, many items of configured data can be altered "on the street" via a handset or the web interface.

The IC4 View Differences facility enables the combined handset altered/configured data from the controller to be compared with the original configuration that was loaded in to the controller, or even a modified version of it.

6.2 User Interface



The Refresh button initiates communication with the controller to upload the configured/handset altered data to the PC. If the EM number of the configured controller data differs from that of the selected IC4 configuration file a warning message appears but the procedure may be continued if required. Any differences between the data from the Controller, and the IC4 configuration selected when selecting the View Differences option, are displayed in the different tabs, depending on the type of data.

Junction data includes parameters and timings that cannot be modified via the maintenance terminal; such differences indicate that the configuration loaded in the controller is not exactly the same as the IC4 file used for the comparison, e.g. that the IC4 file has been modified after the configuration has been loaded in to the controller.

Handset data includes data that may be modified via the maintenance terminal. Each difference listed in the IC4 Handset Data window can be treated in one of three ways:

a) Downloaded to the controller (Update Controller), i.e. the value listed in the IC4 column is sent to the controller and is treated as if it had been updated using a handset command.

b) Merged into IC4 (Update IC4), i.e. the value listed in the Controller column is put into the IC4 .8SD file and saved and therefore will appear on the IC4 screen.

c) Ignored.

6.3 Print to File

The 'Print to File' button will write the differences displayed on the screen to a text file (with the 8TX extension by default). An example of such a file is shown below:

```
                              IC4 View Differences Report


IC4 Handset Data

Item  Mnemonic IC4 Data          Controller Data     Description

373   DFS 19   0                  1                  DFM Suspended
209   DSI 1 0  18                 48                 DFM Inactive Time
209   DSI 1 1  18                 48                 DFM Inactive Time
209   DSI 1 2  18                 48                 DFM Inactive Time
209   DSI 1 3  18                 48                 DFM Inactive Time

IC4 Junction Data

Item  Mnemonic IC4 Data          Controller Data     Description



Other Data

Item  Mnemonic IC4 Data          Controller Data     Description

258   BSA      0                  14                 BST Advance (Week Number)
259   BSR      0                  44                 BST Retard (Week Number)
```

6.4 For More Information

More information on the View Differences facility can be found in the Help within the IC4 Configurator program.

7 REMOTE REBOOT

Where a controller has ceased operation and is in a shutdown state, a request may be made through a web page or handset command to reboot the controller. This mimics the power being cycled (off / on) and is known as "Remote Reboot" although the request could equally be made from a location remote or local to the controller. There is no guarantee that the procedure will cause the controller to resume normal operation as the fault which caused it to shutdown may still be present. However, if the controller can be restored to running during the traffic peak times, then it will reduce disruption and allow further investigation of the fault to be performed on site later.

7.1 Conditions Required to Enable Remote Reboot

In order to ensure that the remote reboot operation does not occur inappropriately, a reboot is only performed if the certain conditions are met. These conditions are checked by different pieces of hardware and software to ensure that a single fault doesn't cause this checking not to occur.

The hardware only permits the signals used to perform the reboot to reach their destination if the following conditions are met:

- Remote reboot is enabled on the CPU card (hardware link PL18)
- The controller is in the shutdown state
- The hardware watchdog has not expired

The SEC software only permits the reboot request if the following conditions are met:

- The shutdown was not requested by the SEC
- At least ten minutes has passed since the system started
- No previous remote reboot attempts have been made since the system started
- The correct Remote Reboot Code is provided by the user

7.2 User Checks Before Requesting Remote Reboot

The state of the controller should be checked before requesting a remote reboot to ensure that it is in a suitable state:

- Confirm that the controller has a major fault
- Confirm that the controller is shutdown
- Confirm that the fault may be of a spurious nature, e.g. a correspondence fault not seen before at this site, and no unusual events have occurred.

7.3 Clearing The Fault

The first step in requesting a remote reboot is to clear the fault which has caused the controller to shut down. This can be done through the Fault Table web page or using the RFL=1 handset command.

7.4 Initiating a Remote Reboot Using the Web Interface

If a remote reboot is appropriate and desired then it can be performed as follows:

1. View the Controller - Faults web page

2. Enter the Remote Reboot Code (11)
3. Press the Save button
4. Observe the countdown. It is possible to abort the operation during this countdown by setting the Remote Reboot Code back to zero and pressing the Save button.
5. Controller reboots

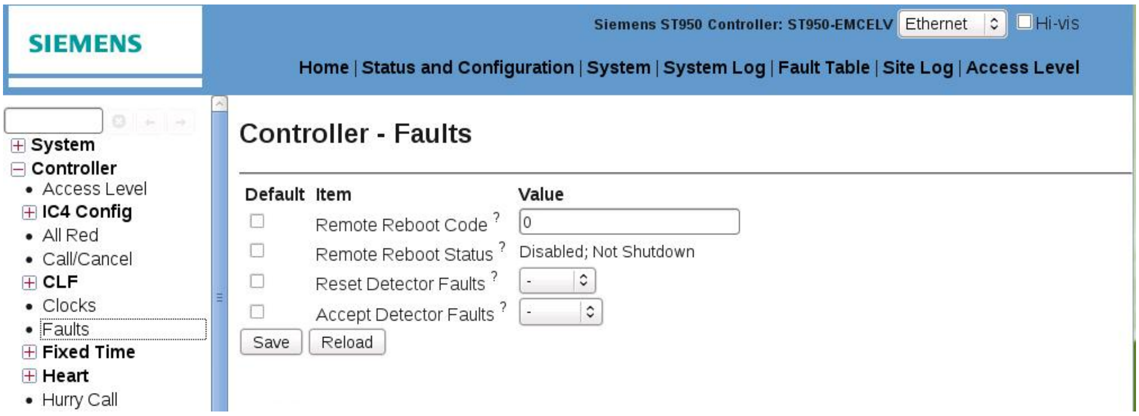


Figure 2 Controller - Faults web page

The current status of the remote reboot system can be seen in the Remote Reboot Status field.

Ready	The feature is ready to accept the reboot code.
Disabled; Not Shutdown	The feature is disabled because the controller has not shutdown.
Disabled; Watchdog	The feature is disabled because a watchdog fault has been detected.
Reset Fault Log	The feature is disabled until a user has made an attempt to reset the fault.
10,9,8,...	Countdown showing the number of seconds before reboot. It is possible to abort the sequence during this countdown by setting the reboot code back to zero.
Rebooting	The controller is attempting to reboot. Access to the Web pages will be interrupted while the controller reboots.

Table 1 Remote Reboot Status values

7.5 Initiating a Remote Reboot Using a Handset Command

A remote reboot can be request using the controller handset command "RBC=11".

8 STAGES

8.1 Facilities

There are up to 32 stages (0 to 31) available for use.

Stage 0 is normally used as a manual all-red facility. It may be used as a traffic stage.

Stage 1 normally is the start-up stage and must not be deleted.

Some stages may appear in some modes but not others.

Note: Since a change of mode can occur at any time, the controller may temporarily reside in a stage that is not normally used by the new mode if the controller was in that stage just prior to the change of mode. The controller can be configured to leave the stage as soon as possible (i.e. when all minimum green times have expired) or to leave the stage when normal conditions dictate.

8.2 Allocation of Phases

The available phases are allocated to the stages in any combination subject to the method of control, the traffic requirements and safety considerations.

8.3 Stages Active

A stage is considered active when all the fixed phases that are allocated to the stage are at green and all phases (fixed or non-fixed) that are not allocated to the stage are at red.

A stage is considered to be terminating when the first phase which has had ROW (i.e. been at green) during the stage, loses right of way.

8.4 Interstage Period

The interstage period is the time between one stage terminating and another stage becoming active.

8.5 Stage Change Algorithm

In all modes, the controller monitors the following every 200ms:

- all demands (for both phases and stages)
- all extensions and maximum green timers

These are monitored in order to check to see if it is possible to move to a new stage, and serve new demands.

Normally the controller waits until the interstage movement is complete before looking for a new stage to move to. However, the “Ripple Change Facility” allows the controller to look for a new stage while the controller is still moving between two stages.

In order to select the next stage, the “SUGGESTED STAGE”, the controller goes through the following decision-making process.

Firstly, the controller sets the “suggested stage” as the current stage and the number of new “phases & stages to get right of way” to ‘none’. These two items will then be updated as the controller goes though its decision-making process.

The following process is performed for each stage in cyclic order starting at current stage +1. Stages not allocated to the same stream are ignored.

1. Are any of the fixed phases in the stage or the stage itself prevented and/or deleted?

   If YES, (i.e. prevented and/or deleted) try the next stage in cyclic order (starting at step 1).

   If NO, proceed to next step.

2. Are there demands for phases in this stage or for the stage itself?

   If NO, (i.e. phases/stage not demanded) try the next stage in cyclic order (starting at step 1).

   If YES, proceed to next step.

3. Can the current stage be terminated, e.g. will all phases which have extensions (and for which the maximum green timer has not expired) or have minimum green times running, keep right of way in this stage?

   If NO, add the demanded phases in this stage (or the stage itself if stage is demanded) to “Phases & Stages to Get right of way” (for checking later). Then try the next stage in cyclic order (starting at Step 1).

   If YES, proceed to next step.

4. Will all demanded phases which appeared in previously checked stages and any specifically demanded stages previously checked (i.e. “Phases & Stages to Get right of way”) get right of way, i.e. be serviced by this stage?

   (N.B. Obviously if a previously checked stage is itself specifically demanded, no other stage can satisfy the demand and the answer to the above question will be NO. Stage demands are normally only inserted from special conditioning or modes of operation where specific stages are requested, i.e. CLF, UTC, Hurry Call, Fixed Time, Manual or Manual Step-On.)

   If NO, add the demanded phases in this stage (or the stage itself if the stage is demanded) to “Phases & stages to Get right of way”. Then try the next stage in cyclic order (starting at Step 1).

   If YES, proceed to next step.

5. Will additional demanded phases be serviced by this stage compared to the previously “Suggested Stage” (i.e. is this stage better than the currently suggested stage)?

   If NO, add the demanded phases in this stage (or the stage itself if the stage is demanded) to “Phases & Stages to Get right of way”. Then try the next stage in cyclic order (starting at Step 1).

   If YES, set “Suggested Stage” equal to this stage.

At the end of the decision-making process, the “Suggested Stage” is either a new stage or it will have remained as the current stage.

If the suggested stage is other than the current stage, the controller then checks the "Stage movement restriction" table that is appropriate to the mode, to see if it can make the move.

If the move from the current stage to the "Suggested Stage" is prohibited, the controller will stay in the current stage until the decision-making process comes up with a different "Suggested Stage" to move to.

If the move from the current stage to the "Suggested Stage" is an Ignore move, the controller will repeat the decision-making process but now ignore this suggested stage.

If the move from the current stage to the "Suggested Stage" has an alternative stage move specified, the controller will move to the alternative stage (unless phases that must keep right of way do not appear in that stage).

If the move from the current stage to the "Suggested Stage" is unrestricted, the controller will move to the "Suggested Stage".

8.5.1 Effects of Modes other than VA on Stage Change Algorithm

In V.A. mode, the stage change algorithm is allowed to suggest a stage based on the influences current at the time without any manipulating of those influences.

However, in other modes, those modes influence the outcome of the stage change algorithm. This can be done by:

- Applying stage/phase prevents,
- Masking out phase demands,
- Inserting stage demands,
- Masking out extensions, i.e. causing them to be ignored,
- Suspending maximum green times.

Thus for the above-mentioned modes, specific stages may be requested, and the controller forced to serve them when required.

8.5.2 Usage of Stage Movement Restriction Tables

The controller will always use the stage movement restriction table, applicable to the mode in which it is operating when it initiates the stage change.

EXAMPLE

If a priority demand invokes a stage change, the controller will be in priority mode due to the priority demand and will use the stage change restrictions table applicable to priority mode.

However, if the controller has already decided to make a stage change in the VA mode and a priority demand is received, the controller will continue to make the VA move although the mode will have changed. The controller will then only use the stage movement restriction table applicable to priority mode if it makes any subsequent moves whilst still in priority mode.

8.6 Exceptional Stages

Under some circumstances, right of way is required to 'jump' to a specific stage that does not form part of the normal stage sequence.

The controller will typically be configured to allow movement to this dedicated stage from any other stage, thus interrupting the normal cyclic order of demand servicing.

Example: a dedicated stage is configured that allows a higher priority vehicle such as a tram to proceed through the intersection while all the traffic and pedestrians phases remain at red. Refer to the LRT documentation for more information the LRT facility and trams, but note that the Exceptional Stage feature can be used for any purpose; it is not dependant on the LRT facility.

This dedicated stage can be considered as an ***exceptional stage*** if the stage does not gain ROW in the stage cycle ***except*** when specifically and occasionally requested, and it interrupts and temporarily suspends the usual stage sequence.

After an exceptional stage has gained ROW (except in VA, FT or CLF mode*), the controller attempts to resume the original stage sequence. It does this by considering demands for the stage following the stage that was active before the move to the exceptional stage, not the demands for the stage following the exceptional stage:

If ROW moved from the 'normal' stage N to the exceptional stage X, the stage change algorithm would consider stage N+1 as the next stage to consider after stage X, not stage X+1.

It should be noted that if mode other than VA mode is active, that mode of operation may force a particular stage, effectively overriding this option. For example, if a CLF plan is active and it is requesting an immediate move to a stage, that request will take priority.

The following diagrams show examples of this operation:

Example 1 shows the normal operation of the intersection. The Stages 1 through 4 are called in sequential order, if demanded. Stage 5 is the exceptional stage, which is not called unless demanded and so does not appear at right of way in the normal stage sequence.

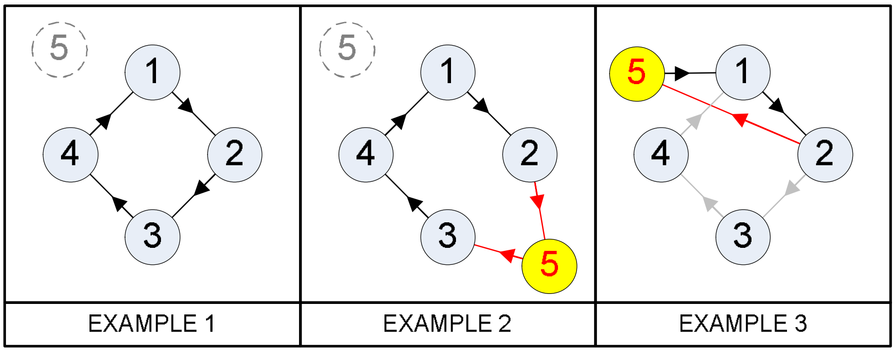


Figure 3 - Exceptional Stage Examples 1 to 3

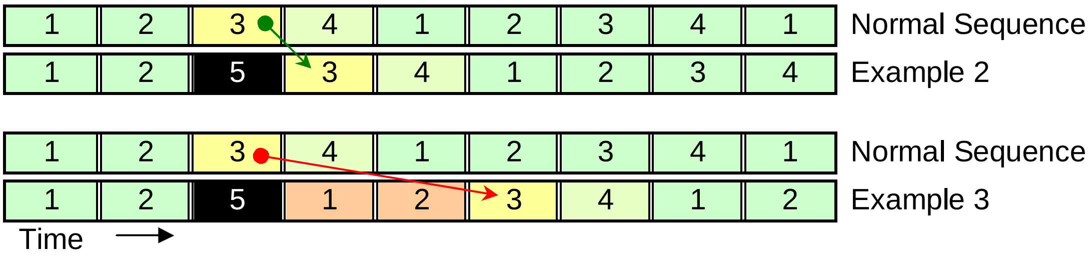
Examples 2 and 3 show the stage sequence if right of way jumps from Stage 2 to Stage 5 to service the high priority request.

* Firmware 46059 issue 6 onwards includes the control of Exceptional Stage logic by Mode.

Example 2 shows the stage sequence when Stage 5 is configured as exceptional; when Stage 5 terminates, the controller will consider demands for Stage 3, then Stage 4, and so on. This attempts to resume the original stage sequencing and thus minimise delays at the intersection.

Example 3 shows the stage sequence without this feature. When Stage 5 terminates, the controller will consider demands for Stage 1, then Stage 2, and so on. It shows that Stages 3 and 4 are 'skipped' and Stages 1 and 2 are allowed to run again. This will therefore delay the traffic that requires Stages 3 and 4.

The diagram below shows order of stages as time advances left-to-right. It highlights the minimal delays if the controller is configured with Stage 5 as exceptional (as in Example 2), and the delays experienced by stages 3 and 4 without this option (as in Example 3) because stages 1 and 2 are given right of way again:



Example 4 shows the stage sequence if right of way jumps from Stage 3 to Stage 5 to service the higher priority vehicle. When Stage 5 terminates, the controller will consider demands for Stage 4, then Stage 5, then Stage 1, and so on. Although the controller considers Stage 5 again shortly after running Stage 5, normally there would no longer be any demands for Stage 5 so it will not gain ROW again, as in Example 1.

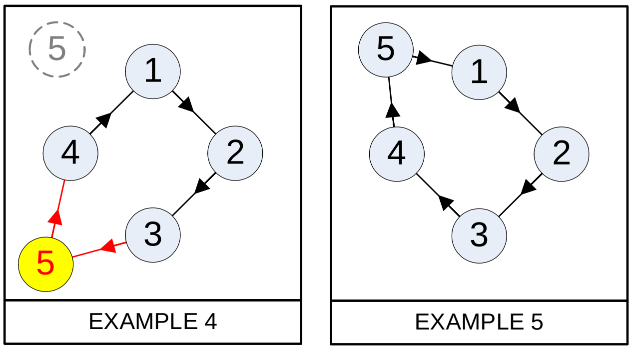


Figure 4 - Exceptional Stage Examples 4 & 5

Example 5 shows the stage sequence if right of way moves from Stage 4 to Stage 5 due to a request for the high priority vehicle during stage 4. When Stage 5 terminates, the controller will consider demands for Stage 1, then Stage 2, and so on as normal. In this case, the operation of the controller is not changed by the feature even if it were enabled.

Examples 6 and 7 show the stage sequence if two requests for the exceptional stage are received shortly after one another:

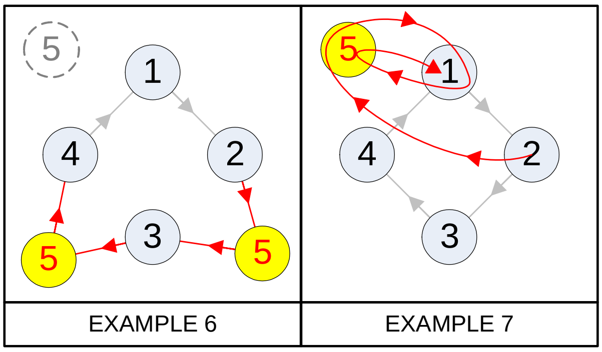
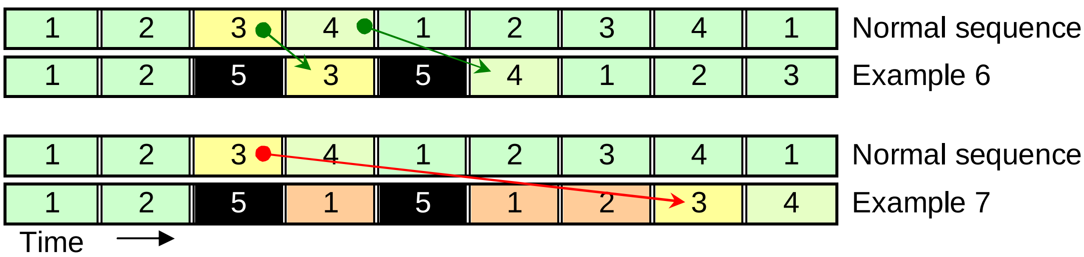


Figure 5 - Exceptional Stage Examples 6 & 7

Example 6 shows the stage sequence with this feature enabled. Although the appearance of each 'normal' stage is inevitably delayed by the exceptional stage, the stage sequencing is preserved to minimise the delays.

Example 7 shows the stage sequence without this feature. Right of way jumps from Stage 2 to Stage 5 to service the first request as expected, but then right of way resumes with Stage 1. While in Stage 1, the second request is received and right of way jumps from Stage 1 back to Stage 5. Right of way then resumes with Stage 1 again if there is a demand present. In this case, Stages 3 and 4 have been omitted twice, delaying the traffic on those approaches. This sequence can be avoided if the second request is prevented for a period (using inhibit periods for example), however this will delay the high priority vehicle instead.

The diagram below highlights the minimal delays if the controller is configured to resume the original stage sequence (as in Example 6), and the excessive delays experienced by stages 3 and 4 without this option (as in Example 7) because stages 1 and 2 are given right of way again:



It can therefore be seen that configuring the dedicated stage used by an occasional high priority vehicle (such as a tram) as an exceptional stage naturally reduces the impact of that stage on the other traffic.

8.7 Parallel Stage Streaming

8.7.1 General

Parallel Stage Streaming provides independent control of up to 8 separate intersections, later referred to as Streams, from one controller, i.e. the eight intersections may be considered as being controlled by separate controllers, with the exception of certain modes, see section 8.7.4.

This facility would normally be used if there were to be no cross-stream Phase Conflicts. However, cross-stream Phase Conflicts and cross-stream Linking can be covered by using cross-stream Phase Inter-green and Special Conditioning Software.

8.7.2 Stage Streams

The controller will support up to 8 streams (numbered 0 to 7). Each stream may contain any number of stages but no stage or phase may appear in more than one stream and the total number of stages for all streams must not exceed 32.

If a stream requires an all red condition, a separate all red stage must be provided for that stream.

8.7.3 Mode Selection

Each stream will independently run the highest priority mode for which a request exists.

Most modes will automatically only run on the streams which have active requests for phases and/or stages in those streams. For example, CLF mode will only run on the streams that the CLF plan affects.

Each mode may be configured so that it is disabled on an individual stream using Special Conditioning.

8.7.4 Mode Operation

VA, Fixed Time, UTC, Hurry Call and Priority modes will normally operate independently on each stream.

Linked Fixed Time, CLF, Manual and Part-Time modes will normally affect all streams of the controller, unless individual streams have the mode disabled or are running a higher priority mode, although CLF will only run on the streams that the group influences affect.

Within the sections that describe each mode is a sub-section detailing the operation of the mode when more than one stream is configured.

8.7.5 Other Facilities

Parallel stage streams may also affect other facilities available in the traffic controller.

Most facilities such as Call/Cancel units, Window Times and the Ripple Change facility automatically run independently on each stream.

Others, such as SDE/SA, the Extend All-Red facility and the Red Lamp Monitor may need to be configured carefully when more than one stream is configured.

8.8 Modifying Stage Settings

The settings for stages can be updated using the following web pages.

8.8.1 Controller - Stages - Settings Web Page

This page can be used to modify general stage settings. Level 3 access is required to modify some items.

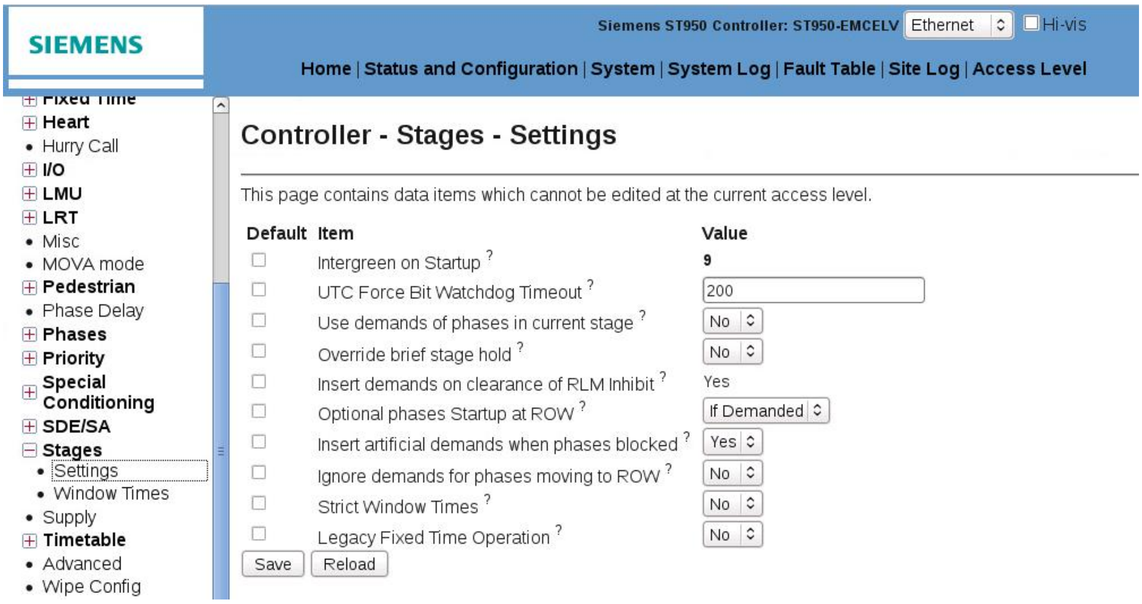


Figure 6 - Controller - Stages - Settings web page

9 PHASES

9.1 Facilities

There are up to 32 phases (A to Z and A2 to F2) available for use as any of the following types of phase:

- Traffic
- Pedestrian
- Green arrow, filter or indicative
- Dummy
- Switched sign.

Traffic, pedestrian, and green arrow phases are considered as real phases and require phase hardware as well as phase software.

Dummy phases require only phase software. As no phase hardware is required the dummy phases are allocated after the real phases.

Switched sign phases do not require phase software. They only require the software necessary for switching them on and off and phase hardware.

It is possible to use phase software for a dummy phase and phase hardware for a switched sign phase.

9.2 Types of Phases

9.2.1 Traffic Phase

A traffic phase controls vehicle movements via a 3-aspect signal comprising red, amber and green. The green aspect may be a left turn or a right turn or straight-ahead green arrow as required by the method of control.

The standard signal sequence is as follows:

At no ROW	-	RED
Changing to ROW	-	RED/AMBER
At ROW	-	GREEN
Changing to no ROW	-	AMBER
At no ROW	-	RED

The red/amber period is normally 2 seconds and the amber period is normally 3 seconds.

If required, alternative signal sequences, e.g. RED-GREEN-AMBER-RED, can be easily configured on the lamp sequence screens ('non-UK' configurations only).

A traffic phase green is normally extendible, running longer to allow more traffic to pass through as controlled by the mode of operation.

9.2.2 Pedestrian Phase

A pedestrian phase controls pedestrian movements via a 2-aspect signal comprising red and green man plus a WAIT indicator normally driven from the amber aspect.

The standard signal sequence is as follows:

at no ROW	-	RED MAN
at ROW	-	GREEN MAN
changing to no ROW	-	BLACKOUT
at no ROW	-	RED MAN

Alternative signal sequences, e.g. RED MAN - GREEN MAN - AMBER MAN, or RED MAN - GREEN MAN - FLASHING GREEN MAN, or others may be obtained if required.

The WAIT indicator uses the amber aspect drive (if not used for anything else) and is illuminated when a demand is inserted for the pedestrian phase from a pedestrian push-button unit. It will normally remain illuminated until the pedestrian phase gains ROW when it will be extinguished. However it can be extinguished earlier and the pedestrian demand cancelled when kerbside detectors are fitted. During the green man period, demands for the pedestrian phase are disregarded but they will be accepted during the blackout period and thus illuminate the WAIT indicator.

A pedestrian phase green is not normally extendible. However, if it appears in the same stage as a traffic or green arrow phase and they are extended, the pedestrian phase will normally be held at green.

The pedestrian clearance period, which may be configured as ‘red’ rather than ‘black-out’, can be extended by the use of ‘on-crossing detectors’, see the details documentation on Pedestrian Phases for more information.

Audible and Tactile Indications (Low Voltage)

It is possible to have an audible indication when a pedestrian phase is at green, if required. This may be sounded for the entire period of green or just for a minimum period.

The audible units fit into the pedestrian push-button / wait indicator box. Up to two may be fitted to give an alternative of loud for daytime use and soft for night time, switched by the master time clock operating an I/O output.

Alternatively, or in addition to audible units, tactile units may be fitted. These are also mounted in the pedestrian push-button / wait indicator box, but with a cone-shaped rotating shaft protruding from the bottom of the box. This rotates when the pedestrian phase is at green.

Note: it is a requirement in the U.K. that if audible and/or tactile indications are fitted, the controller must also include the Red Lamp Monitoring facility.

High Voltage Audible Indication (Not UK)

The audible signals are driven direct from the aspect supply to the pedestrian red and green signals via relay contacts.

An I/O port can be used to drive a relay to disconnect the red and green feeds to the audible signal when it is not required. Eight pedestrian signals can be controlled usually by time switch control.

Eight relays are provided and driven from an output port bit to switch the above feeds on and off.

The handset command "DET" for the specific output port/bit can be used to switch this facility permanently ON, OFF, or allow it to follow the output state as dictated by the controller logic.

9.2.3 Green Arrow Phase

A green arrow phase controls vehicle movements via a single aspect green arrow. It is normally associated with a three-aspect Red-Amber-Green phase. The appearance of these two phases needs to be carefully considered - see the section on Green Arrows.

Where the round green aspect of three-aspect Red-Amber-Green traffic signal is replaced by a green arrow, it is ***not*** normally associated with a second phase. In this case the phase operates as a normal three-aspect phase so these phases are not considered 'green arrow' phases.

9.2.4 Dummy Phase

A dummy phase may be used in situations where timings or detector conditioning have to be associated with a traffic movement that is not uniquely signalled. The dummy phase provides suitable time periods or conditions for stage changes even though no signal aspects are associated with the phase.

9.2.5 Switched Sign Aspect

A switched sign aspect is an aspect of a hardware phase that is not allocated to a stage but is illuminated and extinguished at certain times of day or when specific conditions occur.

The normal functions of a switched sign aspect are as follows:

Secret Regulatory Signs

Secret regulatory signs, e.g. "No Right Turn", "No Left Turn", etc. are illuminated and extinguished at a certain time of day when a specified associated phase loses ROW.

WAIT Indicator for 3-Aspect Phases (Non UK Only)

When a pedestrian phase has a WAIT indicator the power to it is normally supplied by the amber drive. If a pedestrian phase has 3-aspects (i.e. Red Man-Amber Man-Green Man), or if a traffic phase requires a WAIT indicator, this drive is not available.

A switched sign phase is then used. It is illuminated when the phase is not active and a demand for it is present. It is extinguished when the pedestrian phase gains ROW.

9.3 Conflicting Phases

Real phases that cannot appear at right of way together for safety reasons are considered to be conflicting and as such must have inter-green times between them.

Phases which conflict but may never make a phase to phase transition due to stage movement restrictions must also have inter-green times between them. This is to cover the possibility of inter-green and minimum green times of phases in intermediate stages being set low enough on the handset to allow the phase to phase transition to take place. If the Customer does not specify an inter-green time, it will be set to 5 seconds.

Phases that do not conflict, even if they never appear together in the same stage, are considered to be non-conflicting phases and as such will not have an inter-green time.

9.4 Opposing Phases

Demands for opposing phases are used to start phase maximum green timers.

Normally, phases that 'conflict' also 'oppose' each other. Dummy phases that would conflict if they were real phases also oppose.

Phases that do not conflict but do not always appear together may be programmed to oppose each other in order to start one or the others maximum green timers.

Opposing phases that gain right of way at the same time will not start each other's maximum green timers since the demands for those phases are disregarded while they are at right of way.

Therefore, each phase is usually configured to 'oppose' all the other phases (in the same stream) to guarantee that the maximum green timers for the phases at right of way are started whenever there is a demand for a phase not at right of way.

9.5 Timing Periods

Each phase has its own timers to time periods such as its minimum green time, its green extension time and its maximum green time. Each phase to phase transition has its own inter-green timer.

The diagram below is intended to indicate the relationships between the various timers in the controller:

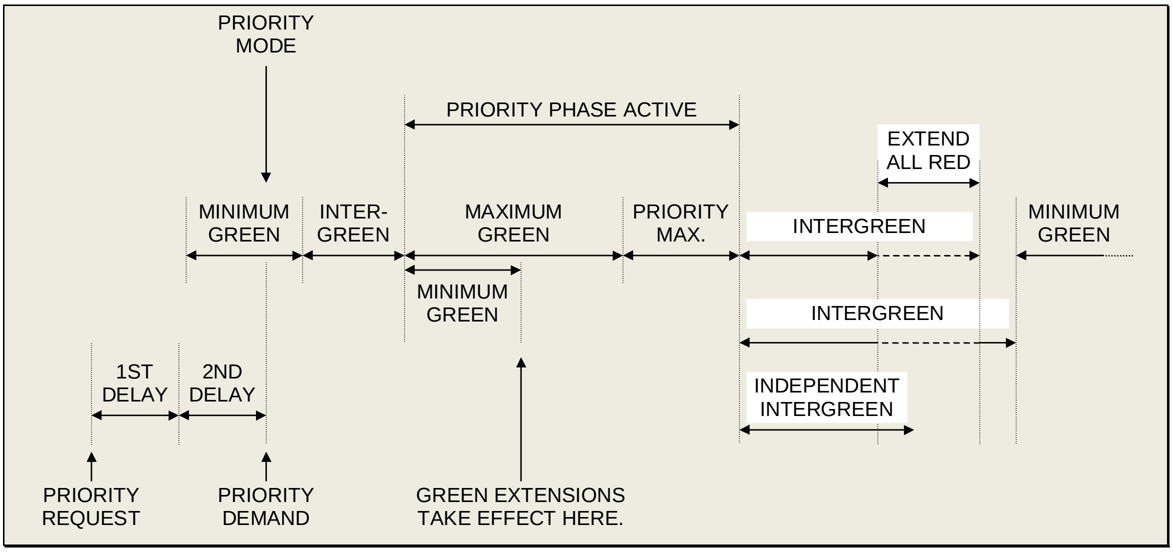


Figure 7 - General Timers

It shows the normal phase minimum green, inter-green and maximum green periods which are described in this section, as well as showing their interaction with ‘priority’ mode and the ‘extend all-red’ facility.

The following timing periods are set at the time of configuration but may be changed using the handset commands in brackets or by using the Phase - Timings web page.

9.5.1 Minimum Green (MIN)

When a phase gains ROW, a minimum green period commences to time. For safety reasons the phase cannot lose ROW until the minimum green has timed off. Whatever mode of control is operative, the minimum green cannot be terminated prematurely.

A stage change will not take place until the minimum green times for all phases that need to terminate have timed off.

The timing range is 0 to 255 seconds in 1-second steps. There is one minimum green time and one set of range limits for each phase.

9.5.2 Green Extension (EXT or IPX)

When a ‘vehicle actuated’ phase (i.e. a traffic, green arrow or dummy phase) is at green, it is possible to extend it past the minimum green period by means of green extensions, up to a maximum green period.

The occupation of an extension loop will generate a green extension for its associated phase. The green extension will continue while the loop is occupied.

When the extension loop is cleared, the green extension will continue for a fixed period, the extension time. The timer will be restarted if the loop is occupied again before the extension time expires.

The phase cannot be terminated whilst the green extension is active unless it is legitimately overridden (e.g. maximum green timer terminating or under influence of UTC or CLF).

It is also possible to program the controller so that extensions for a phase are lifted during any stage that the phase appears in.

If no vehicles are detected for a period longer than the extension time, the extension timer will terminate and the phase will ‘gap change’ if there is an opposing demand.

The timing range is 0 to 31.8 seconds in 0.2-second steps. There is one extension time for each phase or optionally, one for each detector.

Each phase can be configured with a number of extension detector inputs.

If the extension time is configured against the phase (using the EXT handset command), the extension time commences when all of these detector inputs have gone inactive.

If the extension time is configured against the individual detector inputs (using the IPX handset command), each detector has its own extension timer that commences when the input goes inactive. The green extension on the phase will cease when all of its detector inputs and extensions are inactive.

If extension times are configured against the individual detector inputs (using the IPX handset command), phase extension time (using the EXT handset command) should be set to zero.

9.5.3 Maximum Green (MAX, MBX etc to MHX)

A maximum green timer is provided for each 'vehicle actuated' phase and commences to time upon receipt of a demand for any opposing phase. If opposing demands are present when the phase gains ROW, the maximum green period will commence immediately.

A stage change will not take place until the maximum green times for all phases that need to terminate have timed off, called a 'max change', assuming green extensions are also present for those phases preventing a 'gap change'.

The maximum green timer will only be effective during VA, Bus Priority and Emergency Vehicle modes. During CLF mode it will be ignored.

During UTC mode, the timers are held reset. During MOVA mode, the timers work in the same way as in VA mode. These settings for UTC mode and MOVA mode can be changed using the web pages for those modes or the MCM handset command.

Eight sets of maximum green timings are available, referred as 'maxsets' 'A' to 'H', hence the handset commands MAX, MBX, MCX, etc., to MHX. These are switched in and out as required by the master time clock.

The timing range is 0 to 255 seconds in 1-second steps. Up to 8 maximum green times can be configured for each phase (one for each 'maxset').

It is possible to program the controller so that a specified phase has a pre-timed maximum green (using the PTM handset command). This means that the maximum green timer will always start whenever the phase is active, regardless of opposing demands. Therefore, the phase at right of way will terminate after its maximum green time has expired, even if the opposing demand does not appear until part way through this period.

If the opposing demand does not appear until after the maximum green time has already expired, the phase will terminate immediately, even if green extensions are active. However, a 'pre-timed maximum extra period' can also be configured (using the PTX handset command). If the pre-timed maximum green time has already expired (or is close to expiring) the timer is restarted with this short 'extra' period. Thus if green extensions are present, the phase will remain at right of way for those few seconds or until a 'gap change' rather than terminating immediately the opposing demand appears.

9.5.4 Pedestrian Clearance Period (PBT)

When a basic intersection pedestrian phase terminates, the green man is followed by a pre-set blackout period for the U.K. (or flashing green for some countries abroad) which in turn is followed by the red man. The blackout period is considered as part of the inter-green, i.e. the two timers will run in parallel. Also see the detailed section on Pedestrian Phases for more information.

The timing range is 0 to 255 seconds in 1-second steps and there is one time for each phase. If no blackout/flashing green is required the timer should be set to 0 seconds.

9.5.5 Red Amber Time (RAT)

The red/amber 'gaining right of way' step for traffic phases is fixed at 2 seconds of red/amber for all UK controllers. This period is also known as the 'starting amber' or 'phase starting' time.

However, the 'gaining right of way' step for traffic phases can be configured differently for non UK controllers. For example, it can be removed altogether so the phase moves directly from red to green, or the red/amber time can be configured to use the RAT timings.

The RAT timing range is 0 to 255 seconds in 1-second steps (although all inter-green times to this phase must be the same or longer than this time period). There is one time for each phase.

9.5.6 Leaving Amber Time (LAT)

The 'leaving right of way' step for traffic phases is fixed at 3 seconds for all UK controllers. This period is also known as the 'leaving amber' or 'phase leaving' time.

However, the 'leaving right of way' steps for traffic phases can be configured differently for non UK controllers. Up to three configurable 'steps' can be configured.

The duration of one of those steps can be controlled by the 'leaving amber time', although the controller can be configured to illuminate any aspects not just amber, including flashing green for example.

The leaving amber time period is linked to the eight maximum green time sets (see section 9.5.3) and thus different amber periods can be configured for different times of day.

The LAT timing range is 0 to 31.8 seconds in 0.2-second steps. Up to 8 times can be configured for each phase (one for each 'maxset').

9.5.7 Inter-green (IGN)

The inter-green period is a safety period between one phase losing ROW and another phase gaining ROW. Only conflicting phase to phase transitions can have individual inter-green timing values.

No inter-green period is reduced below its value during phase changes. In the event of different inter-green values to phases gaining ROW, the longest inter-green will be effective.

If phases conflict, but due to stage movement restrictions, the phase to phase transition never takes place, an inter-green value should still be configured, see section 9.3.

The timing range is 0 to 199 seconds in 1-second steps with one time and minimum range limit for each phase-to-phase transition.

See the detailed section on Pedestrian Phases for information on the intergreens to and from pedestrian phases.

9.5.8 Starting Inter-green (IGS)

The starting inter-green period is a safety period in Start-up Mode before any phases gain ROW.

The timing range is 0 to 255 seconds in 1-second steps with one time for the whole controller.

9.5.9 Conditioning Timers (PIR, CDT)

Up to 480 conditioning timers (numbered 0 to 479) are available for use as auxiliary timers.

The uses of the conditioning timers include the following:

- Holding a stage for a specified fixed period when no phases gain ROW, e.g. the all-red stage. Normally dummy phases are used for this purpose, but this method may be used if no dummy phases are available.
- Timing long periods - can be achieved by running the same timer several times, e.g. to time 20 minutes, give the timer a value of 20 and run it 60 times.
- Switched window timers.
- Limit Green watchdog timer.
- Hurry Call watchdog timer.

The timing range for each timer can be configured as either 0 to 255 seconds in 1-second steps or 0.0 to 31.8 in 0.2 second steps.

NOTE: 480 timers requires ST950 software version 46059 issue 5 or later. Prior to this, only 96 timers were supported.

9.5.10 Limit Green Watchdog

(Facility constructed in Special Conditioning for Non UK Only)

In all modes except Hurry Call, Vehicle Actuated and Manual Control, the maximum duration of each stage green can be governed by a limit green watchdog time. One limit green watchdog timer (a Special Conditioning timer) is provided, which is applied to each stage in turn.

The stage limit green watchdog timer commences timing when the stage green is reached and is reset on a plan change, a mode change and when the stage terminates.

If the limit green override code is sent from the ATC computer during computer stage control mode, the limit green watchdog timer is held reset.

In the event of a limit green watchdog timer timing out before its associated phase green has terminated, the controller will then revert to the next highest priority mode configured for which a request exists and the fault will be logged. If the current mode at the time of failure is fixed time mode, the controller switches off the power to the lamps.

9.6 Conditions of Appearance

If more than one phase is allocated to a stage, it may be required to make the appearance of some of them conditional so that they will only appear if demanded. The condition will apply in all the stages to which the phase is allocated.

There are four different types of appearance.

9.6.1 Appearance Type 0

This is the normal type of condition with the phase always appearing whenever its associated stage runs. If more than one Type 0 phase is allocated to the stage they will all appear regardless of which phase was demanded.

9.6.2 Appearance Type 1

The phase will only appear whenever its associated stage runs if a demand for the phase is inserted before the start of the interstage. If the demand is inserted after this point it will be stored and serviced later.

The normal use for this type of condition is for a pedestrian phase.

Normally the controller will continue to ignore these demands when considering the next stage change and only consider the demand once the controller is at a stage that no longer contains the phase. However, if there are no other demands present or the PMV handset command has been set to ‘1’, the next stage decision making process will consider the demand.

9.6.3 Appearance Type 2

The phase will only appear whenever its associated stage runs if the phase is demanded, regardless of when the demand is inserted. There is no limit point for when the demand may be inserted.

If the demand is inserted before the stage runs, the phase will appear at the start of the stage. If the demand is inserted during the stage, the phase will appear immediately. The appearance of the phase in both cases will be subject to any relevant inter-green periods timing off.

When the phase appears its timing periods will be considered for the stage duration. Therefore, if the phase appears during the stage its minimum green period, and possibly maximum green period, may affect the termination of the stage. Therefore this type should only be used if essential. Appearance Type 3 should be used unless the phase is a filter green arrow.

The normal use for this type of condition is a filter green arrow phase. A demand for the filter green arrow should not be latched to ensure that a filter green arrow demand does not exist without an associated main green demand. The green arrow active should insert a demand for the main green phase.

9.6.4 Appearance Type 3

This is as Appearance Type 2 but the appearance of the phase after the stage has commenced is inhibited when the ‘window period’ expires.

The window period is started when an opposing demand starts the maximum green timer of a phase running in the stage*. Any demand inserted after this will be stored and serviced later but will be initially ignored in the same way as a type 1 phase.

* Except that by default in UTC Mode the window period always starts at the beginning of the stage, regardless of opposing demands. The operation of the window period in UTC and MOVA Modes can be changed using the MCM handset command or the web pages.

The window period is normally the difference between the longest maximum green period of the other phases in the stage and the minimum green period of the conditional phase. This means that the phase will not appear if there is not enough time left for its minimum green to run and so will not affect the stage termination.

Provision has been made within the software to provide 8 separate window timers, one for each stream. This is necessary because up to 8 stages may be running simultaneously, each demanding a different window time. Each window timer will run the window time related to the stage within its associated stream.

If the alternative maximum green facility is used, this may affect the required window time. There are two ways to overcome this. One is to have a compromise window time that will suit all of the alternative maximum green periods. The other is to switch the window times along with the alternative maximum green times.

There are two methods to achieve switched window times:

- Alternate stages with the alternative window times are introduced and deleted by the master time clock at the same time as the alternative maximum green periods.
- The conditional phase is programmed as an Appearance Type 2 and conditioning timers are used as window timers to inhibit the appearance of the phase. The conditioning timers are introduced and deleted by the master time clock at the same time as the alternative maximum green periods.

The timing range of the window period is 0 to 255 seconds in 1-second steps. There is one time for each stage. The programmed value of the window timer may be changed via the handset using the PWN command.

With Appearance Types 1, 2 and 3, the appearance or non-appearance of the phases may affect the inter-green periods following the stage termination.

The condition of appearance of phases that are deleted by the master time clock will only be effective during the period of non-deletion.

9.7 Fixed Phases

A fixed phase is a phase (real or dummy) that has a condition of appearance Type 0 and is not deleted by time switch at any time.

- At least one fixed phase must be allocated to each stage (with the exception of the ‘all-red’ stage if it is only used in manual mode).
- On stage changes at least one fixed phase must gain ROW.

9.8 Non-Fixed Phases

A non-fixed phase is a phase (real or dummy) of Appearance Type 1, 2 or 3, or a phase of Appearance Type 0 and is deleted at some time.

During Manual Mode the appearance of a non-fixed phase during its associated stage(s) may be configured to:

- Never appear
- Always appear (subject to any delete phase conditions)
- Be demand dependent

9.9 Conditions of Termination

9.9.1 Termination Type 0

The phase terminates at the end of its associated stage. If the phase appears in consecutive stages, it will remain at green throughout the interstage period.

This is the normal type of phase termination.

9.9.2 Termination Type 1

The phase terminates when a specified associated phase gains ROW. The associated phase must be a fixed phase.

The normal use for this type of phase is a filter green arrow.

9.9.3 Termination Type 2

The phase terminates when a specified associated phase loses ROW. The associated phase must be a fixed phase.

The normal use for this type of phase is an indicative green arrow.

9.10 Early Termination of Phases

Once a phase has gained ROW in a stage it cannot normally be terminated before the end of the stage.

If early termination of a phase is required, usually for a pedestrian phase, it can be achieved by using two consecutive stages. The phase that is to terminate early is allocated to the first stage while the other phases that are to stay at ROW are allocated to both stages.

The normal method of operation is for a demand to be inserted for the second stage when the first stage becomes active. A stage change will then occur following the expiry of the minimum green of the early terminating phase.

The controller is programmed so that the stage change occurs without an interstage to give the appearance of one stage instead of two.

Variations of this method of control may also be achieved.

9.11 Extinguishing Individual Phases

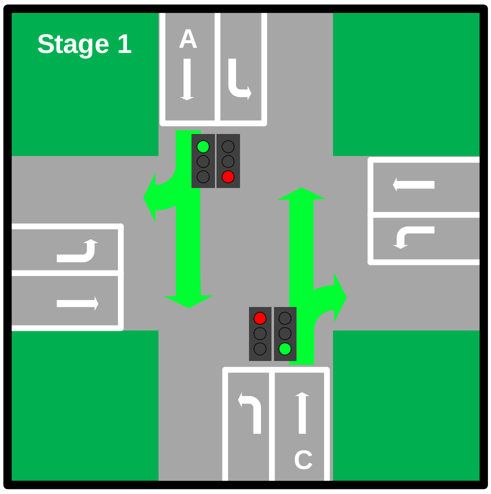
9.11.1 Introduction

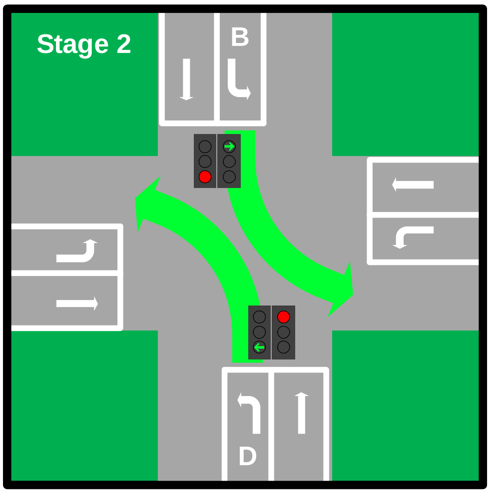
Sometimes it is required to completely extinguish one phase at the intersection, while others continue to operate normally. Later, that phase is required to illuminate again and sequence normally.

IMPORTANT: It is vital that the designers of the intersection consider all the consequences of extinguishing one phase while others remain illuminated. The designer must consider the traffic normally controlled by the phase and consider when that phase is extinguished what prevents that traffic from proceeding and becoming in conflict with the traffic controlled by the other phases that remain on and have been granted ROW.

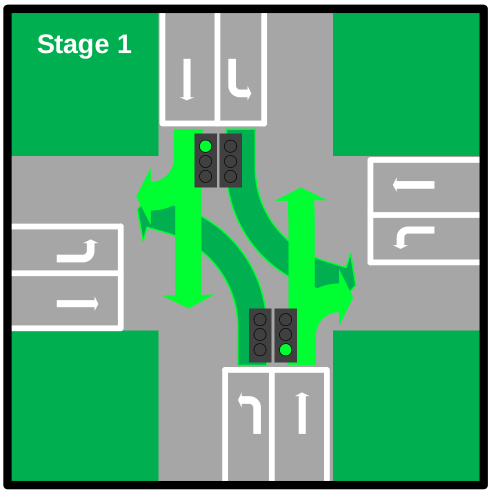
9.11.2 Example Scenario

During busy periods, the turning traffic (B & D) needs a dedicated stage (2) separate to that for the main traffic flows (A & C). The turning movements have their own three-aspect RAG signals.

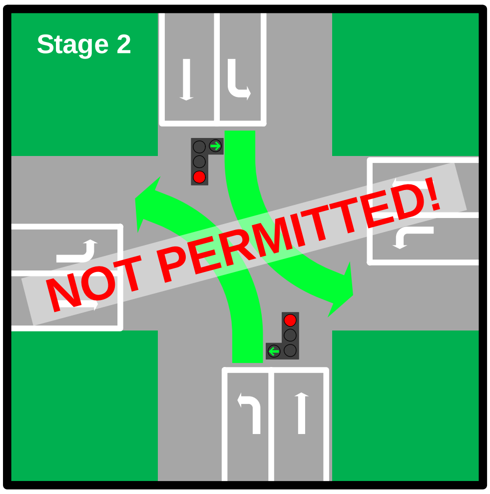




However, when the roads are quieter such as overnight, the turning traffic could be allowed to turn safely in the gaps in the conflicting traffic, without needing to call the specific stage for the turning movement and stopping the main traffic flow.



During this stage, the signals for the turning traffic can show neither Red nor Green, but instead need to be extinguished. They can't show Red because that would stop the traffic turning. They can't show Green because that would imply that the turning traffic has ROW over the conflicting traffic crossing the intersection.



Note also that 'Indicative' Green Arrows cannot be used because those signals would not show the correct Phase termination sequences to the traffic at the end of Stage 2, but instead the Green Arrows would simply extinguish.

9.11.3 Switching the Phase off

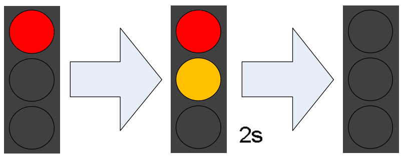
To allow flexibility, requesting that the Phase switches off is performed using Special Conditioning.

This allows multiple conditions to be checked before the Phase is switched off. For example, only switch off the Phase when requested by the Timetable and only while certain Modes are active, and also time the switch off to a specific stage-to-stage movement event to avoid confusing the traffic.

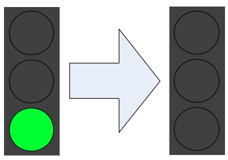
There are built-in restrictions on when the phase will switch off, designed to reduce any confusion to the road users and to simplify the Special Conditioning. For example, a Phase cannot be extinguished during its Red & Amber, Minimum Green or Amber-Leaving period.

Any request to extinguish a Phase will not be actioned until one of the following conditions occurs.

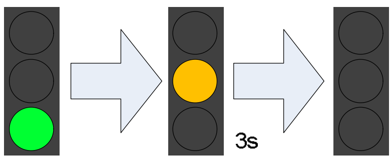
- Immediately after the Gaining ROW period, just as the Phase is about to reach ROW (when the switch off request is made during that period).



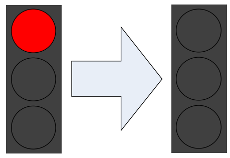
- While the Phase is at ROW and the Minimum Green period has completed.
- Just as the Phase leaves ROW, instead of showing an Amber-Leaving period for example.



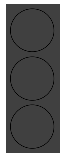
- Immediately after the Leaving ROW period (when the switch off request is made during that period).



- While the Phase is at no ROW (Red).



- Any time during the start-up sequence, so the phase never illuminates for example.

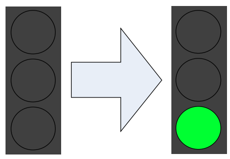


9.11.4 Switching the Phase back on

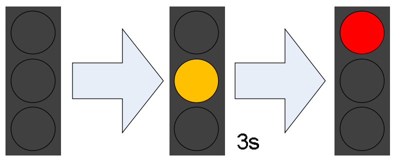
To allow flexibility, requesting that the Phase switches on is also performed using Special Conditioning.

This allows multiple conditions to be checked before the Phase is switched back on. Again there are built-in restrictions on when the phase will switch on. Thus, a request to illuminate an extinguished Phase will be postponed until one of the following conditions occurs.

- Just as the Phase is about to reach ROW, so at the usual start point of the stage the Phase illuminates at Green, but without any Gaining ROW sequence.



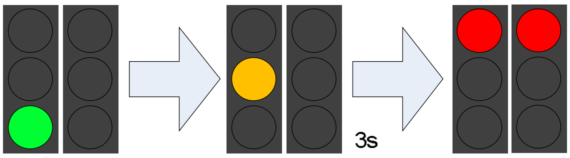
- Just as the Phase leaves ROW, showing the usual leaving-ROW sequence.
- When the stream restarts, such as when the Signals are switched ON, so the Phase illuminates through the normal start-up sequence with the others.



In addition to the above, the Controller can also be configured to permit the Phase to illuminate while at no-ROW (Red). It is not permitted by default because no leaving ROW sequence is shown before the Red.

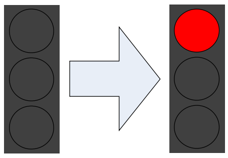
Two alternatives exist, controlled by whether or not the Phase is configured with an Associated Phase.

- With an Associated Phase defined – The Phase switches back on just as the Amber-Leaving period of the Associated Phase completes, with the intention that both Phases appear at Red at the same time (but only the Associated Phase displayed the Amber-Leaving signal).



So in the original example, if the request to switch Phase B back on is triggered during Phase A showing Amber-Leaving, then when Phase A changes from Amber-Leaving to Red, Phase B will change from Off to Red at exactly the same time, e.g. [A/Green] → [A/Amber] → [A/Red + B/Red]

- With no Associated Phase defined – Any time the Phase is at no-ROW (Red), the Phase appears when instructed to switch back on*.



* Use this option carefully because no leaving ROW sequence is shown, e.g. no Amber-Leaving period. Also note that when Reserve State begins, any request to extinguish a Phase is automatically cancelled and with this option the Phase will simply appear at Red if it is currently at no-ROW.

9.11.5 Implementation

By default this facility is disabled. To enable the facility, a 'Default PROM data file' needs to be included in the IC4 Configuration.

To enable the facility, select the 'Default PROM data file' called: **AuxCmdOff46059.8df**

To enable the additional option to switch the Phase back on during Red, select this file instead: **AuxCmdOnToRed46059.8df**

To extinguish a Phase using Special Conditioning, set the mnemonic 1AUXCMD*0 TRUE, where '*' should be replaced by the Phase identification letter, e.g. TRUE=1AUXCMDC0 to extinguish Phase C.

Requests in 1AUXCMD*0 only persist briefly. They are not latched. The Phase will switch back on if the mnemonic is no longer explicitly set TRUE. So the mnemonic needs to be held TRUE while the Phase is required to remain off.

To avoid confusing road users, the Special Conditioning should monitor the signals and only request the Phase is extinguished or illuminated at specific points in the cycle.

Example using AuxCmdOnToRed46059.8df and Associated Phases:

```
; Extinguish Phases B and D if Timetable flag set
```

```
; But only as their associated Phases go Green
MTCF0.PHASEA.NOT(PREVA)=+SCRT0
MTCF0.PHASEC.NOT(PREVC)=+SCRT1

; Phases B and D back on if Timetable flag not set
; Since these phases are prevented from reaching ROW,
; Typically these only illuminate as their associated Phases go Red
MTCF0=.SCRT0
MTCF0=.SCRT1

; Keep the Phases extinguished as required by the above checks
SCRT0=1AUXCMDB0
SCRT1=1AUXCMDD0

; While the Phases are extinguished, prevent Stage 2
SCRT0+SCRT1=PRVST2
```

If all the Phases in a Stage are extinguished using this facility, it is advisable that the stage is also prevented from gaining ROW otherwise the signals that remain on will all be showing Red. So in the original example, Stage 2 should be prevented while the turning Phases are extinguished.

If VA operation is required, and traffic relating to the extinguished Phase needs a different stage to gain ROW in order to proceed through the intersection, some manipulation of the Phase demands is needed using Special Conditioning. In the original example, the Phase A (main flow) needs to be demanded if there are vehicles waiting for Phase B (turning flow).

9.11.6 Notes

This subsection contains a number of important notes on this feature.

- When a Phase is extinguished, the Red, Amber and Green drive outputs for that Phase are switched off, but the state and timings of the Phase continue regardless, in a similar way to how the Phases continue to cycle internally when the Signals On/Off Switch is in the OFF position.
- For Pedestrian Phases where the Amber output illuminates a 'Wait' or Demand Indicator, that Amber output is also switched off when the Phase is extinguished. If the indicator is required to remain illuminated, consider using a Switched Sign.
- Lamp monitoring is aware that the Phase is extinguished so monitoring is naturally suspended. Red Lamp or Last Lamp actions are not triggered, so for example conflicting pedestrian phases will still be permitted to gain ROW. If this is to be prevented, it must be explicitly requested and implemented using Special Conditioning.
- Demands remain for the Phases that are extinguished – extinguishing a Phase does not automatically remove the demands. Care is needed because these demands may impact other Phases (e.g. start Max Green Timers) and cause a different stage to be called for example.

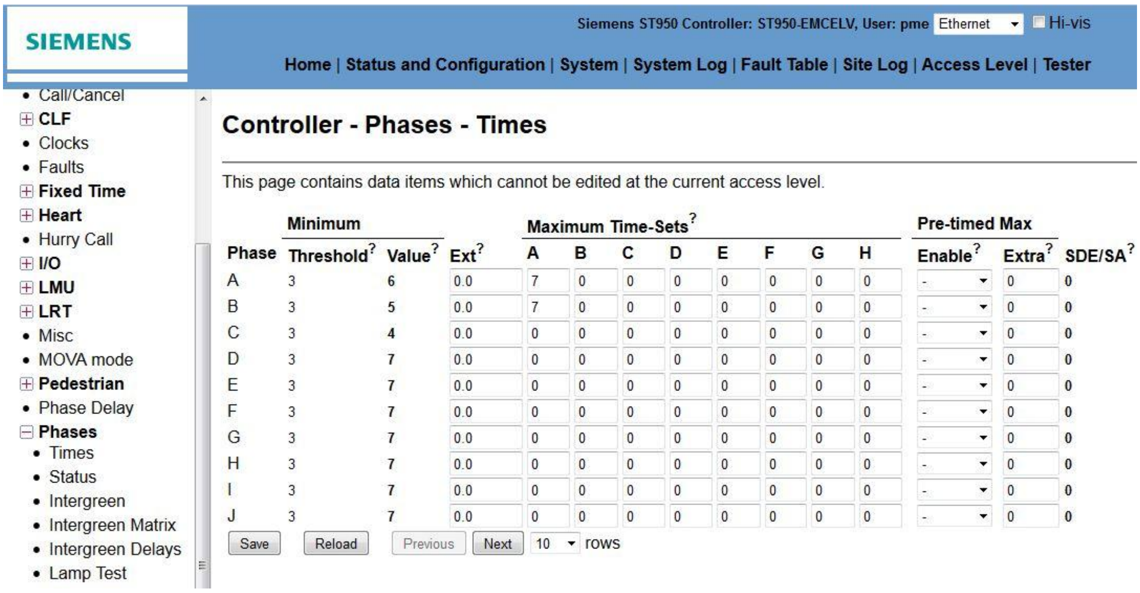
- The only Lamp Sequences that can be shown as the Phase switches on or off are the normal To-ROW and From-ROW sequences. The start-up and switch off sequences cannot be used. If a Phase is requested to switched off while at ROW (Green), it is simply extinguished and it does not follow the From-ROW Amber-Leaving sequence.
- When the signals enter their configured Reserve State (section 5), any request to extinguish a Phase will be cancelled, and the Phase will illuminate on the next permitted event (9.11.4), e.g. as the Phase gains or leaves ROW.

9.12 Monitoring and Modifying Phases

The status of phases and their configuration can be monitored and changed using the following web pages.

9.12.1 Controller - Phases - Times Web Page

The phase timings can be reviewed and changed on this page. This page requires Level 3 access to change some items.



	Minimum			Maximum Time-Sets								Pre-timed Max		
Phase	Threshold?	Value?	Ext?	A	B	C	D	E	F	G	H	Enable?	Extra?	SDE/SA?
A	3	6	0.0	7	0	0	0	0	0	0	0	-	0	0
B	3	5	0.0	7	0	0	0	0	0	0	0	-	0	0
C	3	4	0.0	0	0	0	0	0	0	0	0	-	0	0
D	3	7	0.0	0	0	0	0	0	0	0	0	-	0	0
E	3	7	0.0	0	0	0	0	0	0	0	0	-	0	0
F	3	7	0.0	0	0	0	0	0	0	0	0	-	0	0
G	3	7	0.0	0	0	0	0	0	0	0	0	-	0	0
H	3	7	0.0	0	0	0	0	0	0	0	0	-	0	0
I	3	7	0.0	0	0	0	0	0	0	0	0	-	0	0
J	3	7	0.0	0	0	0	0	0	0	0	0	-	0	0

Figure 8 - Controller - Phases - Times web page

9.12.2 Controller - Phases - Status Web Page

The current status of the phases can be monitored through this page.

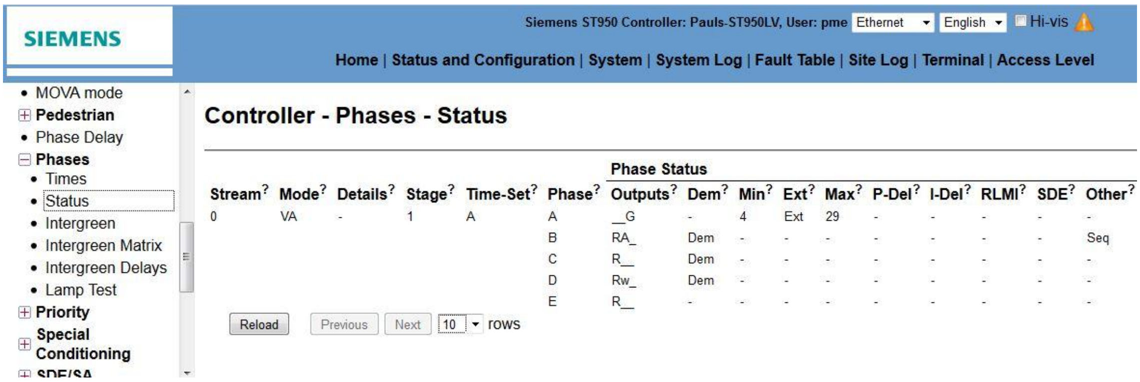


Figure 9 - Controller - Phases - Status web page

9.12.3 Controller - Phases - Intergreen Web Page

The intergreen times can be reviewed and changed through this page. This page contains items which require Level 3 access to change.

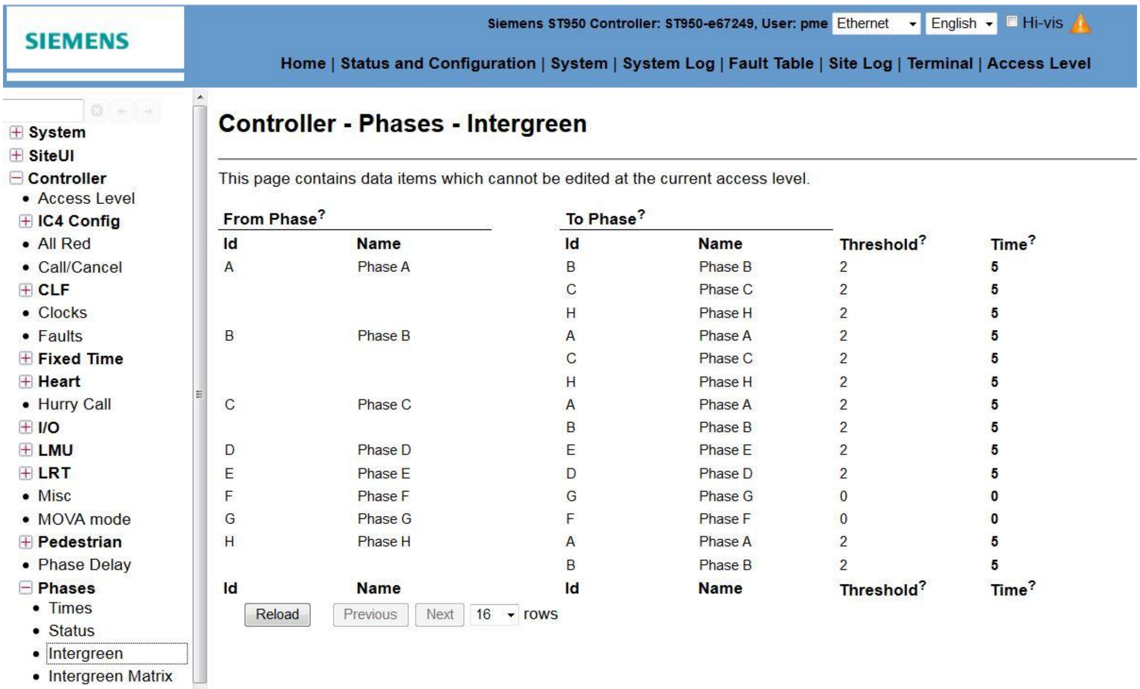


Figure 10 - Controller - Phases - Intergreen web page

9.12.4 Controller - Phases - Intergreen Matrix Web Page

This page shows the intergreen times between the phases.

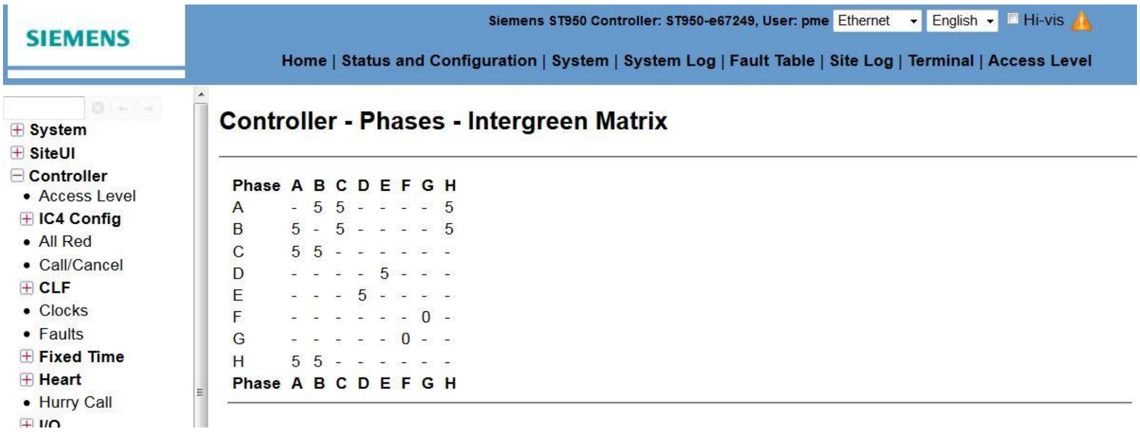


Figure 11 - Controller - Phases - Intergreen Matrix web page

9.12.5 Controller - Phases - Intergreen Delays Web Page

Intergreen delays can be reviewed on this page.

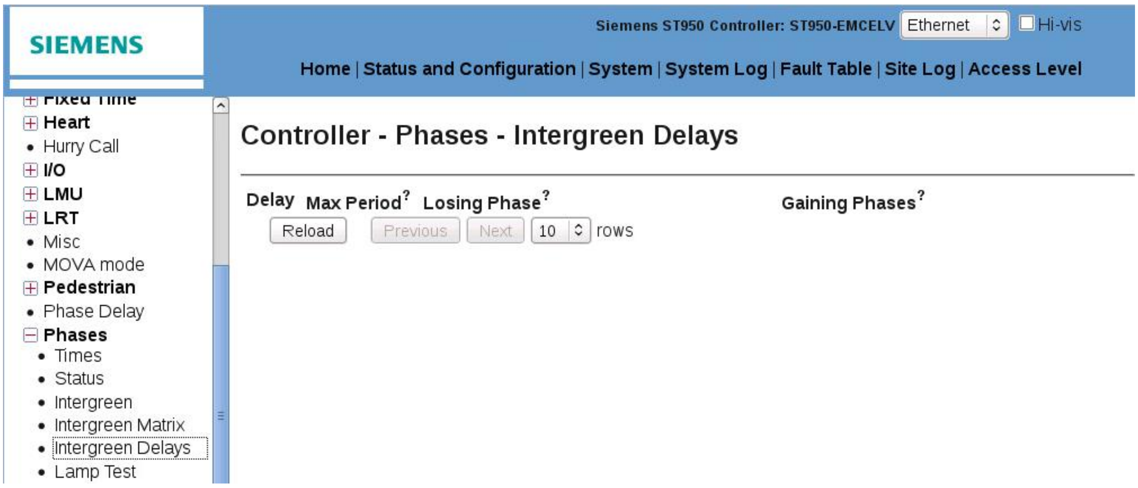


Figure 12 - Controller - Phases - Intergreen Delays web page

9.12.6 Controller - Phases - Lamp Test

Lamp tests can be configured and requested through this page. Level 3 access is required to modify items on this page.

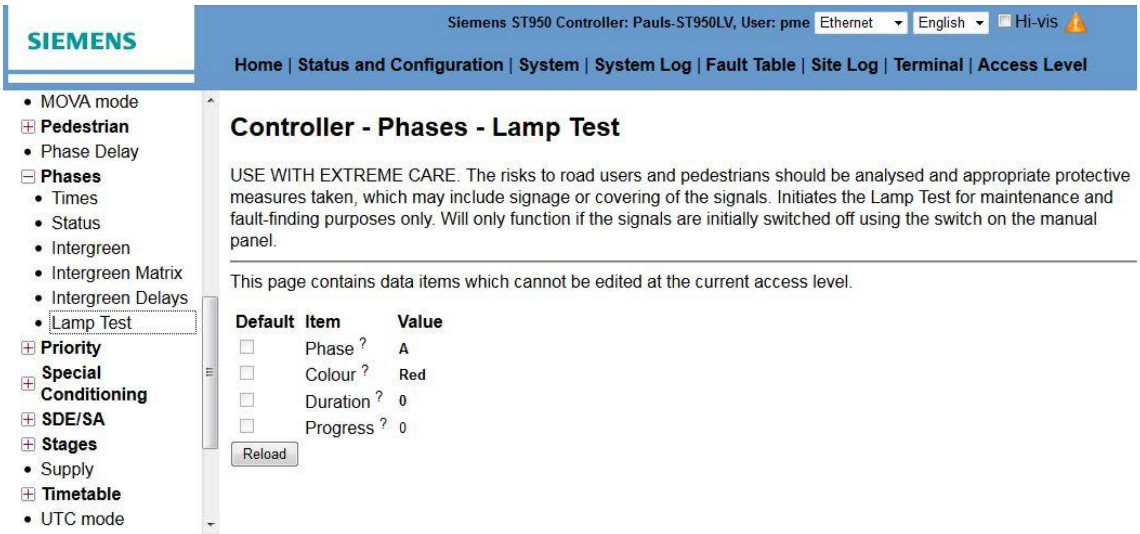


Figure 13 - Controller - Phases - Lamp Test web page

9.12.7 Controller - Stages - Window Times Web Page

Window times can be modified using this page.

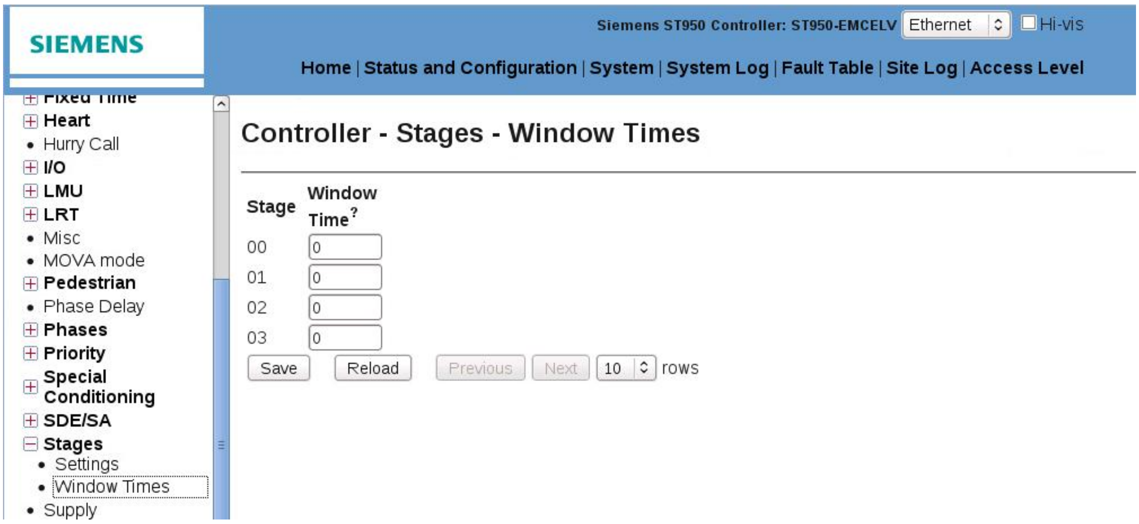


Figure 14 - Controller - Stages - Window Times web page

10 PEDESTRIAN PHASES

This section covers the Pedestrian phase types, clearance periods and demand processing options available on the controller.

Note: More information on stand-alone pedestrian streams is available in the documentation for 'Linking' and 'Red Lamp Monitoring'.

10.1 Pedestrian Phase Types

This section describes the various different types of pedestrian phase supported by the controller, with the following table summarises the facilities of the various types of pedestrian crossing available.

Type of Crossing	Ped. Signal Position	Veh To Ped I/G	SDE/SA Clearance	Ped to Veh Clearance Display	Ped to Veh Timings	On-Crossing Detectors	Kerbside Detectors	UTC Type
Stand-alone Pelican	Far-side	PAR	3	Flash Amber Vehicle Phase. Flash Green Ped Phase.	PIT	No	No	PV/PX GX/PC
Stand-alone Pedestrian	Far-side	PAR	3	Pedestrian Blackout	PBT [CMX & CDY] CRD	Optional	No	PV/PX GX/PC
Intersection Pedestrian	Far-side	IGN	SCT	Pedestrian Blackout	PBT [CMX & CDY] CRD	Optional	No	Fn/Dn Gn
Stand-alone Puffin	Near-side	PAR	3	Pedestrian Red	PBT CMX & CDY	Yes	Yes	PV/PX GX/PC
Intersection Puffin	Near-side	IGN	SCT	Pedestrian Red	PBT [CMX & CDY]	Optional	Optional	Fn/Dn Gn
Stand-alone Toucan	Far-side	PAR	3	Pedestrian Blackout	PBT CMX & CDY CRD	Yes	No	PV/PX GX/PC
Stand-alone Toucan	Near-side	PAR	3	Pedestrian Red	PBT CMX & CDY	Yes	Yes	PV/PX GX/PC
Intersection Toucan	Far-side	IGN	SCT	Pedestrian Blackout	PBT [CMX & CDY] CRD	Optional	Optional	Fn/Dn Gn
Intersection Toucan	Near-side	IGN	SCT	Pedestrian Red	PBT [CMX & CDY]	Optional	Optional	Fn/Dn Gn

Table 2 - Summary of Pedestrian Phase Types

10.1.1 UK ‘Pelican’ Crossing

A UK ‘Pelican’ crossing is a stand-alone pedestrian stream containing one vehicle and one pedestrian phase. The vehicle phase may control the signals of one or more vehicle approaches.

The signals normally reside at vehicle green and pedestrian red. The controller responds to pedestrian push-button demands that cause the vehicle phase to move to red and the pedestrian phase to appear at green.

The vehicle to pedestrian inter-green is always controlled by the PAR Pedestrian All-Red period since ‘Pelican’ crossings are only available on stand-alone pedestrian streams. Section 10.1.4 has more information on the PAR time.

When pedestrian phase has been at steady green for its configured period (MIN), the green flashes for a configured period before returning to red. During the flashing green period, the vehicle phase moves from red to flashing amber. This is the fixed clearance period of the ‘Pelican’ crossing.

The pedestrian to vehicle inter-green is divided into three periods governed by the PIT Pelican Inter-green Times.

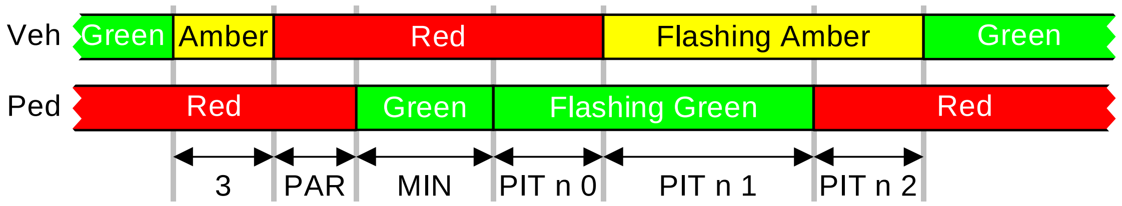


Figure 15 - Pelican Sequence ('n' is the stream number)

Note that it is common for the durations of the first (PIT n 0) and last periods (PIT n 2) to be set to zero. In this case the signals appear at flashing green / flashing amber for a fixed period (PIT n 1) between the pedestrian phase green and the vehicle phase green.

10.1.2 Far Side Pedestrian Crossing

This type of crossing can be used at both intersections and at stand-alone pedestrian crossings (also known as ‘mid-block’ crossings). The pedestrian signals are still mounted on the far side of the crossing so the pedestrians look across the road to see their red and green signals.

On-crossing detectors (section 10.1.5) may be added to these crossings to give a variable clearance period, i.e. a longer clearance period while pedestrians are still crossing, but also see section 10.1.6 for a “Fixed Clearance Period”.

The vehicle to pedestrian inter-green on a stand-alone crossing is again controlled by PAR, however if the far-sided pedestrian phase is part of an intersection stream, this period is controlled by the IGN inter-green command. Section 10.1.4 has more information on the vehicle to pedestrian inter-green.

The pedestrian to vehicle blackout clearance period consists of:

- a minimum period governed by PBT p,
- an extendable period limited to a maximum governed by CMX p,
- a gap clearance delay CDY p 0*, or
- a max clearance delay CDY p 1 - where ‘p’ is the pedestrian phase letter

Following this blackout clearance period, there is a clearance all-red period CRD p.

* The gap clearance delay CDY p 0 is usually set to zero and hence is not shown on the following diagram.

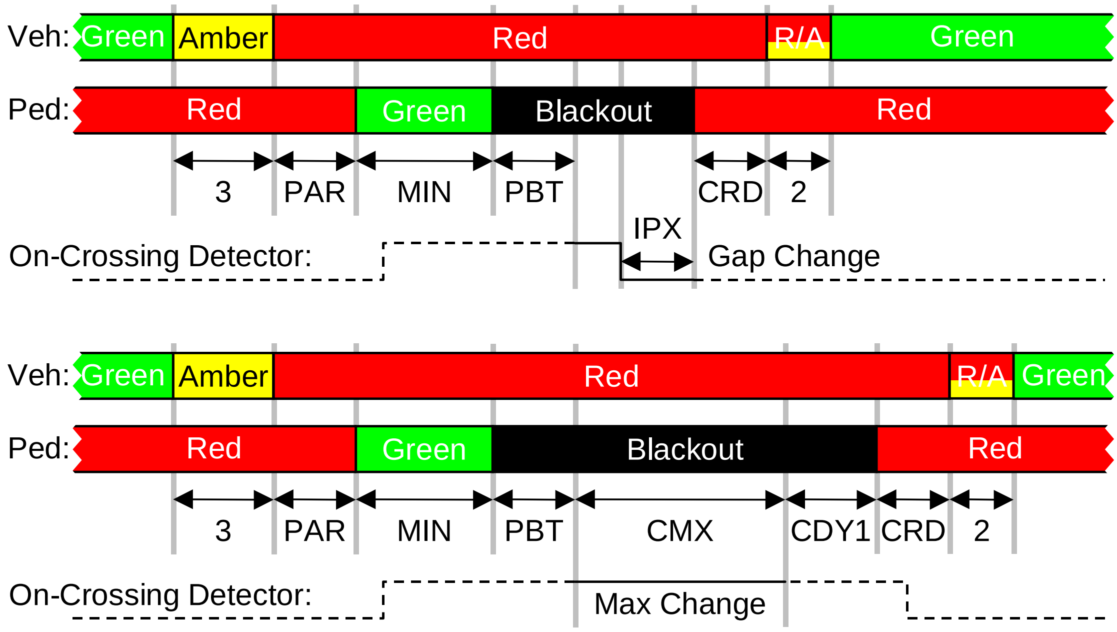


Figure 16 - Pedestrian Far Side Sequence

If a fixed blackout period is required, i.e. with no on-crossing detectors, CMX should be set to zero so that the blackout period is controlled solely by PBT, see section 10.1.6.

On intersections, the appearance of the vehicle phase may be delayed further by the IGN inter-green time, see overleaf for details.

Note that for non UK controllers, the blackout clearance period can be configured as flashing green for example.

The far side pedestrian lamp sequence includes an extendable blackout period that extends the inter-green time between the pedestrian phase and any conflicting vehicle phases. The appearance of any real/dummy phase configured with an inter-green time from the pedestrian phase leaving ROW will be delayed by this extendable period.

The complete inter-green consists of:

- a fixed minimum blackout clearance time (PBT),
- an extendable period (CMX) plus its switched clearance period (CDY),
- a fixed red clearance period (CRD)
- a fixed two second vehicle red/amber time

The fixed part of the inter-green from a far side pedestrian phase to a vehicle phase is controlled by larger of either:

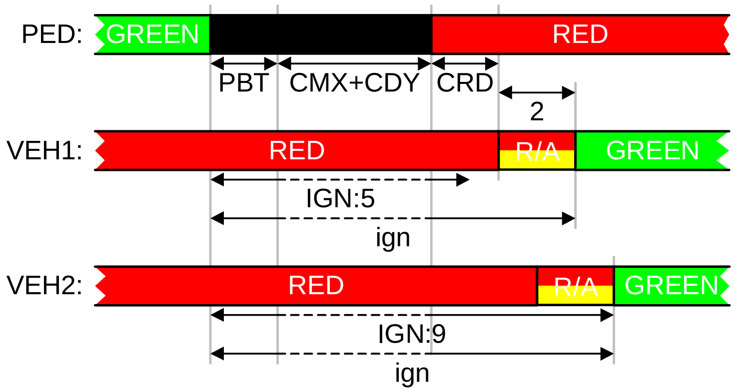
The configured inter-green time (IGN)

OR

The fixed blackout and red clearance times (PBT+CRD) plus the red/amber time

The controller will use the configured inter-green time unless that would allow the vehicle red/amber time to start before the clearance red period has finished, i.e. when IGN is set lower than PBT plus CRD plus two seconds. If a customer does not specify an inter-green time, a value of 5 seconds will be used.

Consider the example below.



The configured inter-green time (IGN:5) for PED to VEH1 is set below the required minimum clearance time (PBT:4) plus the required red clearance period (CRD:2) plus the red/amber time (2 seconds). Therefore the actual inter-green (shown as 'ign') would run longer than the configured inter-green value and would actually run for eight seconds governed by the PBT, CRD and red/amber times. This would be the normal case on a stand-alone pedestrian stream where the IGN time is zero.

However, if the configured inter-green time to one vehicle phase is increased to say nine seconds (VEH2), it controls the actual inter-green time and thus delays the vehicle phase by an extra one-second. Note that the vehicle is always delayed by one second, regardless of how long the extendable period actually runs for, and so always appears one second later than the other vehicle phase.

10.1.3 Near Side Pedestrian Crossing

This type of crossing can be used at both intersections and at stand-alone pedestrian crossings (also known as 'mid-block' crossings). The pedestrian signals are mounted on the 'near side' of the crossing, i.e. on the same side of the road as the pedestrian. When the pedestrian green finishes, these signals immediately show red, even though a clearance period still delays the appearance of any conflicting vehicle phases.

On-crossing detectors (section 10.1.5) should be added to these crossings to give a variable clearance period, i.e. a longer clearance period while pedestrians are still crossing.

The vehicle to pedestrian inter-green on a stand-alone crossing is again controlled by PAR, however if the near-sided pedestrian phase is part of an intersection stream, this period is controlled by the IGN inter-green command. Section 10.1.4 has more information on the vehicle to pedestrian inter-green.

The pedestrian to vehicle clearance period consists of:

- a minimum period governed by PBT p,
- an extendable period limited to a maximum governed by CMX p,
- a gap clearance delay CDY p 0, or
- a max clearance delay CDY p 1 - where 'p' is the pedestrian phase letter

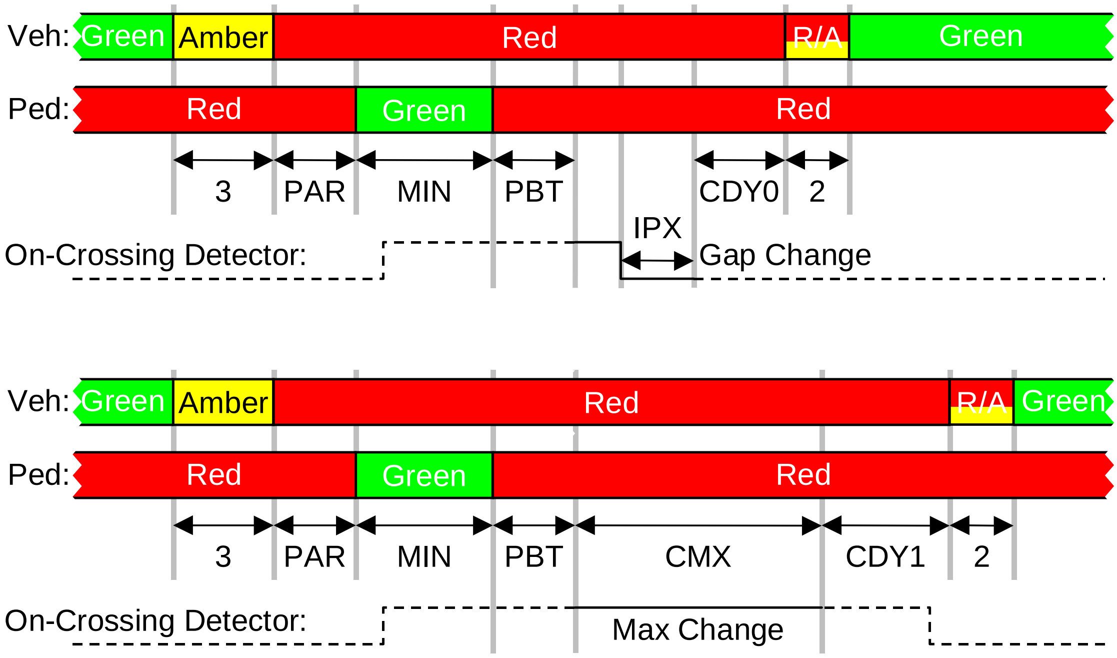


Figure 17 - Pedestrian Near Side Sequence

On intersections, the appearance of the vehicle phase may be delayed further if the IGN inter-green time is larger than PBT plus the red/amber period, see overleaf…

The near side pedestrian sequence includes an extendable all-red period which extends the inter-green time between the pedestrian phase and any conflicting vehicle phases. The appearance of any real/dummy phase configured with an inter-green time from the pedestrian phase leaving ROW will be delayed by this extendable period.

The complete inter-green consists of:

- a fixed minimum red clearance time (PBT),
- an extendable red period (CMX) plus its switched clearance period (CDY),
- a fixed two second vehicle red/amber time

The fixed part of the inter-green from a near side pedestrian phase to a vehicle phase is controlled by larger of either:

The configured inter-green time (IGN)

OR

The minimum clearance time (PBT) plus the red/amber time.

The controller will use the configured inter-green time unless that would allow the vehicle red/amber time to start before the minimum red clearance time set by PBT has finished, i.e. when IGN is set lower than PBT plus two seconds. If a customer does not specify an inter-green time, a value of 5 seconds will be used.

Consider the example below.

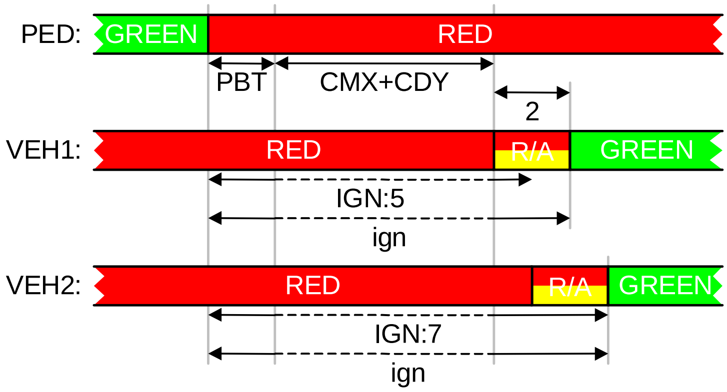


Figure 18 - Pedestrian Clearance and Intergreen Times

The configured inter-green time (IGN:5) for PED to VEH1 is set below the required minimum clearance time (PBT:4) plus the vehicle red/amber time (two seconds). Therefore the actual inter-green time (shown as 'ign') would run longer than the configured inter-green value and actually run for six seconds governed by the PBT and vehicle red/amber time. This would be the normal case on a stand-alone stream where the IGN time is zero.

However, if the configured inter-green time to one vehicle phase on an intersection is increased to say seven seconds (VEH2), it controls the actual inter-green time and thus delays the vehicle phase by an extra one second. Note that the vehicle is always delayed by one second, regardless of how long the extendable period actually runs for, and so always appears one second later than the other vehicle phase.

10.1.4 Vehicle to Pedestrian Inter-green

All the pedestrian lamp sequences include the Pedestrian All-Red (PAR) period in their gaining right of way steps, although its effect depends on whether the pedestrian phase is assigned to an intersection or stand-alone pedestrian stream.

The examples below show the vehicle to pedestrian inter-green period for a stand-alone pedestrian stream (where the IGN inter-green is set to zero) and for a pedestrian phase on an intersection (where the IGN command determines the inter-green period and the PAR value is ignored):

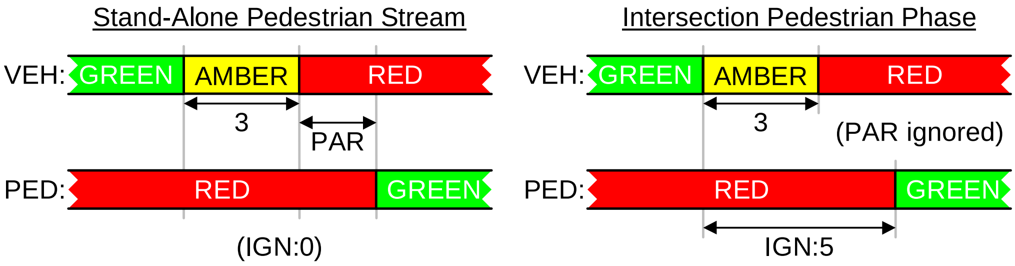


Figure 19 - Vehicle to Pedestrian Intergreen

Intersection Stream

If the phase is running as part of an intersection, the PAR lamp sequence step is ignored and the vehicle to pedestrian inter-green is controlled solely by the IGN handset command as normal for intersection phases.

Stand-Alone Pedestrian Stream

On a stand-alone pedestrian stream, the IGN inter-green time is still executed, however, it will have no effect since it is set to zero. Also note that the IGN inter-green time cannot be changed using the handset on a stand-alone pedestrian stream.

The PAR sequence waits until the stream is at all red, i.e. until the vehicle phase reaches red, before beginning its timings.

For each stream, up to five different PAR times can be configured, one for each termination conditioning. There is one time for when the vehicle phase terminates on a ‘gap change’ in VA mode and one for when it terminates on a ‘max change’. Different times can also be defined for fixed vehicle period mode and for a ‘linked’ changed, UTC, local link or CLF.

However, if the speed discrimination or speed assessment facility is enabled on the stream (because of the higher speed of the traffic), the all-red time runs for at least 3 seconds in order to meet UK requirements.

10.1.5 Pedestrian On-Crossing Detectors

‘On-Crossing Detectors’ are above ground detectors that are used to determine when pedestrians are still crossing. While pedestrians are still crossing, the extendable clearance period is extended, up to its configured maximum (CMX).

If an on-crossing detector has not been activated since the end of the previous extendable clearance period (CMX) it is treated as suspect, forcing the current extendable clearance period to run to its maximum. Monitoring of an on-crossing detector continues during the current extendable clearance period, such that if the detector is activated during this period, it is no longer treated as suspect.

A fault will not be recorded if this occurs, instead the controller will wait until the normal DFM time-outs confirm and report a fault.

Also note that if the Continuous Ped Demand (CPD) button on the Manual Panel is pressed, the red clearance of near-side signals will be extended to its maximum as required by TR2500.

10.1.6 Fixed Clearance Period

Even though the Pedestrian lamp sequences default to including the extendable blackout period, if the clearance maximum (CMX) time is set down to zero, the phase will run a fixed blackout period determined solely by PBT and a fixed minimum all-red period determined solely by CRD.

Note that for non UK, the blackout period can be configured to show flashing green for example.

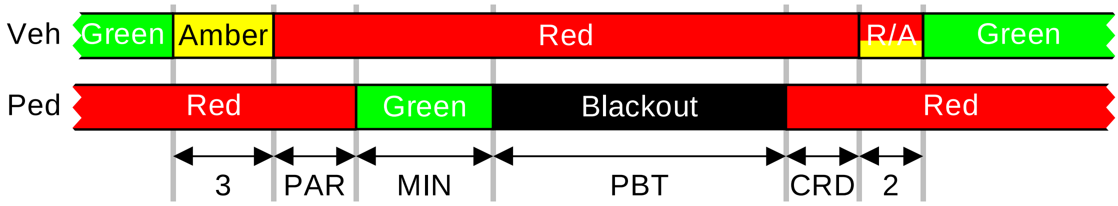


Figure 20 - Fixed Pedestrian Clearance Period

The controller checks that the IGN inter-green time is not shorter than the required clearance period. After the pedestrian phase, the controller will ensure that if PBT+CRD are set longer than IGN, the vehicle red/amber period does not start until the pedestrian blackout period (PBT) and the minimum red clearance period (CRD) have finished.

On a stand-alone stream, the above is true even if the red clearance time CRD is set to zero, i.e. the vehicle red/amber time will start when the blackout time PBT expires.

However, on an intersection stream, if the red clearance time CRD is set to zero (as well as CMX), the controller reverts to its original style of operation to be backward compatible. If CRD is zero, the inter-green between the pedestrian phase and the vehicle phase is controlled solely by the IGN handset command, even if the blackout time PBT is set longer. This ensures that existing configurations, which will default to having CMX and CRD times set to zero, operate exactly as before.

10.1.7 Parallel Pedestrians

In the case where the pedestrian phase is running in parallel with a vehicle phase, the pedestrian could be configured to terminate on a minimum green using special conditioning. If the parallel vehicle phase was still being extended after the pedestrian terminated, the pedestrian clearance periods could be completed by the time that the vehicle phase terminates. In this instance, the next phases starting would be controlled by the vehicle-to-vehicle inter-greens, rather than those defined for the pedestrian.

10.1.8 Non-Conflicting Vehicle Phases

If a vehicle phase which is gaining right-of-way after the pedestrian phase terminates does not conflict with it, the vehicle phase will appear as soon as any inter-greens from vehicle phases running in parallel with the pedestrian phase to the vehicle phase gaining right of way have expired.

Thus, IGN effectively switches on the ped clearance delays, in the sense that if IGN from the pedestrian to a vehicle phase has been configured as “non-conflicting”, the ped clearance times will have no effect on the appearance of that vehicle phase.

Where the pedestrian clearance is required to delay the appearance of any non-conflicting phases, an All-Red Extension or Intergreen Delay could be configured, with the extension input defined as the ped phase ‘changing to no-right-of-way’ condition.

10.2 Pedestrian Demand Control

10.2.1 Introduction

In addition to pedestrian push buttons, the controller can be configured with ‘cycle detectors’ and ‘kerbside detectors’. The controller treats ‘cycle detectors’ and ‘push-button inputs’ the same and both should be configured to demand the phase in the usual way.

‘Kerbside detectors’ allow the controller to cancel the demand (and switch off the wait / demand indicator) if the pedestrian crosses before the pedestrian phase gains right of way, see section 10.2.4.

Each push button input is associated with a specific kerbside input in order to determine the type of pedestrian demand inserted (10.2.2). A kerbside input can be associated with one or more push button inputs, or it can be associated with none in which case it is only used to hold and cancel the demand (10.2.4).

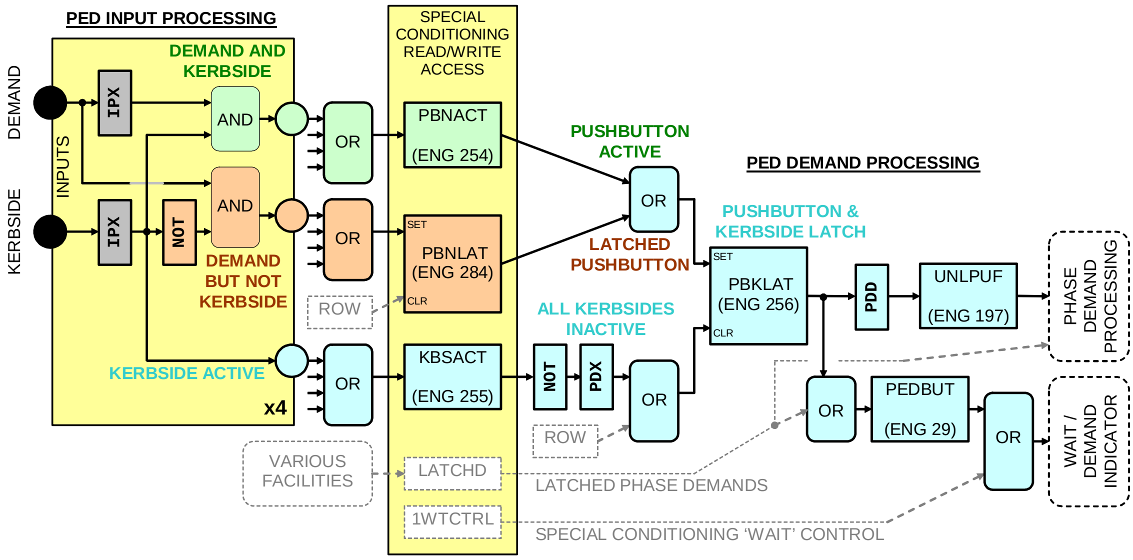


Figure 21 - Pedestrian Demand Processing

The following lines can be used in special conditioning to add pedestrian phase demand and kerbside inputs in addition to those provided by the firmware:

```
;xxPB = Pushbutton input, xxKBS = Associated Kerbside input, 'p' = Phase letter
xxPB_ext.xxKBS_ext=+PBNACTp   ;Pushbutton and Kerbside both active
xxPB.NOT(xxKBS_ext)=+PBNLATp  ;Pushbutton active while kerbside inactive
xxKBS_ext=+KBSACTp            ;Kerbside extension active
```

10.2.2 Pedestrian Demand Acceptance

For the purposes of this section, push button inputs include any demand inputs assigned to a pedestrian phase, including for example inductive loops for cycles.

If no kerbside detectors are configured on the phase, pressing the push buttons generates a latched demand for the pedestrian phase, which is only cleared when the pedestrian phase gains right of way.

If kerbside detectors are configured on the phase, then the operation is as follows:

Every push button input and every kerbside input is configured with its own extension period (which can be modified using the IPX handset command). The extension remains active for the configured period after the input goes inactive.

An unlatched demand for the pedestrian phase is accepted and the wait / demand accepted indicator illuminated when a push button (or its extension) and its associated kerbside detector (or its extension) are both active at the same time. This demand will be cancelled when all the kerbside inputs go inactive.

A latched demand for the pedestrian phase is accepted and the wait / demand accepted indicator illuminated when a push button input is active but its associated kerbside detector (and its extension) is inactive, or no kerbside detector has been associated with that push button input. This demand is only cleared when the phase gains right of way.

10.2.3 Pedestrian Demand Delay (PDD)

The transition from vehicle green to pedestrian green starts with the vehicle changing to amber. A delay before starting this transition can be configured so that the vehicle phase does not terminate as soon as the pedestrian push button is pressed, although the wait indicator is illuminated.

The delay is controlled using the handset command PDD.

The controller uses the following rules:

- In VA mode, if one or more real phases are at right of way (and none of the phases at right of way have pre-timed maximums configured) the delay is not applied, since if vehicles are present, their extensions will keep the vehicle phase at green.
- In VA mode, the controller will examine the maximum green timers of all conflicting phases which are at right of way which have also been configured to run a ‘pre-timed maximum’ but no ‘pre-timed extra period’. If any have expired or have less time to run than the delay, the delay is introduced, otherwise all have more time to run than the delay, so no delay is introduced and the controller will only allow the stage change if none of the phases are being extended.
- In VA mode, if no real phases in the same stream are at right of way, the delay is introduced, so delaying the appearance of the pedestrian green after a quiescent all-red period, for example.
- In all other modes, the delay will always be introduced. This is to cater for cases such as ‘fixed vehicle period’ mode, UTC inserting a demand dependant force for the pedestrian phase, or CLF introducing a demand dependant move just after the push-button is pressed. Introducing the delay prevents these cases making a stage move shortly after the push-button is pressed. In most other cases, the demand delay will have little or no effect.

Note that special conditioning can always be written to ‘short-circuit’ the pedestrian demand delay if required under certain circumstances by putting in an unlatched demand for the phase if the wait indicator is lit.

10.2.4 Pedestrian Demand Cancel (PDX)

The unlatched phase demand is cleared when all kerbside detectors and their extensions for the phase have been inactive for the configured pedestrian demand extension time for the phase (PDX). The wait / demand accepted indicator will be extinguished if there are no other demands present for the phase.

Note that the phase may still appear at green if the controller has already started the move to the stage in which the phase appears.

10.2.5 Kerbside Detector (Mat) Testing

Kerbside detector testing can be performed by the firmware to check the operation of kerbside ‘mat’ detectors.

Every 60 seconds, if there are no pedestrian phase demands active and no push-button (or cycle) inputs active, the controller outputs a 500ms (±50ms) test pulse on a configured output. If the output is de-allocated using IOA, no kerbside testing will be performed.

This output is connected to all the kerbside detectors and should result in all of the kerbside inputs going active during the pulse.

Therefore, the test is not performed while a pedestrian demand exists since this will extend the pedestrian demand if the kerbside input has just gone inactive and the controller is timing off the kerbside and demand extension periods.

Nor is the test performed while any push-button or cycle inputs (or their extensions) are active since the kerbside test will activate the kerbside inputs even though no-one may be present and allow these inputs to produce a demand for the pedestrian phase.

Each configured kerbside detector is sampled twice and if either sample on a particular kerbside detector indicates the detector is inactive*, the detector is logged as faulty, the DFM indicator is illuminated and the detector input forced active (regardless of the setting of the DFM forcing action command ‘DFA’).

* Note that for the input to be seen inactive at the 200ms processing rate, all ten 20ms samples must have been inactive.

Thereafter, the force is only removed after 5 consecutive tests of the detector have passed, but the fault log entry remains set and the DFM indicator remains illuminated, until RFL=1 is entered.

If the maintenance engineer enters RFL=1, the controller will automatically perform a test. If a kerbside detector which was reported as faulty passes this test, even if this is the first test that it has passed, the fault log entry for that detector is cleared and the detector is assumed to be working. This means that when the maintenance engineer fixes a kerbside detector, they do not have to wait for 5 automatic tests before they can clear the fault, they just need to enter RFL=1.

10.3 Monitoring and Modifying Pedestrian Phases

The status of Pedestrian Phases and their configuration can be monitored and changed using the following web pages.

10.3.1 Controller - Phases - Times Web Page

The pedestrian minimum green period can be reviewed and changed on this page. This page requires Level 3 access.

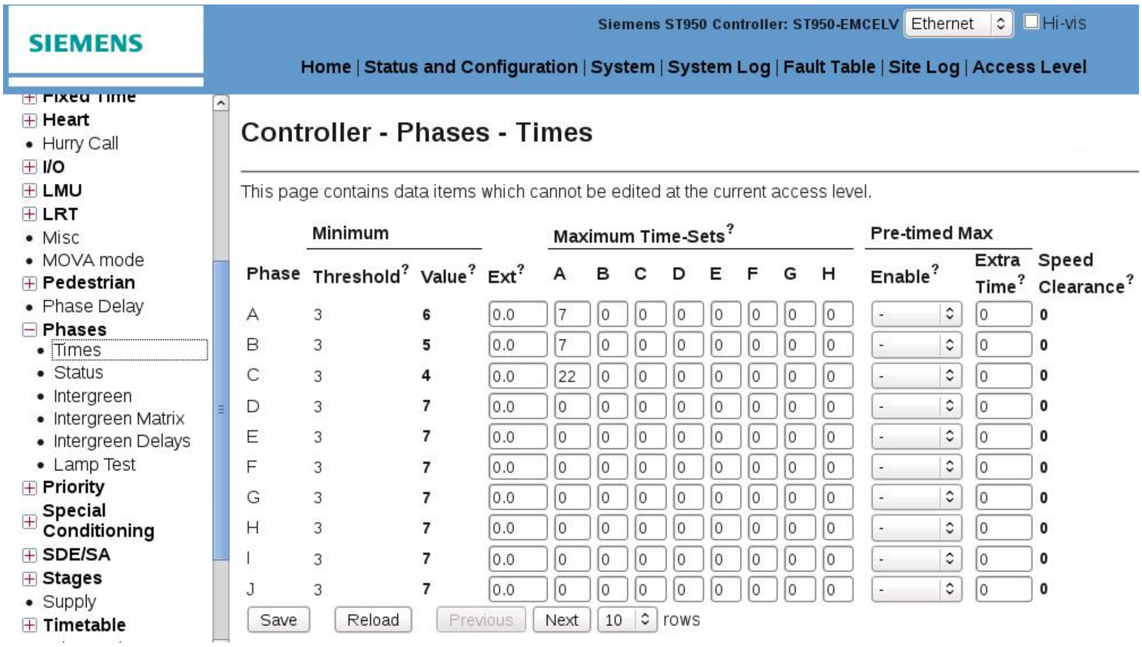


Figure 22 - Controller - Phases - Times web page

10.3.2 Controller - Phases - Status Web Page

The current status of the phases can be monitored through this page.

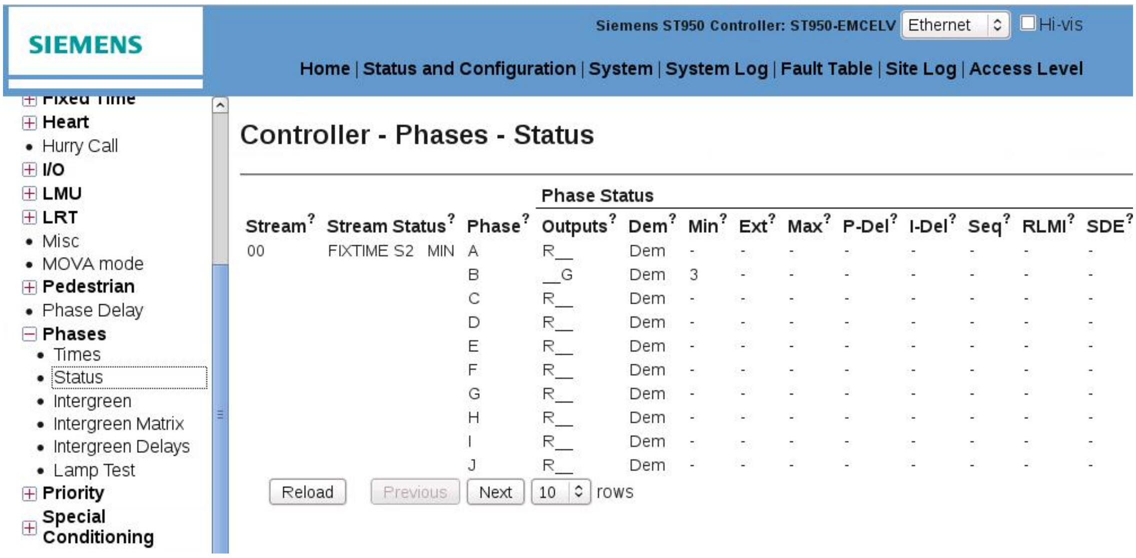


Figure 23 - Controller - Phases - Status web page

10.3.3 Controller - Pedestrian - Phase web page

The Pedestrian Demand Delay (PDD), Demand Extension (PDX) and the various clearance periods (PBT, CMX, CDY, CRD) can be viewed and modified using this page. Some items (bold) require Level 3 access.

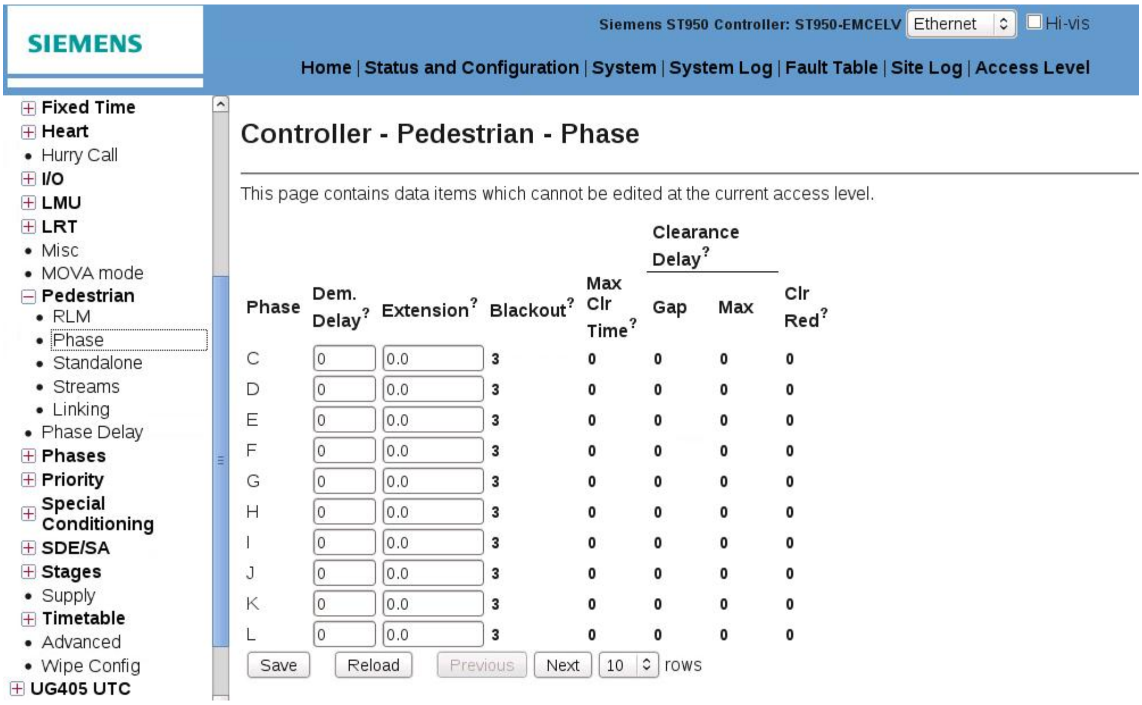


Figure 24 - Controller - Pedestrian - Phase web page

10.3.4 Controller - Pedestrian - Streams Web Page

The Pedestrian All-Red (PAR) and Pelican Intergreen Times (PIT) can be viewed and modified using this page:

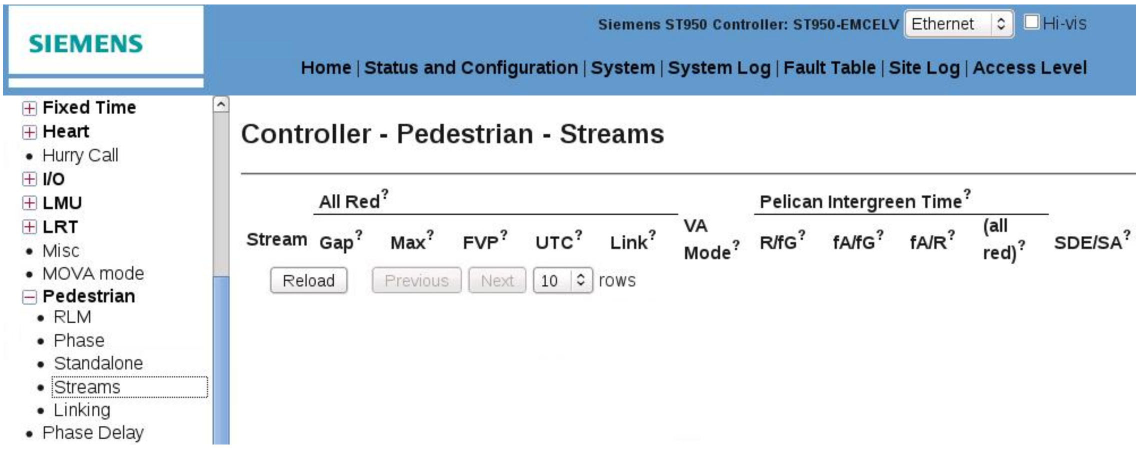


Figure 25 - Controller - Pedestrian - Streams web page

11 GREEN ARROW PHASES

A green arrow phase controls vehicle movements via a single aspect green arrow. It is normally associated with a three-aspect Red-Amber-Green phase. The appearance of these two phases needs to be carefully considered.

Where the round green aspect of three-aspect Red-Amber-Green signal is replaced by a green arrow, it is not normally associated with a second phase. The phase operates as a normal three-aspect phase so these phases are not considered ‘green arrow’ phases.

There are two types of green arrow – a ‘Filter Arrow’ and an ‘Indicative Arrow’.

11.1 Filter Green Arrow

A filter green arrow may be used to allow filter traffic to gain ROW in advance of the main movement. It is illuminated during the stage or stages preceding the stage in which its associated phase appears. Where the traffic drives on the left, this is a left turn arrow. In the example Figure 26, Phase E is a filter arrow associated with Phase D.

It will remain illuminated during the interstage period, normally until its associated phase gains ROW, when it will be extinguished – achieved by configuring the phase as ‘Termination Type 1’. Alternatively, it can remain illuminated during the green of its associated phase and extinguish at the commencement of the amber leaving.

For safety reasons in the U.K., a filter green arrow must always be followed by the green and then the amber-leaving of its associated phase. If the green arrow terminated while the associated phase is at red, there would be no amber-leaving period displayed to the drivers.

To achieve this, a demand dependent filter green arrow must also demand its associated phase. A filter green arrow that appears unconditionally must always be followed by its associated phase by means of Stage Movement Restrictions. Alternative methods of control can be provided to meet other specifications, such as the ‘Improved Green Appearance’ option detailed below.

During Manual Mode the appearance of the filter green arrow during its associated stage(s) is configurable, i.e. ON, OFF or Demand Dependant.

11.2 Indicative Green Arrow

An indicative green arrow may be used when an early cut off facility is required to allow turning traffic. Where the traffic drives on the left, this is a right turn arrow. In the example Figure 26, Phase C is an indicative arrow and Phase A terminates early to allow the traffic to turn right.

The green arrow will be illuminated after a pre-determined inter-green period from the conflicting main movement. This is normally set at 3 seconds so that the green arrow appears at the start of the conflicting red. The green arrow will then remain illuminated throughout the rest of the green of its associated phase and will be extinguished at the commencement of the amber leaving.

If required, the demand for the indicative green arrow will only mature if a demand exists for an opposing or other specified phase.

It may be required to use a Call/Cancel facility with an indicative green arrow.

For safety reasons in the U.K., the amber leaving of the associated phase must always follow an indicative green arrow. To ensure this, configure the phase as 'Termination Type 2'. If a direct move back to the main movement is required the stage change must go via an All-Red Stage configured as an Stage Movement Restrictions. Alternative methods of control can be provided to meet other specifications.

11.3 The 'Improved Green Appearance' option

This is a new option available with the introduction of the ST950 controller but is disabled by default. Selecting this option enables the following features:

- Automatic appearance timings for green arrows, preventing the green arrow appearing before an associated full green aspect reaches green.
- Automatically prevents (ignores) stage movements that would violate the green arrow phase termination rules, but only when the green-arrow phase is at right-of-way.

If Alternative, Prohibited or Ignore Moves are configured for movements from the stage with the Green Arrow, these restrictions will still be followed. Therefore care needs to be taken not to configure an Alternative Move that would take the controller to a stage that cannot terminate the Green Arrow.

11.3.1 Automatic appearance timings for green arrows

This feature affects green arrow phases of Termination Type 0 or 2, and configured with an Associated Phase. It does not affect green arrow phases of Terminate Type 1 (filter arrows) or Termination Type 0 with no Associated Phase.

If both the Green Arrow and its Associated Phase are gaining ROW on the stage movement, the feature delays the appearance of the Green Arrow until the Associated Phase has also appeared at green.

For example, if both the indicative (right-turn) green arrow and its associated phase gain ROW on the same stage movement, skipping the stage(s) where the associated phase gains ROW but not the arrow, the appearance of the phases is determined by the configured intergreen times and optional phase delays. These timings could allow the green arrow to appear at green before associated phase reaches green. With this feature enabled, the green arrow is automatically delayed until the associated phase reaches green, preventing the green arrow appearing first. If the configured timings delay the appearance of the green arrow until after the associated phase reaches green, the feature has no effect.

11.3.2 Automatic prevention of stage movements that would violate the green arrow phase termination rules

This feature automatically prevents (ignores) stage movements that would violate the green arrow phase termination rules, but only when the green-arrow phase is at right-of-way. If the arrow does not appear (because there are no demands for it for example), the stage movements are not restricted. This means that fixed alternate stage moves do not need to be configured.

It is recommended that an unlatched demand is inserted using Special Conditioning when the green arrow appears to ensure the correct stage sequence. E.g. insert a demand for the main road while the filter arrow is at ROW.

11.4 A Vehicle Actuated Example

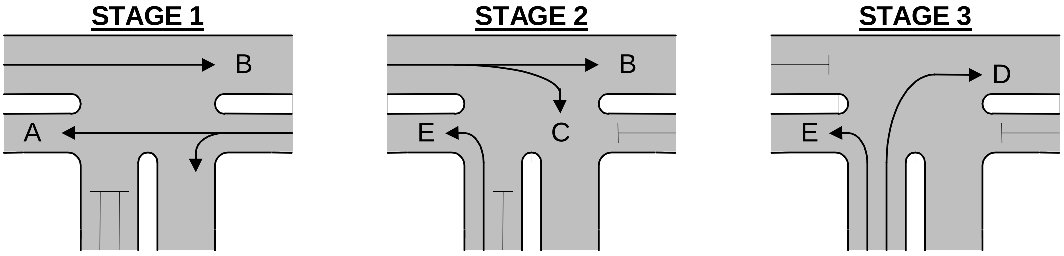


Figure 26 VA Stage Changes and Green Arrows

11.4.1 Indicative Green-Arrow Stage Restrictions

If phase C is an indicative green-arrow (and phase E is a normal 3-aspect traffic signal), the move from stage 2 to stage 1 should be configured to go via an all-red stage (in this case stage 0).

This ensures that when the green arrow is extinguished, it is followed by the amber leaving period of its associated phase, in this case phase B.

Otherwise, on the move from stage 2 back to stage 1, the green-arrow would just switch off while its associated phase remains at green.

Due to this restriction, it is commonly required that stage 2 is prevented unless there is a demand for the side road, in this case either phases D or E so the controller always moves from stage 2 to stage 3. The move may also be restricted unless there is a demand for phase C as well, not just phase E – see section 11.4.2.

Thus the controller remains in stage 1 even if demands exist for phase C and gaps appear in the traffic on phase A that would normally allow the controller to ‘gap change’ to stage 2. However, since the vehicles demanding phase C should be able to turn across phase A through these gaps, the demand for phase C should clear naturally.

This is just one of the many ways that Special Conditioning can be used to modify the controller’s normal stage change algorithm.

11.4.2 Filter Green-Arrow Stage Restrictions

If phase E is a filter green-arrow (regardless of how phase C is configured), the move from stage 2 to stage 1 (and all other moves out of stage 2) should be configured to go via stage 3.

This ensures that the appearance of the green filter arrow is followed by its associated phase; in this case phase D, appearing at green followed sometime later by phase D’s amber leaving period.

When phase D appears at green, the green-arrow is normally extinguished (since the full green signal on phase D’s signals naturally allows the traffic to turn left). Alternatively, the green-arrow can be configured to remain illuminated through stage 3 until phase D loses right of way.

Due to this restriction, it is commonly required that stage 2 is prevented unless there is a demand on phase C from the right-turning traffic (and possibly only if there is a demand for the side road as well – see section 11.4.1).

Thus, if there is no demand for phase C, the controller normally moves from stage 1 to stage 3 (omitting stage 2) if there is a demand for the side road, even if it is from left-turning traffic that could just use the filter green-arrow (in stage 2).

11.4.3 Filter Green-Arrows and the Main Stage Green

If phase E is as filter green-arrow and is configured to switch off when its associated phase (phase D) gains right of way, it must not be configured in stage 3 otherwise it will not switch off when required.

Thus, since phase E now only resides in stage 2 and not stage 3, demands for this phase will demand stage 2 and not stage 3.

Therefore, the detectors on the approach for phase E are normally configured to demand and extend phase D (and thus stage 3), not phase E (stage 2).

Even though phase E is now no longer demanded, it will automatically appear in stage 2 if it is configured as a fixed phase.

Alternatively a dummy phase can be configured in stages 2 and 3 that is demanded and extended by the detectors on phase E's approach. An unlatched demand can be configured (using special conditioning) to illuminate the green arrow during stage 2 if the dummy phase appears due to a real street demand.

12 DEMANDS AND EXTENSIONS

12.1 General Description

Demands may be inserted for phases or stages, but extensions may only be inserted for phases.

Demands will only be acted upon when the phase or stage is not at right of way and request (i.e. demand) that the phase / stage gains right of way.

Extensions will only be acted upon when the relevant phase is at right of way and will request that the phase remains at right of way for longer.

12.2 Types of Demands

12.2.1 Latched

The demand remains active until the phase or stage is served, i.e. gains right of way.

Thus, an activation of a detector (e.g. when a vehicle passes over an inductive loop or when a pedestrian push-button is pressed) is ‘latched’ so that it keeps requesting (i.e. demanding) the phase until the phase eventually gains right of way.

12.2.2 Unlatched

The demand is cleared if the demand condition ceases before the phase or stage is served.

Any maximum green timers started by an unlatched demand will be reset if all of the opposing demands are cleared.

12.3 Origins of Demands and Extensions

12.3.1 On-Street Detection Equipment

This refers to the approach detectors at the intersection.

These are normally inductive loops cut into the road’s surface or above ground detectors mounted on the top of signal poles. Both detect traffic moving towards the signals.

An activation of such a detector normally inserts a ‘latched demand’ for the phase that gives right of way to the detected vehicle. When the phase gains right of way, further activations of these detectors normally extend the green period.

12.3.2 Pedestrian Push-Buttons

When a pedestrian push-button is pressed, a ‘latched demand’ is inserted for the pedestrian phase that will give right of way to the pedestrian and the associated WAIT indicator(s) are illuminated. If Kerbside detectors are used, refer to the detailed documentation on Pedestrian Phases for more information.

If it is required, it is possible to illuminate the WAIT indicator without inserting a demand or conversely insert a demand without illuminating the WAIT indicator.

12.3.3 Revertive Demands

When a vehicle actuated phase terminates with an extension still active, e.g. because the maximum green timer expired, a revertive latched demand is inserted for the phase to prevent any vehicles being trapped between the detectors and stop line without a demand for the phase.

If required, the revertive demand may be inserted for an alternative phase rather than for the terminated phase.

12.3.4 UTC Demand Bits

These provide simulated on-street demands and/or extensions from the UTC computer. In the case of pedestrian demands, the WAIT indicator will be illuminated on receipt of the demand unless specifically requested otherwise.

12.3.5 Conditions Occurring

When demands and/or extensions are required to be inserted when certain conditions occur, rather than the operation of detectors. For example, a stage becoming active inserts a demand for a following stage.

12.3.6 Repeat Pulses

When controllers are linked together, demands and/or extensions can be inserted when certain conditions occur in the first controller and the pulses are repeated to the second controller.

12.3.7 SDE/SA

This facility provides extra extensions to phases for high-speed vehicles.

12.3.8 Handset

Fixed demands and extensions for phases may be inserted and removed via the handset using the PHD and the PHE commands.

12.4 Operation during Certain Modes

This section describes the operation of demands and extensions during modes other than ‘vehicle actuated’.

Note that regardless of the current mode, the controller continues to process demand and extension inputs, even if those demands and extensions are being ignored by the current mode. Thus, when the mode returns to ‘vehicle actuated’ for example, the demands and extensions can immediately take effect.

12.4.1 Manual, Fixed Time and Start Up Mode

During Manual and Fixed Time Mode demands and extensions are disregarded.

This does not apply when Fixed Time to Current Maximums is the operative mode.

However, demands are inserted for all non-running real phases when these modes terminate. Pedestrian phase WAIT indicators will be illuminated while a demand is present. The actual phases to be demanded can be configured.

12.4.2 UTC

For UTC it is possible to configure the following:

- Which phases and/or stages have latched or unlatched demands inserted when a certain UTC demand bit is applied.
- Which phases are extended by which UTC demand bits.
- Demand dependent force bits and, for each force bit, which demands are to be considered.

12.4.3 CLF Mode

Extensions are disregarded during CLF mode. However, it is possible to configure demand dependant moves to stages during CLF. This is achieved by selecting the group influence as a demand dependant move to a stage and specifying the stage.

12.4.4 Priority and Hurry Call Modes

While the controller is in priority or hurry call mode, it normally ignores all demands and extensions except those associated with the priority / hurry call unit.

13 CALL / CANCEL

There are up to 8 call/cancel units (0 to 7) available which may be used for turning movements or in conjunction with queue loops or switched facilities.

The input to a unit must remain active for the call period before the output goes active and inactive for the cancel period before the output returns to the inactive condition.

If the call/cancel unit were used for a turning movement, the output would be configured to insert an unlatched demand for the appropriate phase to allow for it to be cancelled.

Note that each call/cancel unit therefore will only affect the stream in which the phase resides. No other streams will be affected.

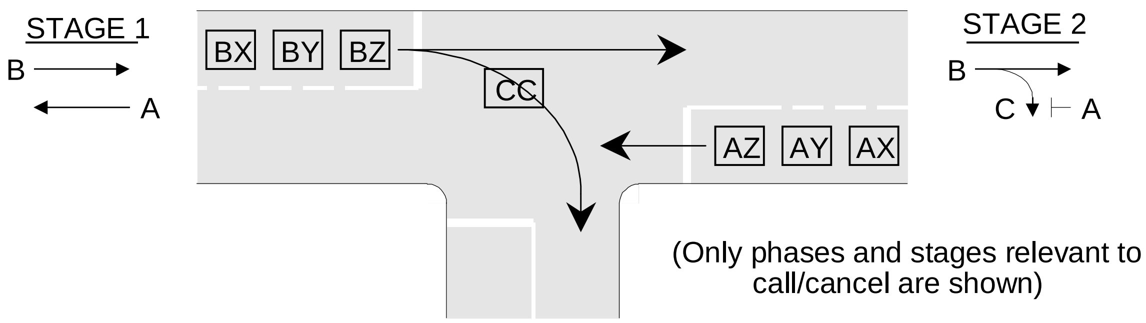


Figure 27 - Call/Cancel Example

In this situation the controller will move from stage 1 to stage 2 if there is a demand from the call/cancel loop CC for phase C and either a gap appears in the traffic on phase A or maximum green time of phase A expires. Note that vehicles on phase B do not affect this decision since phase B has right of way in both stages.

By default, both the call/cancel loop CC and vehicles on phase B would extend stage 2. However, where the maximum green time for phase B is set much longer than phase C (typically because there is little turning traffic), this could result in phase B holding stage 2 at right of way for an excess period, delaying the traffic on phase A. The controller can be configured to ignore the extensions from phase B while stage 2 is active so the controller terminates stage 2 when the call/cancel loop goes inactive or maximum green time of phase C expires. Eventually right of way returns to stage 1 allowing the traffic of both phase A and B to proceed.

A demand for stage 2 may or may not be dependent on a demand for the side road and stage 3 (not shown). If it is not, the move from stage 2 back to stage 1 must be programmed to go via the all-red stage 0 if phase C is an indicative green arrow rather than a full 3-aspect red / amber / green signal.

13.1 Modifying Call / Cancel Settings

Call / Cancel settings can be reviewed and modified using the Controller - Call / Cancel web page.

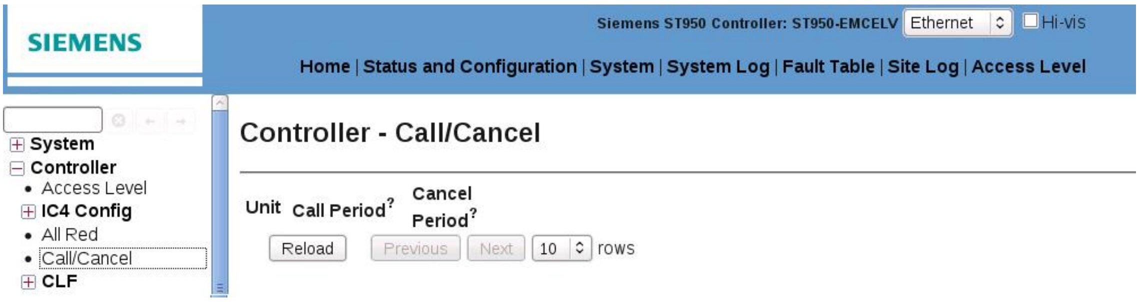


Figure 28 - Controller - Call / Cancel web page

14 HIGH SPEED VEHICLE DETECTION

To provide this facility, specially positioned vehicle loops are required. These should be connected to the Controller through the normal serial I/O cards or Intelligent Detector Backplanes.

On roads where it is required to detect high-speed vehicles to ensure safe passage through an intersection, one of two methods may be used:

- SDE (double or triple) where a fixed extension is generated.
- SA where a fixed extension is generated after a variable delay dependent on the vehicle speed.

14.1 Speed Discrimination Equipment (SDE)

Each traffic lane is provided with either one or two speed measurement points, assessors, situated further from the stop line than the normal detectors, to implement either double or triple SDE. An assessor consists of two loops (A and B) with a 12ft leading edge to leading edge spacing. The loop-loop traversal time gives a measure of the vehicle speed. A vehicle travelling over an assessor above a pre-set threshold generates a pre-set extension for the approach's phase green so it retains ROW until the vehicle reaches the normal point of detection.

14.1.1 Double SDE

This facility is used at intersections where vehicle approach speeds in excess of 35mph / 56kph and less than 45mph / 72kph are normally anticipated.

The standard assessment speed is 30mph / 48kph and the distance of the assessor is 79 metres from the stop line. A fixed extension period normally of 3.0 seconds is provided for each vehicle exceeding the threshold velocity.

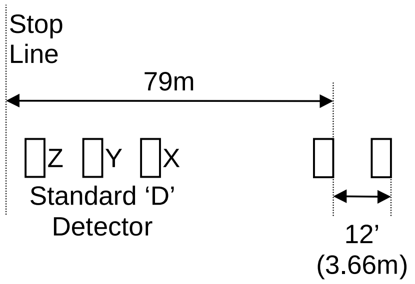


Figure 29 - Double SDE Layout

14.1.2 Triple SDE

This facility is used where vehicle approach speeds in excess of 45mph / 72kph and less than 65mph / 105kph are normally anticipated.

Two assessors are used, an outer and an inner. The outer is situated 159 metres from the stop line and the inner 91 metres. The outer assessor has a threshold velocity of 45mph / 72kph and the inner 35mph / 56kph. Each assessor provides a fixed extension period normally of 3.5 seconds for vehicles exceeding the threshold velocity.

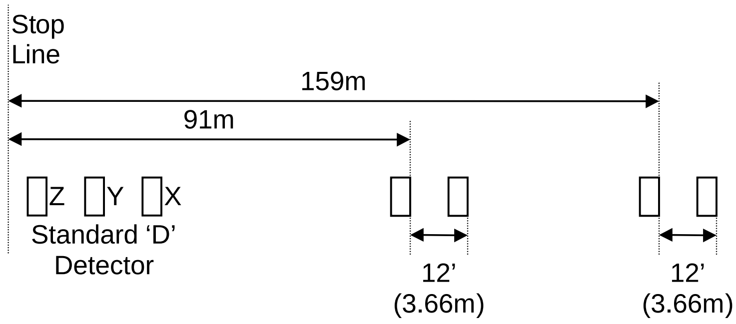


Figure 30 - Triple SDE Layout

14.2 Speed Assessment (SA)

Each traffic lane is provided with an assessor situated 151 metres from the stop line. A vehicle crossing the assessor at a speed above 28mph / 45kph generates a fixed extension of 5.0 seconds after a delay period that is dependent on the vehicle speed. The faster the vehicle speed the less the delay period is. During the delay period a normal 'gap change' can occur.

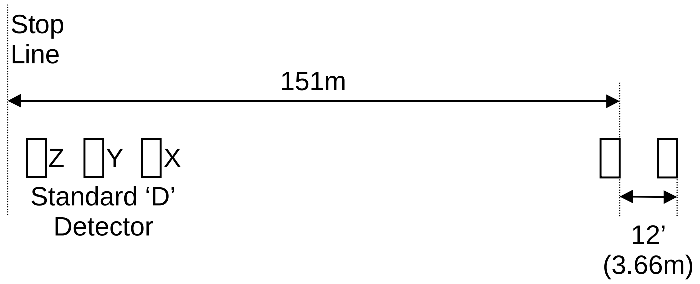


Figure 31 - SA Layout

The formula for calculating the delay period is:

- Delay = (140 / V) – 5 seconds

Where 'V' is the measured vehicle speed in metres per second

For example, the delay at 14 m/s (which is 32mph and 50kph) is 5 seconds and the delay at 20m/s (which is 45mph and 72kph) is 2 seconds. Above 28m/s (which is 62mph and 100kph) the delay period is zero.

14.3 Assessors Available

There are up to 16 assessors (0 to 15) available for use on SDE or SA.

14.4 SDE/SA Actions

14.4.1 SDE/SA Green Extensions

The SDE/SA facility provides green extensions that hold the associated phase(s) at right of way until the vehicle reaches the normal detectors.

An SDE/SA extension may be suppressed, but not the associated extra clearance, using Special Conditioning. This would be used in an early cut-off situation where the overlapped phase would not be required to be extended by its SDE/SA loops during the turning movement.

14.4.2 Extra Clearance Periods

Each intersection phase which is equipped with SDE or SA can be allocated an extra clearance period to extend the subsequent inter-green. The extra clearance period for each phase will be introduced if any of the following conditions occur:

(a) An SDE or SA extension is active for the phase during its amber leaving state.

(b) Any speed measurement detector does not detect a vehicle during the associated phase green period.

(c) Optionally any extension (speed extension, green extension or Priority extension) is active for the phase when it changes from green to amber leaving.

The condition in (c) is not normally enabled at the time of configuration, but note that speed extensions will still request extra clearance because of the operation of condition (a).

An extra clearance period will be given under any mode of control, i.e. manual, VA, fixed time, CLF, UTC, vehicle priority or hurry call. Its effect is to increase all the inter-green timings from the phase that is being given the extra clearance, and also to increase the phase change delay times for gaining phases.

This latter increase is computed as the largest of the extra clearance times currently applied for that stage to stage move.

Phase change delay times for individual gaining phases may be configured so that they are not increased when a specific phase is requesting an extra inter-green due to SDE/SA.

The range of the timing period for the extra-clearance is 0 to 50 seconds in 1-second steps for each SDE/SA phase. The programmed value may be changed via the handset using the SCT command.

Note that if the inter-green is not dependent on the SDE/SA phase inter-green time (because another losing phase has a longer inter-green time), the extra clearance period may not actually delay the appearance of the gaining phase.

Also note that the inter-green from the vehicle phase to the pedestrian phase on a stand-alone pedestrian stream is fixed at three seconds of all red if the SDE/SA is configured, regardless of the PAR value. The ‘extra clearance period’ above is not required.

14.5 SDE/SA Parallel Stage Streaming Facilities

If a phase with SDE/SA is requesting extra clearance and so increasing the time in its associated inter-green timer, it is possible to specify in the configuration data, which delay timers (for phases gaining ROW) are to also be increased. In this way it is possible to specify delay timers just for the phases appearing in a particular stream, whilst not increasing those in other streams.

14.6 SDE/SA on Green Arrows

If SDE/SA is required on a green arrow phase, the phase should actually be configured as a normal 3-aspect traffic signal (with only the green aspect connected to lamps) so that the amber period described in (a) in section 14.4.2 is provided.

If red lamp monitoring is also required, it would normally register a fault if no red lamps are fitted on a phase. In this case, the sensor monitoring this green arrow phase should be explicitly changed from monitoring a normal traffic red, amber, green phase to monitor a green arrow.

This should be achieved by creating a new lamp sequence based on the traffic sequence but modified to change the sequence type from ‘vehicle’ to ‘green arrow' and the lamp monitored states from 'red, amber, green' to 'green only’.

14.7 Common Approach Lanes

Where an assessor is associated with a number of phases, all the phases that require speed extensions and extra clearance periods can be driven from that assessor. If this is required, the termination of the phases should not be staggered.

14.8 Other Loop Spacing

12ft-loop spacing is the default, but the SDE/SA facility can be configured to operate with 10ft-loop spacing. Note that all SDE/SA loops on the site must be 10ft-loop spacing. However, it is recommended that all the loops are re-cut for 12ft-loop spacing and the controller configured for 12ft operation.

14.9 Monitoring SDE & SA

SDE and SA operation can be reviewed through the SDE / SA web pages.

14.9.1 Controller - SDE / SA - Assessors Web Page

The counts and speed detected by the assessors can be monitored through this web page.

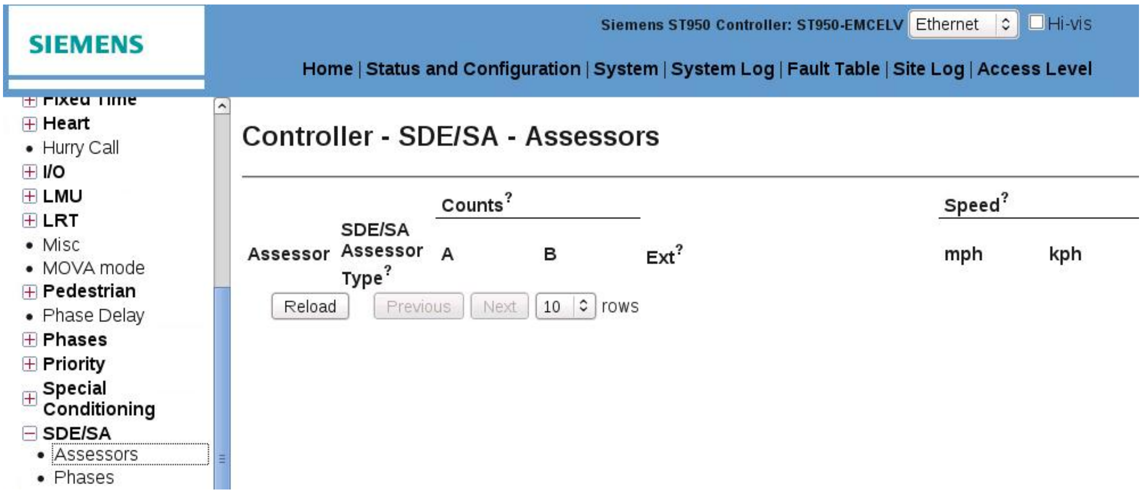


Figure 32 - Controller - SDE / SA - Assessors web page

14.9.2 Controller - SDE / SA - Phases Web Page

The current influence of SDE / SA on the controller can be monitored using this page.

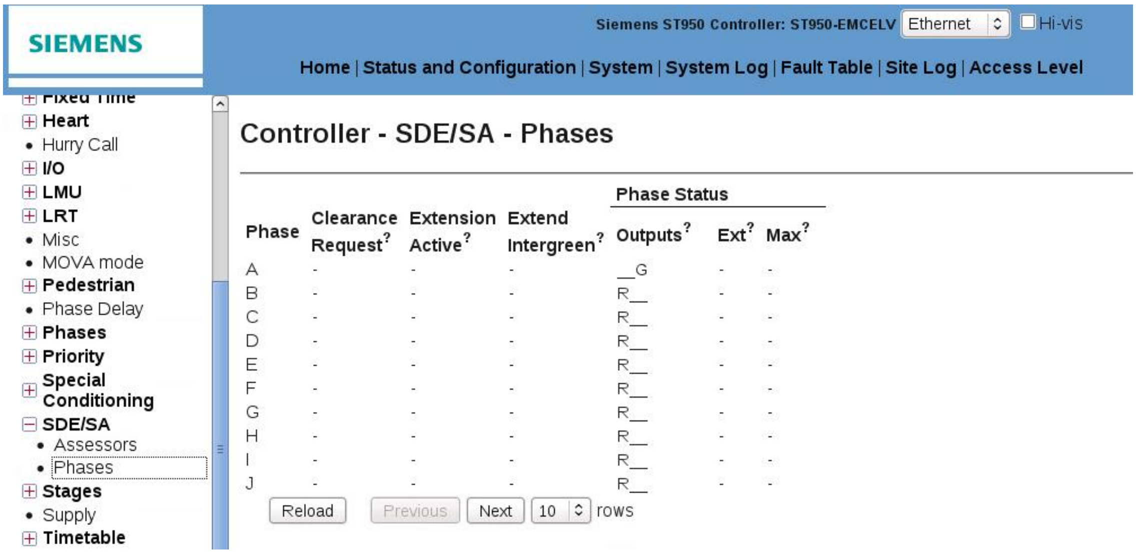


Figure 33 - Controller - SDE / SA - Phases web page

15 ALL-RED DISPLAYS

There are four methods of achieving an all-red display or extending the intergreen between specific phases:

- By using an 'all-red' stage.
- By using the 'extend all-red' facility.
- By using the 'intergreen delay' facility
- By using 'on-crossing detectors' on a near side pedestrian phase.

An All-Red Stage is a stage during which all signal phases are 'at no right of way' and thus display their red signal aspects. This is covered in section 15.1.

The 'extend all-red' facility can extend the all-red condition between conflicting phases in certain stage to stage transitions up to a pre-determined maximum. This is covered in section 15.2.

The 'intergreen delay' facility can extend the intergreen between one phase losing right-of-way and a specified list of phases gaining right-of-way. In the IC4 Configurator, the list of gaining phases defaults to those phases that conflict with the phase losing right-of-way. This is facility works independently of stage movements and does not affect any other phases losing or gaining right-of-way. The Intergreen Delay section of the controller documentation includes more information.

'On-crossing detectors' can be configured to extend the clearance period to all conflicting vehicle phases while pedestrians continue to cross. The Phases section of the controller documentation includes more information on on-crossing detectors and the pedestrian clearance periods.

15.1 All-Red Stage

The All-Red Stage can be called automatically and used to provide a 'buffer stage' between conflicting phases, e.g. as shuttle working on bridges or on moves from an indicative green arrow turning movement back to the main movement.

The All-Red Stage can have a minimum period that can be extended by the relevant detectors up to a maximum period. This is achieved by allocating a dummy phase to the stage to provide a minimum green, green extension and maximum green. But note that during modes other than Vehicle Actuated, All-Red Stages will not normally be extended, they will just be displayed for the minimum period, unless special conditioning is used.

Caution: if Stage 0 is as the alternative move for changes to stages other than Stage 1, problems can arise since the controller will decide on stage changes cyclically and thus naturally consider demands for stage 1, stage 2, etc, in order, regardless of which stage started the move.

However, any of the stages available, including Stage 0, can be considered as an All-Red Stage. Thus for shuttle working on bridges for example, stages 1 and 3 would provide the two traffic flows and stages 0 and 2 would provide the 'buffer' All-Red Stages.

15.2 Red Extension During Interstage

15.2.1 Description

The occupation of an All Red detector loop during its specified stage to stage movement will generate an All Red extension.

(N.B. As the extend all red signals are available in special conditioning, the extend all red period may be introduced due to special conditions when required.)

The extension will continue all the while the loop is occupied. When the loop is cleared the extension will continue for a fixed period - the All Red Extension period.

When the first phase in the stage that is about to go to green reaches the start of its red-green transition period, all inter-green times concerned with the interstage will be 'held', i.e. frozen, until either the All Red Extension period or the All Red Maximum period terminates. Hence the facility is also known as the 'hold inter-green' facility.

The all-red extensions also 'hold' gaining phase delays.

During all modes, except Fixed Time Mode, the red extension and maximum red period can operate as normal or, if required, the extended red period can be automatically extended up to the maximum red value.

During Fixed Time Mode, the controller automatically extends the red period up to the maximum red value for safety reasons.

There are 7 facilities (units 1 to 7) available for different sets of all-red detectors. If one set were to be used for several stage to stage transitions, this would only require one facility.

Tip! If the intergreen between one phase losing right of way and one or more phases gaining ROW is to be extended and it is required that this not affect any other phases in the stage movement, consider using the Intergreen Delay facility instead of the Extend All Red facility.

15.2.2 Independent Inter-greens

In some circumstances, when a normal Extend All Red (Hold Inter-green) is applied to an intersection, some phases are not involved in the conflict and so whose appearance does not need to be delayed.

In order to cater for this requirement, the Independent Inter-green Facility exists. It is possible to specify at configuration, for each terminating phase, the inter-greens to the gaining phases that are not required to be held by the Extend All Red facility.

Care must be taken when using/testing independent inter-greens since the Extend All Red facility terminates when the gaining stage comes to fruition (i.e. when all fixed phases are at right of way) since the controller is no longer in an interstage.

Therefore problems may arise when the inter-greens to all fixed phases are configured as independent and it is the inter-green to one or more non-fixed phases which are to be delayed by the All Red Extensions.

All the fixed phases will gain right of way after their normal inter-greens have expired and the gaining stage will come to fruition regardless of the Extend All Red facility.

However, since the controller is no longer in an interstage, the extend all red facility could be terminated prematurely, i.e. while All Red Extensions are still active.

If the Extend All Red facility is required to only delay the appearance of non-fixed phases and not any fixed phases, a dummy fixed phase should be configured in the stage which is delayed by the Extend All Red facility. This then prevents the stage from coming to fruition until this dummy phase also reaches right of way.

15.2.3 Extend All Red (Hold I/G) Parallel Stage Streaming Facilities

There is an ‘Extend All Red’ facility available on each stream. There is a separate All Red Extension time and All Red Maximum time for each stream.

The ‘Extend All Red’ facility monitors all of the phases in the stream gaining right of way during the stage to stage movement. It waits until of these first phases reaches the start of its red to green transition period. If the extend all red input is active, the inter-green and phase delay times concerned with the inter-green are then held until the All Red extension period terminates or the All Red Maximum time is reached.

15.2.4 Extend All Red Timings

One All Red Extension (REX) value is provided for all stage to stage transitions on a stream. There is one value for each stream. The values are in the range 0.0 to 31.8 seconds in 0.2-second steps.

One All Red Maximum (RMX) value is provided for all stage to stage transitions on a stream. There is one value for each stream. The values are in the range 0 to 255 seconds in 1-second steps.

The programmed value may be changed via the handset using the commands in brackets.

If alternative extension or maximum red periods are required for different red periods within the same stream, this can be achieved by the use of separate All-Red stages. However care should be taken to ensure that any all-red extensions operate as required during different modes, see section 15.1.

15.2.5 Modifying All Red

The configuration of the Extend All Red facility can be reviewed and modified using the Controller - All Red web page.

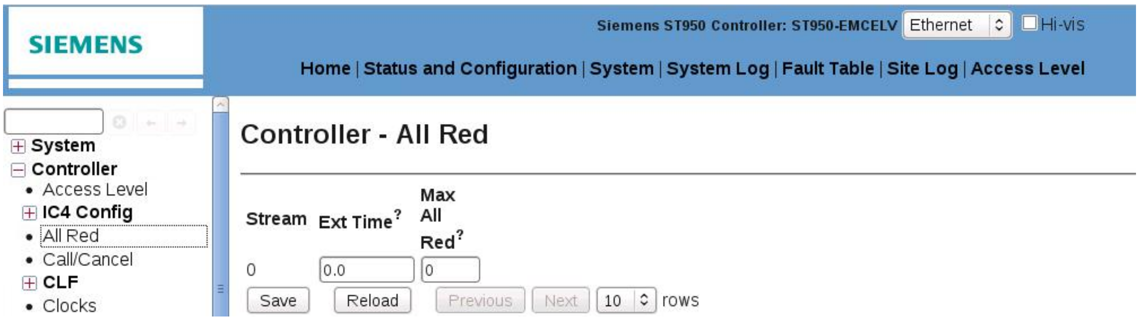


Figure 34 - Controller - All Red web page

16 PHASE DELAYS

16.1 General Description

In order to gain more efficient use of phases during stage to stage transitions, it may be required to delay specific phases from losing or gaining ROW.

There are up to 120 phase delay times (0 to 119) available for different phases on different stage to stage transitions.

The timing range is 0 to 255 seconds in 1-second steps.

Special conditioning can disable and enable individual phase delays and thus is able to change the delay time (by time of day for example) by only enabling one of several phase delays configured for the same phase on the same stage to stage transition.

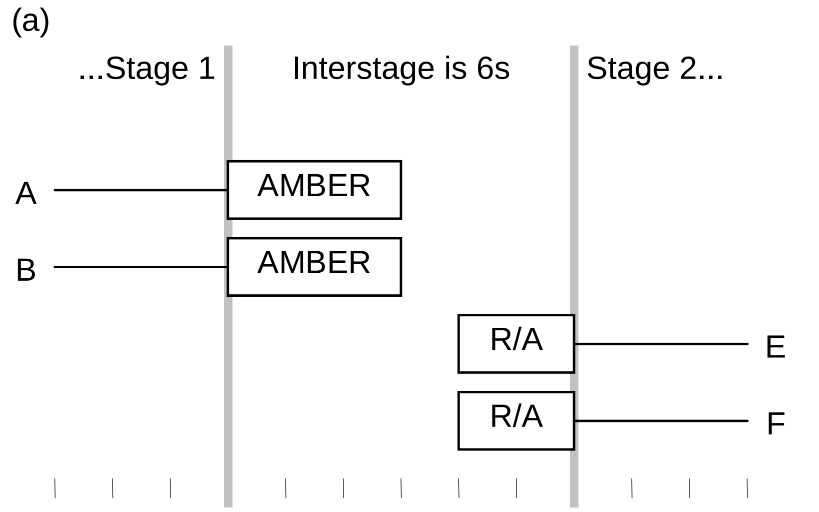
16.2 Phases Losing Right-Of-Way

A phase may be delayed from losing ROW on a specific stage to stage transition to obtain a clearance period.

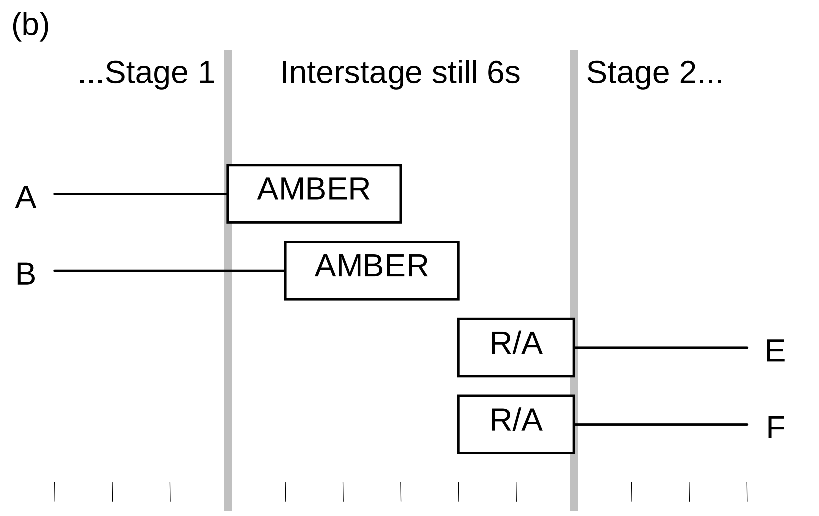
The delayed phase is held at green during the interstage for the period of the delay time, while non-delayed phases that do not appear in the next stage terminate. Any inter-green periods from the delayed phase to conflicting phases will not commence to time until the phase delay period has expired, even though other inter-green timers from phases already terminated will have started and possibly terminated.

Therefore any phases gaining right of way may have their appearance delayed as a result of the difference in inter-green times, unless the inter-green times from the delayed phase are shorter.

In Figure 35 the appearance of phases E and F is controlled by the 6-second inter-greens from phase A. The shorter inter-greens from phase B mean that phase B can remain at right of way for an extra second without affecting the appearance of phases E and F.



Intergreen from Phase A to Phases E and F is 6 seconds.
Intergreen from Phase B to Phases E and F is 5 seconds.



Phase B is delayed by 1 second.
Intergreen from Phase A to Phases E and F is 6 seconds.
Intergreen from Phase B to Phases E and F is 5 seconds.

Figure 35 - Delay Phase Losing Right of Way

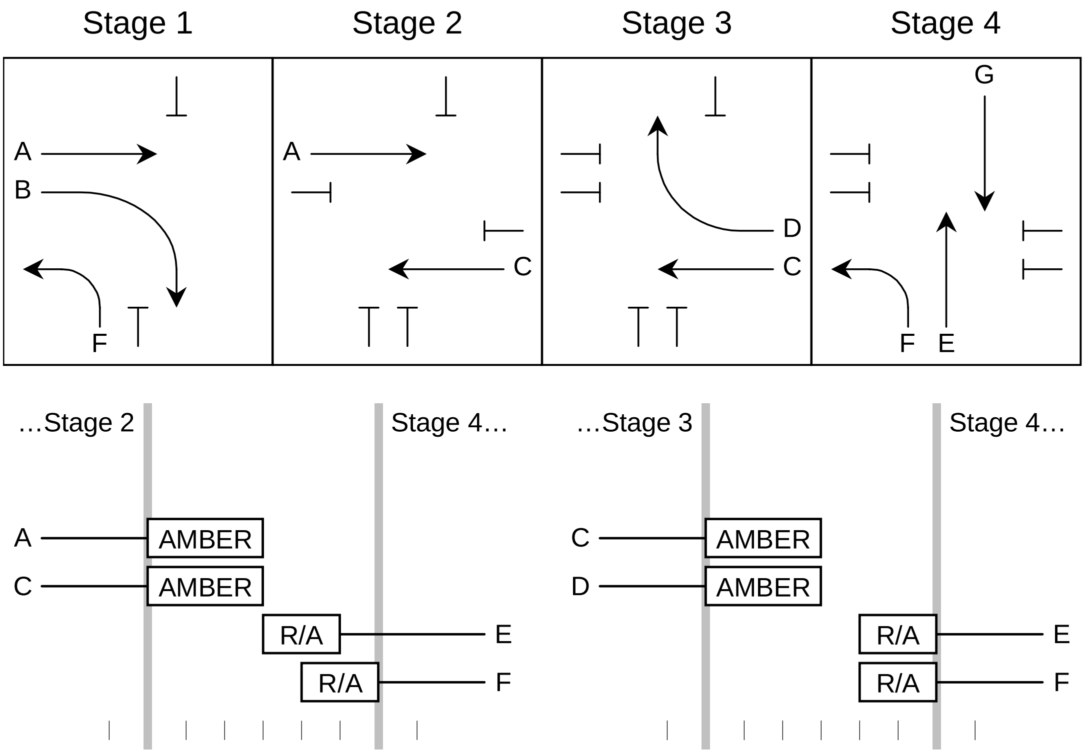
16.3 Phases Gaining Right-Of-Way

The inter-green times from conflicting phases determines at which point a phase gains ROW. If phases gaining ROW have different inter-green times from a conflicting phase, they will gain ROW at different points. The time differences will be the same every time the phase to phase transition occurs regardless of the stage to stage transition.

However, if it is required that a certain phase appears at ROW later than its inter-greens would allow on a certain stage to stage transition, a 'gaining phase delay' can be configured to delay the appearance of the phase.

For example, it may be required that two or more phases appear at ROW at the same instant on a certain stage to stage transition, but the inter-greens to those phases would allow one phase to appear before the other.

Consider the 4-stage intersection below:



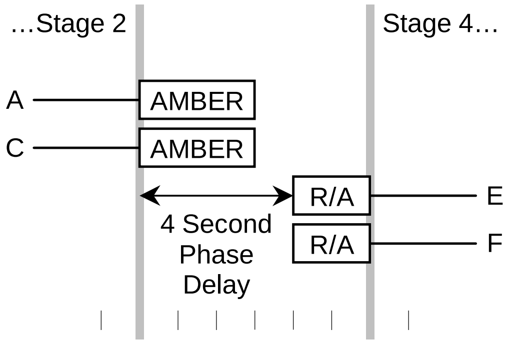
Intergreen between phases A to E = 5s
Intergreen between phases C to E = 5s
Intergreen between phases C to F = 6s

Intergreen between phases C to E = 5s
Intergreen between phases C to F = 6s
Intergreen between phases D to E = 6s

Figure 36 - Delay Phase Gaining Right Of Way

The shorter inter-greens from phases A and C to E mean that on the move directly from stage 2 to stage 4, phase E appears one second before phase F.

While on the move from stage 3 to stage 4, the 6 second inter-green from phase D to phase E forces phase E to appear at the same time as phase F.



If phases E and F are required to always appear at red/amber and then green together, a gaining phase delay can be used to delay the appearance of phase E.

If phase E is delayed by 4 seconds on the move from stage 2 to stage 4, phases E and F would appear at the same time.

16.4 Delay Timer

Whether a phase is losing or gaining ROW, the delay timer starts when the leaving stage terminates.

If a phase losing ROW is delayed, it will be prevented from terminating (i.e. held at green) for the delay period.

If a phase gaining ROW is delayed, it will be prevented from gaining ROW and thus held at red (or blackout for green arrow phases) for the delay period. In this case the delay time must include the longest inter-green time to the phase on this transition plus the actual delay required. In the case of a traffic phase the red/amber time (i.e. 2 seconds) should be subtracted from the total sum.

In the example in above, it was required to delay phase E by just one second. Therefore, the required gain phase delay period would be:

Inter-green from C to E:		5
Plus the required delay:	+	1
Less the red/amber time:	–	2
Gives the delay period:	=	4

Note: If phase E did not include a red/amber period, e.g. it was a non UK vehicle, green arrow or pedestrian phase, the required gain phase delay period would be:

Inter-green from C to E:		5
Plus the required delay:	+	1
(No red/amber time):	–	0
Gives the delay period:	=	6

16.5 Effect of Red Extensions and SDE/SA

During the All Red Extension period or the SDE/SA extra clearance period, delay timings for phases gaining ROW are suspended and the delays will occur unchanged at the end of the extension / extra period.

However, it is possible to configure delay times for individual gaining phases such that they will not be suspended during an extra clearance requested by SDE/SA.

16.6 Monitoring and Modifying

The configuration of the phase delays can be reviewed and changed using web pages or handset commands.

16.6.1 Controller - Phase Delay Web Page

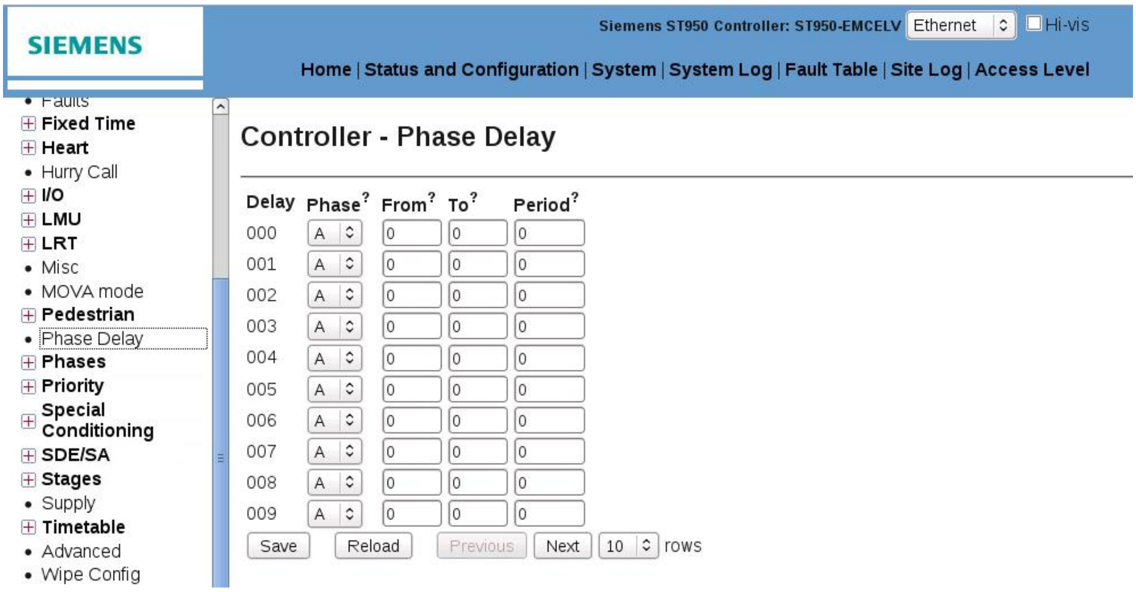


Figure 37 - Controller - Phase Delay web page

16.6.2 Phase Delay Handset Commands

There are four handset commands that can be used to specify phase delays or modify information previously entered in the configuration.

Up to 120 entries can be made to specify the phase to be delayed (DFZ), how many seconds it is delayed by (DPG), and on the move from which stage (DMF) to which stage (DMT).

For example, if the entries 0 to 9 were already allocated and we needed to set-up another phase delay which delays phase E for 4 seconds on the move from stage 2 to stage 4, we would enter:

DFZ 10=E
DPG 10=4
DMF 10=2
DMT 10=4

17 INTERGREEN DELAYS

17.1 Introduction

An Intergreen Delay allows the intergreen between a phase losing right of way (ROW) and one or more phases gaining ROW to be extended. Other facilities (e.g. RLM) may still prevent a phase from gaining ROW even though the Intergreen Delay facility may allow it to gain ROW.

The facility provides for 64 Intergreen Delays.

An Intergreen Delay is characterised by the following configuration items:

- A single phase which enables the Intergreen Delay when it loses ROW
- One or more phases which are delayed if they are gaining ROW when the Intergreen Delay is enabled
- A input which whilst active ensures the gaining ROW phases are delayed; this can be a detector input or a scratch bit output from Special Conditioning.
- A maximum intergreen period (MIP) which terminates the Intergreen Delay when it expires

While the input or the input's extension are active, the appearance of the specified phases gaining ROW is delayed until either the input and its extension go inactive or the maximum intergreen period is reached. The phases then gain ROW. If the configured intergreen times between the phases request an offset or staggered appearance, this is maintained and this also takes Phase Delays in to account.

Intergreen Delays are configured using the IC4 Configurator. The MIP can also be subsequently modified via the handset or web page.

The configured Intergreen Delays can be viewed on the Controller – Phases – Intergreen Delays web page. The “Controller – Phases – Status” Web page indicates whether a given phase is prevented from gaining ROW by an Intergreen Delay.

17.1.1 Comparison with the Extend All Red Facility

Both Intergreen Delay and Extend All Red facilities use inputs to delay the appearance of phases during a stage movement.

An Intergreen Delay extends the intergreen to the specified gaining ROW phases and is limited by the MIP. Naturally it does not affect any other phases and nor does it depend on the stage movement. The Maximum Intergreen Period is timed from the start of the intergreen period, i.e. from when the phase loses right of way.

An Extend All Red extends the all red period of a stage movement and is limited by the maximum all red period. Normally the Extend All Red facility affects multiple phases to extend the whole 'all red' period of the interstage movement. The maximum all-red period is timed from the point the all-red extension begins to delay the appearance of the phases.

17.1.2 Possible Uses for Intergreen Delays

Possible uses for Intergreen Delays are:

Turning Traffic – Vehicles turning across the intersection may be delayed by vehicles travelling in the opposite direction (e.g. right turning traffic when driving on the left). If these vehicles are not given their own indicative green arrow when that opposing traffic is stopped, these vehicles have to complete their turn several seconds after their phase has moved to no right of way. There may be a queue of vehicles on the intersection waiting to turn that have already passed their stop-line. Detectors placed near the centre of the intersection can be used to extend the intergreen to the phases that conflict with the queued turning traffic.

Single File Traffic – An example would be a narrow bridge where vehicles can only proceed in 'single file' and the opposing traffic must be stopped (see section 17.3 on page 121). Detectors on the bridge determine whether traffic is still crossing after the phase has been terminated, and these delay the appearance of the opposing phase. Both sets of traffic signals remain at red until all the vehicles have cleared the bridge (or the max period expires).

Long or Slow Vehicles – If any vehicles regularly occupy the intersection for a significant period, e.g. trams, it may be required to delay when opposing phases are given right of way. Indeed, the LRT facility makes use of the Intergreen Delay facility to provide the intergreen extensions between the LRT Phase terminating when the front of the tram passes the stop line and the conflicting phases gaining ROW. Refer to the LRT documentation for more information.

17.1.3 Fault Conditions

Intergreen Delays can optionally be "forced to maximum". That is, the state of the associated input is ignored and the Intergreen Delay is allowed to run to the MIP. This can be associated with a given mode (e.g. Fixed Time, VA) or with a user specified condition implemented via Special Conditioning.

It is recommended that the input associated with an Intergreen Delay is configured to be forced active when a DFM failure is detected. This forces the Intergreen Delay to run to the MIP when a DFM failure for the input is confirmed.

17.1.4 Phase Start Offsets

Phase Start Offsets can also be referred to as a phase appearance stagger. Two phases gaining right of way in the same stage may not move to right of way (green) at exactly the same time. Instead, there could be an offset or stagger between their appearance.

The offset is determined by different intergreen times and Phase Delays between the phase leaving right of way and those phases gaining right of way.

These offsets may be required because of the physical location of the phases at the intersection. For example, the intergreen times between a vehicle phase leaving ROW and two pedestrian crossings gaining ROW may be set differently because one ped crossing is immediately after the stop line while the other is on the opposite side of the intersection (where the vehicles exit the intersection) and needs a longer intergreen time.

Three options for Phase Start Offsets are available with Intergreen Delays.

Excluded – In the example given of two pedestrian phases, it is unlikely that the ped crossing immediately after the stop line needs to be delayed by the Intergreen Delay. In this case, only the ped phase on the opposite side of the intersection is included in the configuration of the Intergreen Delay, and only that phase is delayed by the detector.

Linked – If the Phase Start Offsets between phases are to be maintained, those gaining phases shall be configured in the same Intergreen Delay. When an Intergreen Delay completes, the offsets will be maintained to all phases gaining right of way specified in the configuration data for that delay. These offset are controlled by the relative values of the intergreen periods configured between the phase leaving right of way and those phases gaining right of way, taking Phase Delays in to account as well.

Unlinked – If Phase Start Offsets do not need to be maintained, configure different Intergreen Delays. Each of those Intergreen Delays can, if required, be configured to use the same detector input. When the Intergreen Delays complete, the phases gaining right of way will move to right of way immediately, subject of course to any other inter-stage facilities.

17.1.5 Interaction with other facilities

An Intergreen Delay has to work in partnership with other facilities configured in the traffic controller.

In general, an Intergreen Delay runs concurrently (in parallel) with alterations to the inter-stage made by other facilities. Thus:

- If the Intergreen Delay input is inactive, it has no effect on the inter-stage.
- If the Intergreen Delay input is active and extends the inter-stage considerably, only the Intergreen Delay remains to control the appearance of the phases, and it is controlled only by its input and maximum period.
- If the Intergreen Delay extends the intergreen periods by just a few seconds, other facilities may still delay the appearance of the phases. For example, a three second Red Lamp Monitor time will take precedence over a shorter Intergreen Delay.

If certain phase start offsets (staggered phase appearance) are important, each facility must be configured independently to correctly ensure these offsets are maintained by that facility. Any interaction between a correctly configured facility and Intergreen Delays still maintains the phase start offsets.

Interaction with other facilities:

SDE/SA Clearance (SCT) – Extensions to the intergreen due to high-speed vehicles run concurrently with Intergreen Delays.

Red Lamp Monitor Time (RLT) – Extensions to the intergreens due to red lamp failures run concurrently with Intergreen Delays.

Pedestrian Clearance Periods (PBT/CMX) – Pedestrian Clearance Periods run concurrently with Intergreen Delays. Although it is unlikely that the specified phase leaving right of way is configured with a pedestrian clearance period and an Intergreen Delay, other phases leaving right of way may be configured to also delay the same phases gaining right of way as an Intergreen Delay. A phase gaining right of way will only be allowed to appear when both the Pedestrian Clearance Periods and Intergreen Delays have expired, with those periods running concurrently.

Extend All-Red – Extensions to the intergreens due to the Extend All-Red facility run concurrently with Intergreen Delays. It is possible to have both Extend All-Red and Intergreen Delays affect the same inter-stage period, although in practice this will probably never be required.

All-Red Stage – An Intergreen Delay is primed whenever the specified phase leaves right of way and remains active until the Maximum Intergreen Period expires or one of the phases gains right of way. Therefore, an Intergreen Delay will extend the intergreen period between the specified phases even if the signals move via an All-Red stage.

Ripple Change – An Intergreen Delay is primed whenever the specified phase leaves right of way and remains active until the Maximum Intergreen Period expires or one of the phases gains right of way. Therefore, an Intergreen Delay will extend the intergreen period between the specified phases regardless of the order and timing of the stage changes.

Leaving Phase Delay (Direct) – A Phase Delay that delays when the losing phase terminates will naturally also delay the Intergreen Delay; the Intergreen Delay is enabled when the phase loses right of way, not when the stage terminates.

Leaving Phase Delay (Indirect) – A Phase Delay that delays one of the other phases that loses right of way runs in parallel with the Intergreen Delay. The configured intergreen periods from that phase to those phases gaining right of way that are also controlled by the Intergreen Delay run in parallel; those phases can only gain right of way when the configured intergreen times and Intergreen Delay expire.

Gaining Phase Delay (Direct) – A Phase Delay could be configured to delay the appearance of a phase gaining right of way that also needs to be configured with an Intergreen Delay. In this case, both periods run independently and in parallel; that phase can only gain right of way when the Phase Delay and Intergreen Delay expire. However, when the Intergreen Delay expires, the configured duration of Phase Delay is taken in to account with the configured intergreen times and is used to replicate the required phase start offsets (staggered phase appearance).

Gaining Phase Delay (Indirect) – A Phase Delay can be used to control the appearance of the phases gaining right of way, so for example two phases gain right of way at the same time. If only one of those phases needs the Intergreen Delay, e.g. only that phase conflicts with the turning traffic, the Intergreen Delay can if required be configured to also delay the other phase so the two phases gain right way together. When the Intergreen Delay expires, the configured duration of Phase Delay is taken in to account with the configured intergreen times and is used to replicate the required phase start offsets (staggered phase appearance). If it is not required that the phases appear together, then the phase that does not need an Intergreen Delay would be excluded and will therefore gain right of way at the usual time.

Special Conditioning – Special Conditioning has complete control over an Intergreen Delay when a scratch bit is used as the input, with the restriction that it cannot override the Maximum Intergreen Period. Mnemonics also allow Special Conditioning to read the status of an Intergreen Delay, e.g. delay enabled / disabled.

17.2 Detailed Intergreen Delay Operation

The operation of the Intergreen Delay facility is best described via the use of specific examples. The examples are contrived and do not necessarily reflect real world scenarios but illustrate the operation of the facility.

Example	Description
1	Overview of a normal stage movement with no Intergreen Delay applied.
2	Intergreen Delay applied and detector input never activates.
3	Intergreen Delay applied and detector input activates for the duration of the MIP.
4	Intergreen Delay applied and detector input activates for an initial period of the MIP which exceeds the time to the first RAT of all gaining ROW phases under a normal stage movement.
5	Intergreen Delay applied and detector input toggles state for an initial period of the MIP which does not exceed the time to the first RAT of all gaining ROW phases under a normal stage movement.
6	As for example 3 with an RLM fault detected whilst the Intergreen Delay is enabled.
7	As for example 4 with an RLM fault detected after the Intergreen Delay is disabled.
8	As for example 3 with multiple Intergreen Delays and a common gaining ROW phase.
9	As for example 4 with a non-conflicting gaining ROW phase already at ROW.
10	As for example 4 with a non-conflicting gaining ROW phase already not at ROW.
11	As for example 3 with a phase delay applied to the losing ROW phase.
12	As for example 3 with a phase delay applied to a gaining ROW phase.

The examples refer to a quantity called the “Adjusted MIP”. This value is derived from the configured MIP, the intergreens and gaining ROW phase delays associated with the phases gaining ROW. The value is the maximum time for which the Intergreen Delay is enabled so that the first of the gaining ROW phases can gain ROW with the required delay applied.

The facility uses several rules when deciding if an Intergreen Delay is enabled or disabled.

Rule 1

An Intergreen Delay is enabled when the associated losing ROW phase starts losing ROW.

Rule 2

An Intergreen Delay is disabled when the associated detector input is inactive at the point when the earliest RAT for all phases gaining ROW would have started or is in progress or already completed under a normal stage movement.

Rule 3

An Intergreen Delay is disabled when the Adjusted MIP for the Intergreen Delay expires.

Rule 4

If an Intergreen Delay satisfies Rule 2 or Rule 3 and another Intergreen Delay is actively delaying a phase which is common to both Intergreen Delays, then the Intergreen Delay remains enabled.

While the Intergreen Delay is enabled and the detector input is active, the phases are prevented from gaining ROW.

If the losing ROW phase associated with an Intergreen Delay has a losing phase delay then the Intergreen Delay is effectively postponed until the phase delay has expired i.e. the phase actually starts losing ROW.

Stagger is defined as the time between any two gaining ROW phases actually gaining ROW.

When an Intergreen Delay is applied, the stagger is maintained whenever possible. Sometimes this is not possible in cases involving RLM delays, common gaining ROW phases and non-conflicting phases.

17.2.1 Example 1

The following figure presents a basic stage movement where no Intergreen Delay has been configured on phase A (the phase losing ROW). Phases B and C are the phases gaining ROW in the stage movement. The lamp sequence entities LAT (amber leaving time), RAT (red amber time) and intergreen time are annotated for clarity.

In this example there is a 5 second stagger between phases B and C gaining ROW.

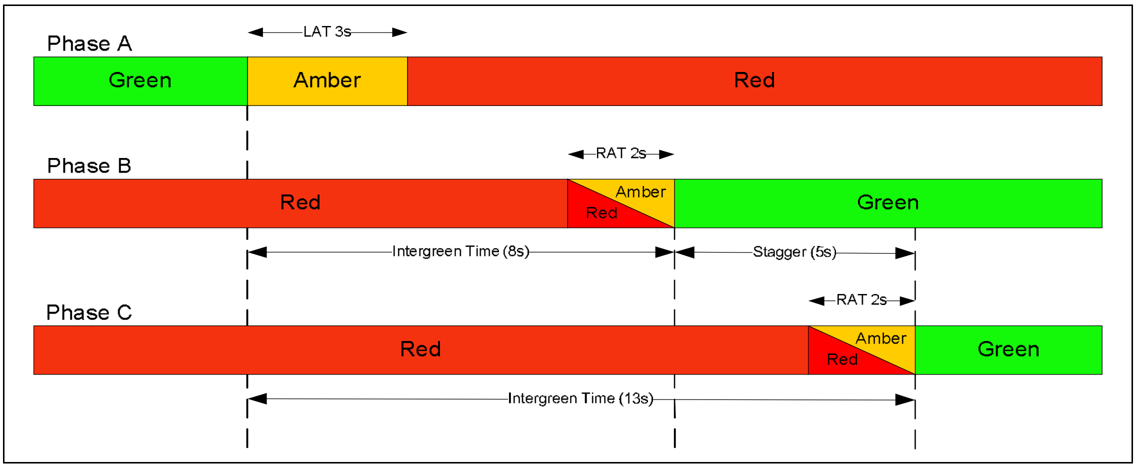
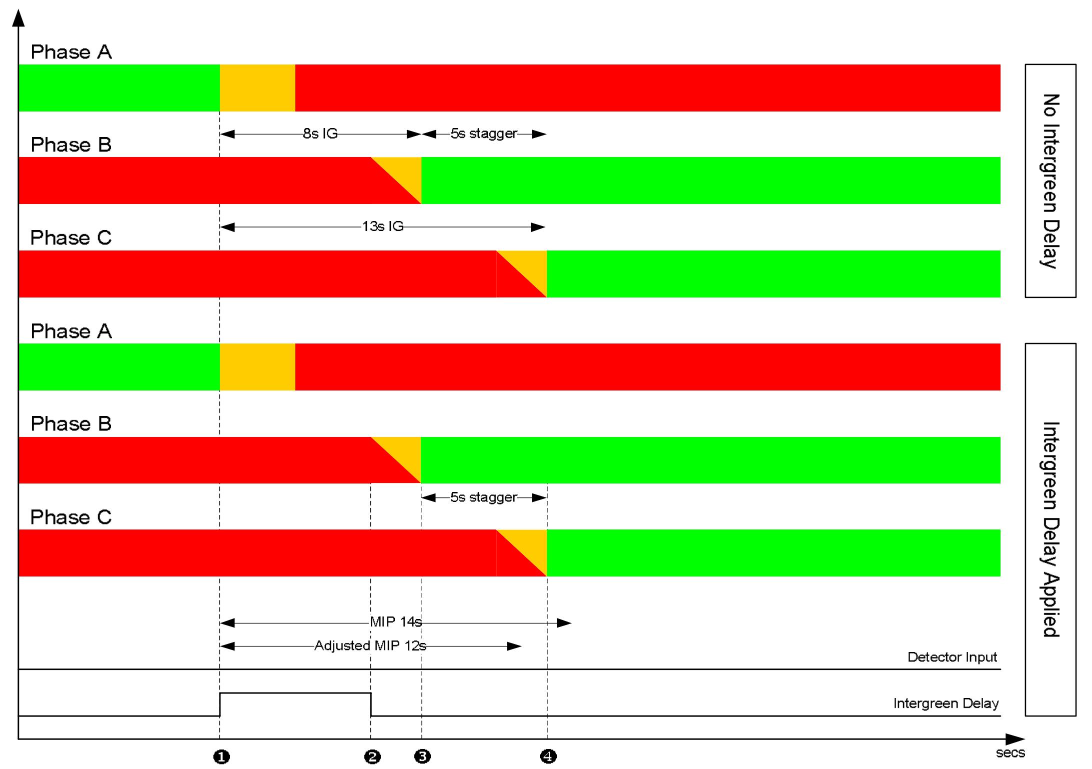


Figure 38 Overview of a normal stage movement with no Intergreen Delay applied.

17.2.2 Example 2

There is an Intergreen Delay associated with phase A losing ROW. Phases B and C are the phases gaining ROW in the stage movement.

No activation of the associated detector input is identified during the stage movement. Accordingly the Intergreen Delay is disabled (Rule 2) and the phases gaining ROW do so in accordance with their normal intergreen times. The 5 seconds stagger between phases B and C gaining ROW is maintained.



❶ Phase A loses RoW.
❷ The detector input is inactive. The RAT for phase B would have started for a normal stage movement, so the Intergreen Delay is disabled.
❸ Phase B gains RoW.
❹ Phase C gains RoW.

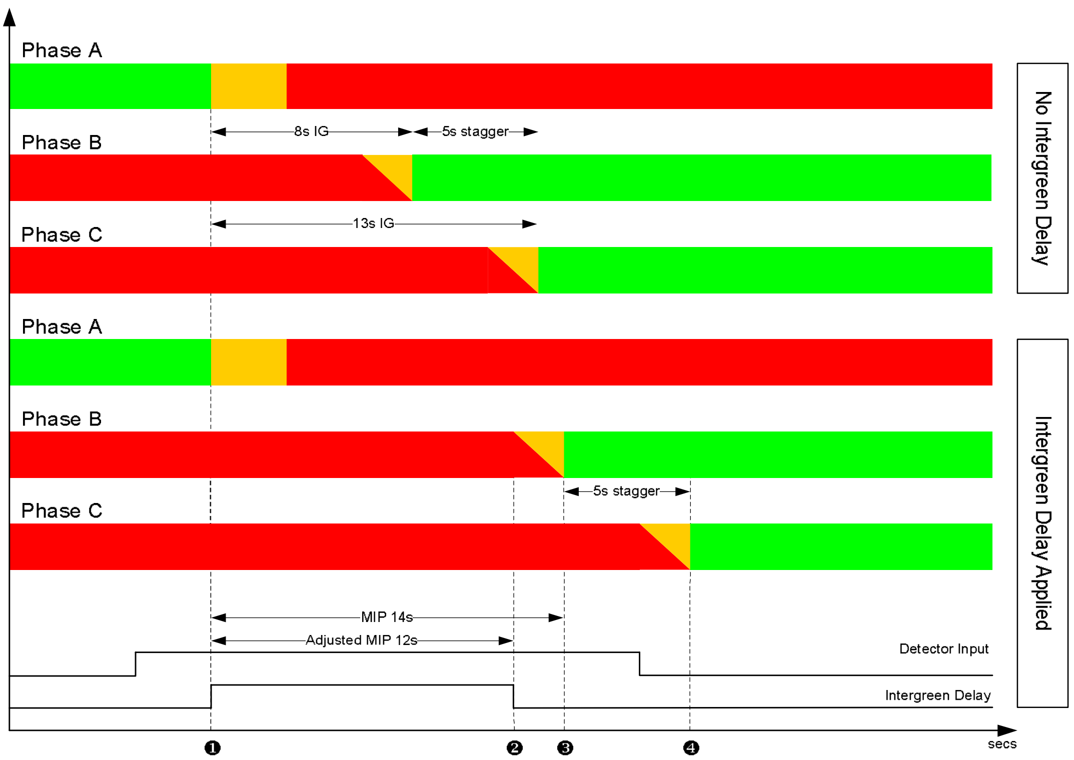
Figure 39 Intergreen Delay applied and detector input never activates, with the result that there is no change to the appearance of the phases.

17.2.3 Example 3

There is an Intergreen Delay associated with phase A losing ROW. Phases B and C are the phases gaining ROW in the stage movement.

The associated detector input is active for at least the duration (12 seconds) of the Intergreen Delay. When the Intergreen Delay is disabled (Rule 3), the phases gaining ROW do so in accordance with the their normal intergreen times. The 5 seconds stagger between phases B and C gaining ROW is maintained.

The phases gaining ROW have been delayed by a total of 6 seconds.



❶ Phase A loses RoW.
❷ The adjusted MIP expires so the Intergreen Delay is disabled. The RAT for phase B is started.
❸ Phase B gains RoW.
❹ Phase C gains RoW.

Figure 40 Intergreen Delay applied and detector input activates for the duration of the MIP.

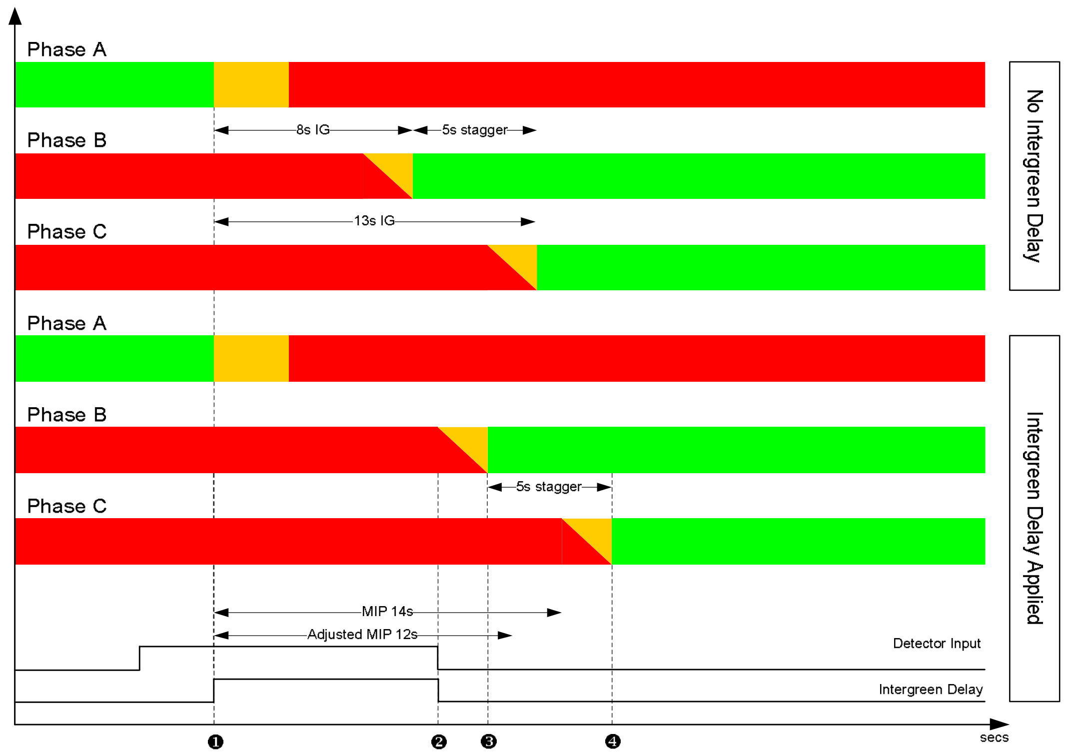
17.2.4 Example 4

There is an Intergreen Delay associated with phase A losing ROW. Phases B and C are the phases gaining ROW in the stage movement.

The associated detector input is active for an initial period (9 seconds) of the duration of the Intergreen Delay (12 seconds). When the detector input deactivates, the Intergreen Delay is disabled (Rule 1).

At this time, the phases gaining ROW do so in accordance with their normal intergreen times. The 5 seconds stagger between phases B and C gaining ROW is maintained.

The phases gaining ROW have been delayed by a total of 3 seconds.



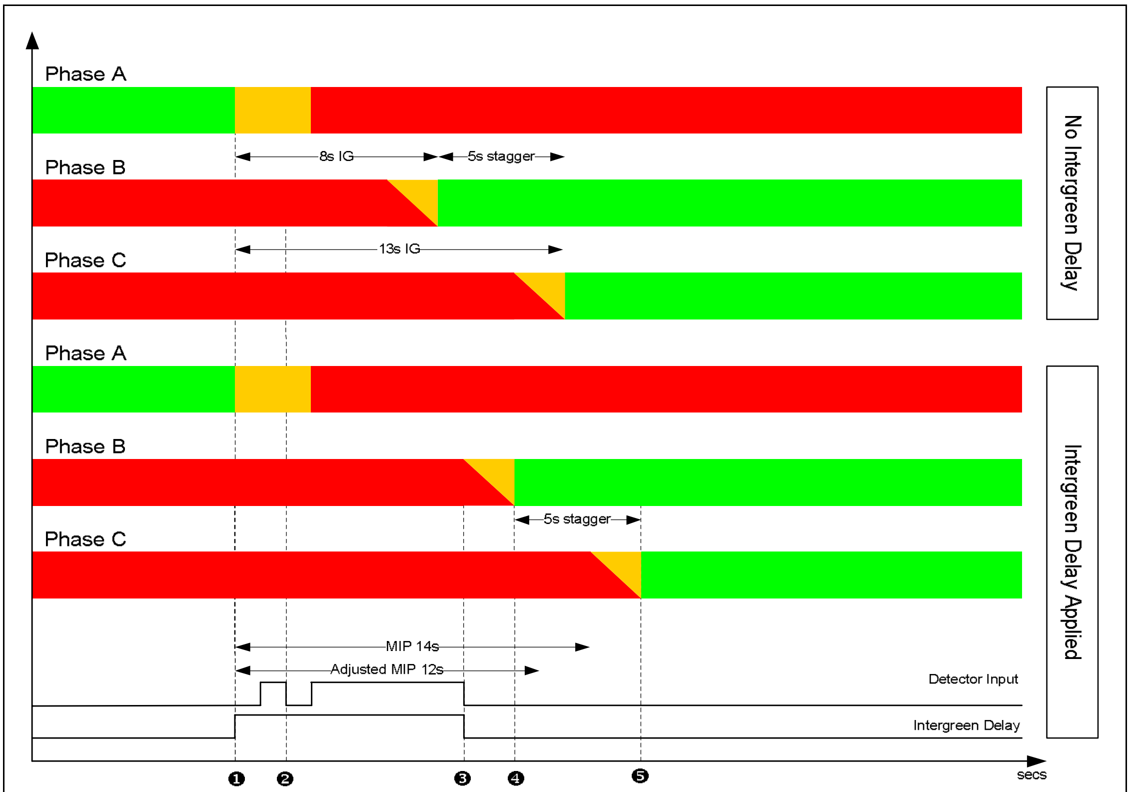
❶ Phase A loses RoW.
❷ The detector input is inactive. The RAT for phase B would have started for a normal stage movement, so the Intergreen Delay is disabled.
❸ Phase B gains RoW.
❹ Phase C gains RoW.

Figure 41 Intergreen Delay applied and detector input activates for an initial period of the MIP which exceeds the time to the first RAT of all gaining ROW phases under a normal stage movement.

17.2.5 Example 5

There is an Intergreen Delay associated with phase A losing ROW. Phases B and C are the phases gaining ROW in the stage movement.

The detector input toggles between inactive and active for an initial period (4 seconds). This period does not exceed the smallest intergreen minus RAT (6 seconds for phase B) of all the phases gaining ROW. During this period, the detector input is ignored and the Intergreen Delay remains enabled. The detector input is only checked from the point at which the first RAT of the phases gaining ROW (phase B in this example) would have started in a normal stage movement. When the detector input finally deactivates, the Intergreen Delay is disabled (Rule 3). At this time, the phases gaining ROW do so in accordance with their normal intergreen times. The 5 seconds stagger between phases B and C gaining ROW is maintained. The phases gaining ROW have been delayed by a total of 3 seconds.



❶ Phase A loses RoW.
❷ The detector input is inactive. The RAT for phase B would not have started for a normal stage movement, so the Intergreen Delay remains active.
❸ The detector input is inactive. The RAT for phase B would have started for a normal stage movement, so the Intergreen Delay is disabled.
❹ Phase B gains RoW.
❺ Phase C gains RoW.

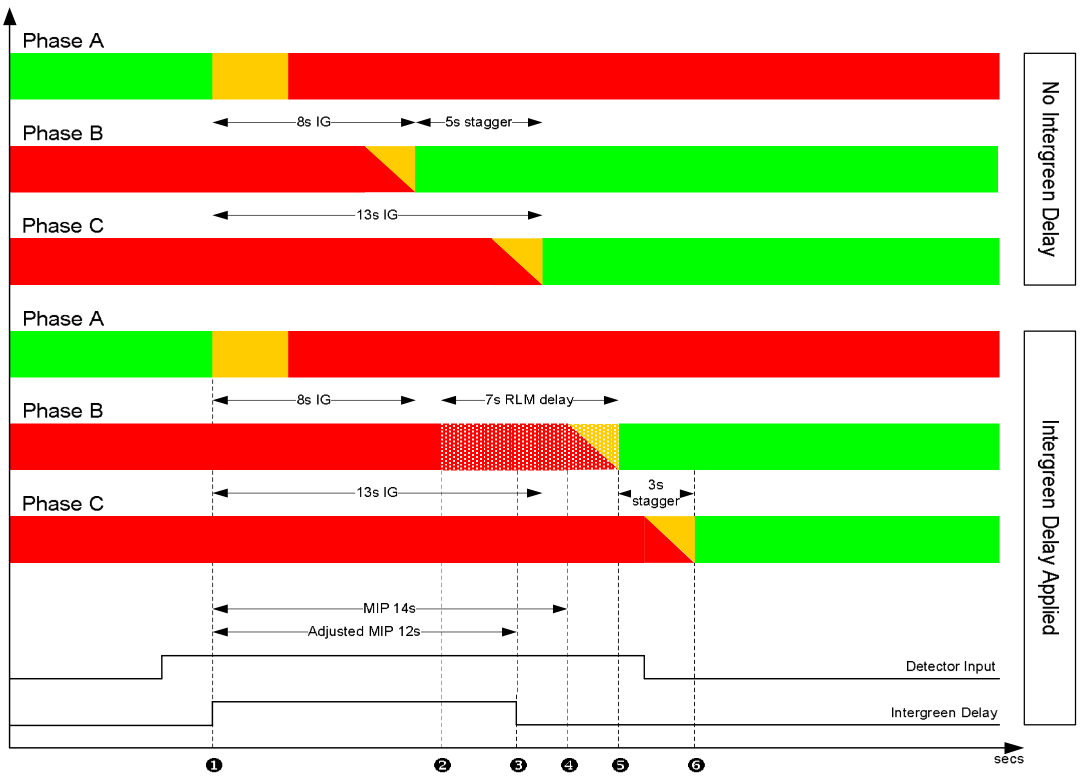
Figure 42 Intergreen Delay applied and detector input toggles state for an initial period of the MIP which does not exceed the time to the first RAT of all gaining ROW phases under a normal stage movement.

17.2.6 Example 6

There is an Intergreen Delay associated with phase A losing ROW. Phases B and C are the phases gaining ROW in the stage movement.

The associated detector input is active for longer than the adjusted MIP (12 seconds). When the Intergreen Delay is disabled (Rule 3), the phases gaining ROW do so in accordance with their normal intergreen times. However, there is a 7 seconds RLM delay (for phase A to B) applied which delays the appearance of phase B by an additional 2 seconds.

The 5 seconds stagger between phases B and C gaining ROW is not maintained (because the RLM delay is configured to only affect phase B). The actual stagger is 3 seconds.



❶ Phase A loses RoW.
❷ RLM fault detected so RLM delay (7 seconds) applied to phase B.
❸ The adjusted MIP expires so the Intergreen Delay is disabled. Normally the RAT for phase B would be started, however this is inhibited by the presence of the RLM delay.
❹ RAT for phase B is started. This ensures that phase B gains RoW when the RLM delay expires.
❺ Phase B gains RoW and the RLM delay expires.
❻ Phase C gains RoW.

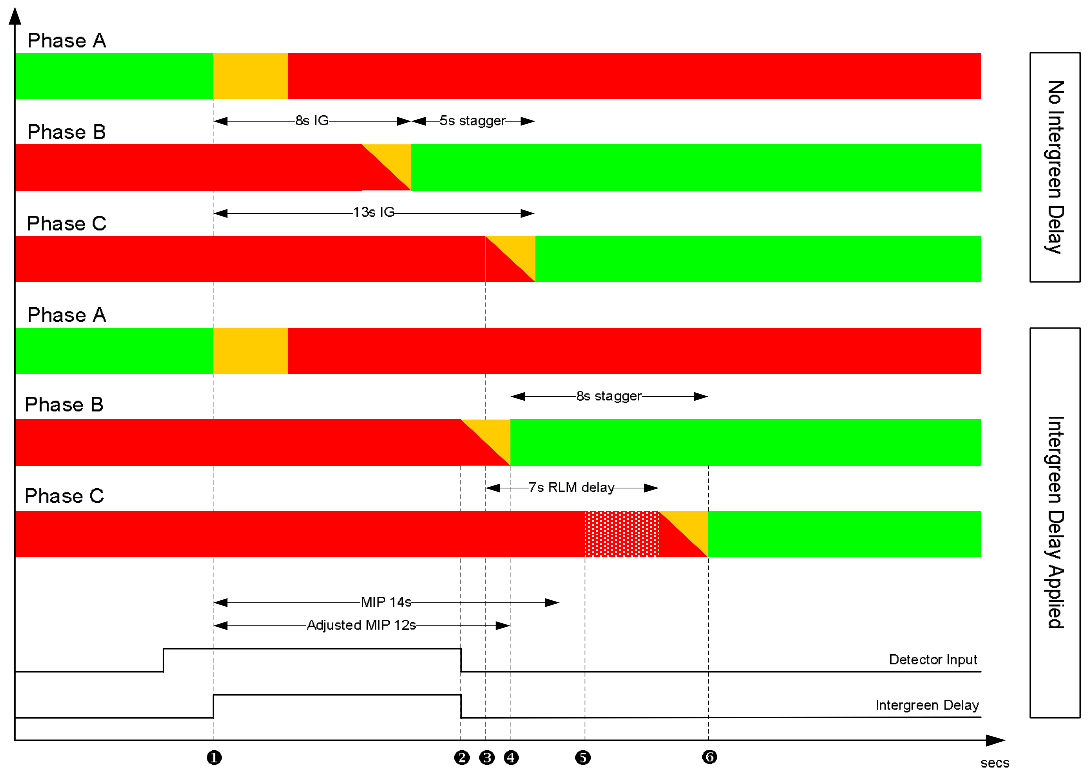
Figure 43 As for example 3 with an RLM fault detected whilst the Intergreen Delay is enabled.

17.2.7 Example 7

There is an Intergreen Delay associated with phase A losing ROW. Phases B and C are the phases gaining ROW in the stage movement.

The associated detector input is active for less than the adjusted MIP (12 seconds). When the Intergreen Delay is disabled (Rule 2), the phases gaining ROW do so in accordance with their normal intergreen times. However, there is a 7 seconds RLM delay (for phase A to C) applied which delays the appearance of phase C by an additional 3 seconds.

The 5 seconds stagger between phases B and C gaining ROW is not maintained. The actual stagger is 8 seconds.



❶ Phase A loses RoW.
❷ The detector input goes inactive. The RAT for phase B would have started for a normal stage movement, so the Intergreen Delay is disabled.
❸ RLM fault detected.
❹ Phase B gains RoW.
❺ The configured RLM delay for phase C is 7s and is timed from ❸ i.e. the point at which the RAT for phase C would have commenced for a normal stage movement. The remaining RLM delay is calculated as 3s and ensures that the RAT for phase C does not begin earlier than 7s from point ❸.
❻ Phase C gains RoW.

Figure 44 As for example 4 with an RLM fault detected after the Intergreen Delay is disabled.

17.2.8 Example 8

This example is concerned with the presence of a common gaining ROW phase in multiple Intergreen Delays.

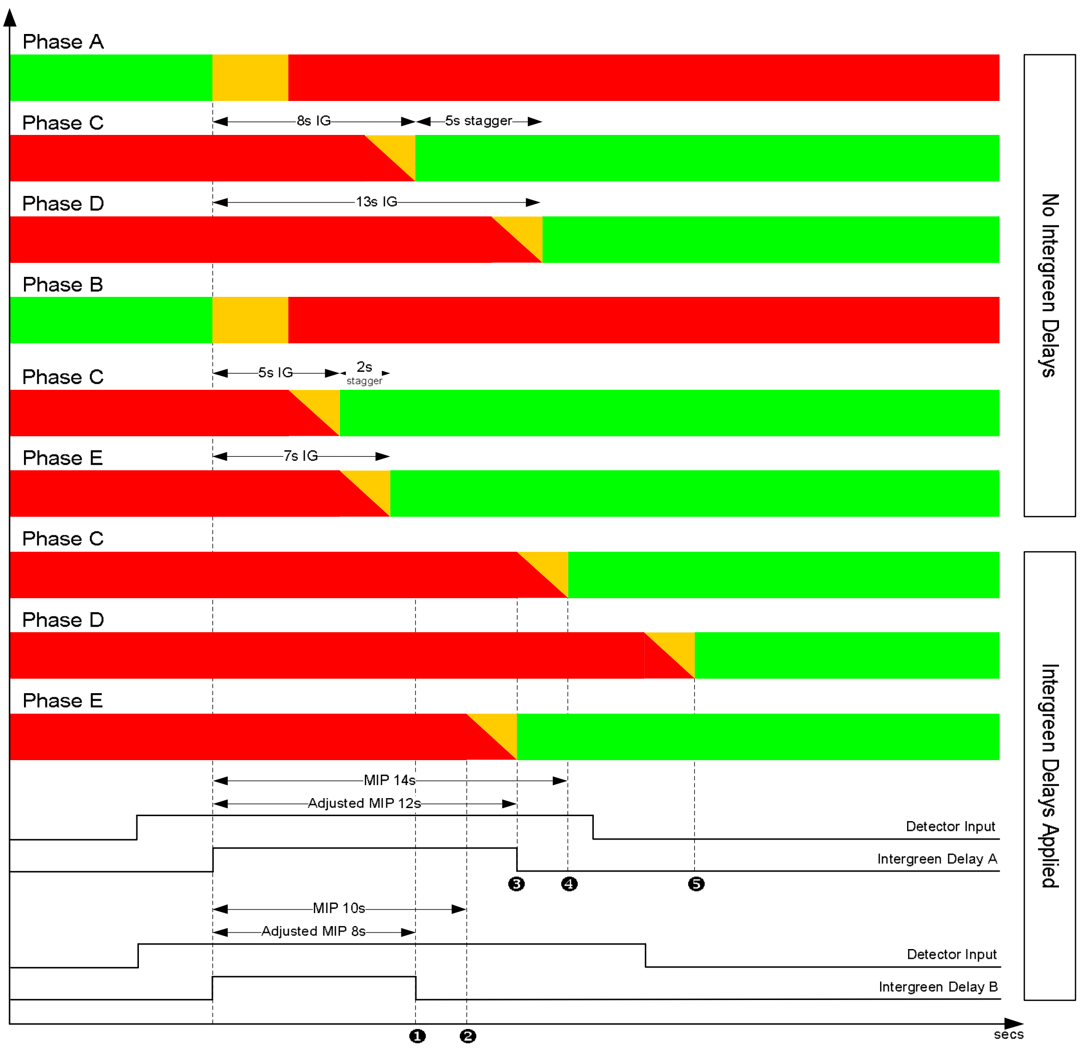
Intergreen Delay A is associated with phase A losing ROW. Phases B and C are the phases gaining ROW in the stage movement. Intergreen Delay B is associated with phase B losing ROW. Phases C and E are the phases gaining ROW in the stage movement.

Both phases A and B lose ROW at the same time.

The detector input associated with Intergreen Delay B is active for longer than the adjusted MIP (8 seconds). When Intergreen Delay B is disabled (Rule 3) the phases gaining ROW (C and E) would be expected to do so in accordance with their normal intergreen times. However, Intergreen Delay A is still enabled and inhibits phase C from gaining ROW. Phase E gains ROW as expected.

The detector input associated with Intergreen Delay A is active for longer than the adjusted MIP (12 seconds). When Intergreen Delay A is disabled (Rule 3) the phases gaining ROW (C and D) do so in accordance with their normal intergreen times.

The 5 seconds stagger between phases C and D gaining ROW is maintained, however the stagger between phases C and E is not maintained.



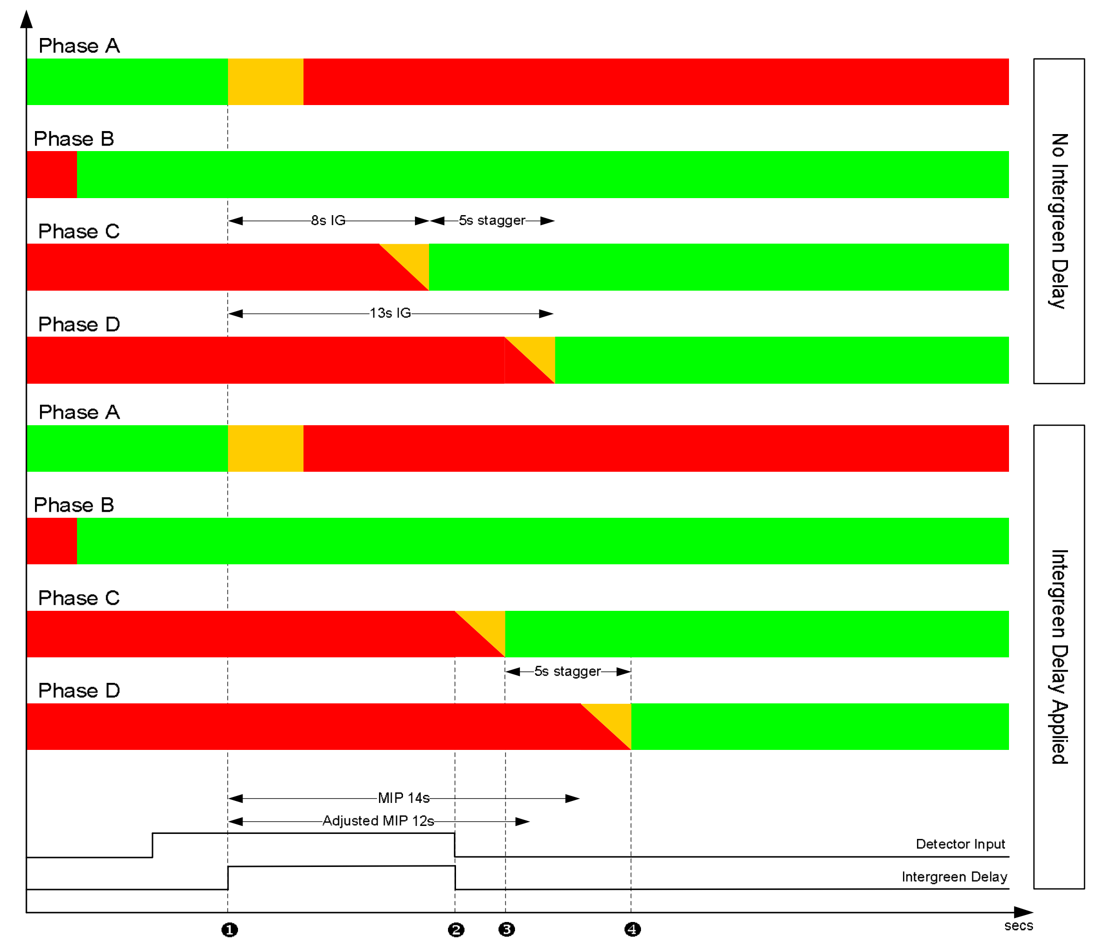
❶ The adjusted MIP for Intergreen Delay B expires and so Intergreen Delay B is disabled. Intergreen Delay A is still enabled and inhibiting phase C, which prevents phase C from gaining RoW via Intergreen Delay B.
❷ RAT for phase E is started.
❸ The adjusted MIP for Intergreen Delay A expires and so Intergreen Delay A is disabled. RAT for phase C is started. Phase E gains RoW.
❹ Phase C gains RoW.
❺ Phase D gains RoW.

Figure 45 As for example 3 with multiple Intergreen Delays and a common gaining ROW phase.

17.2.9 Example 9

Intergreen Delay is associated with phase A losing ROW. Phases B, C and D are the phases gaining ROW in the stage movement. Phase B is a non-conflicting phase which is already at ROW when phase A loses ROW and consequently plays no part in the Intergreen Delay.

The detector input is active for an initial period of the Intergreen Delay. When the detector input deactivates, the Intergreen Delay is disabled (Rule 1). At this time, the phases gaining ROW do so in accordance with their normal intergreen times. The 5 seconds stagger between phases C and D gaining ROW is maintained. The phases gaining ROW have been delayed by a total of 3 seconds.



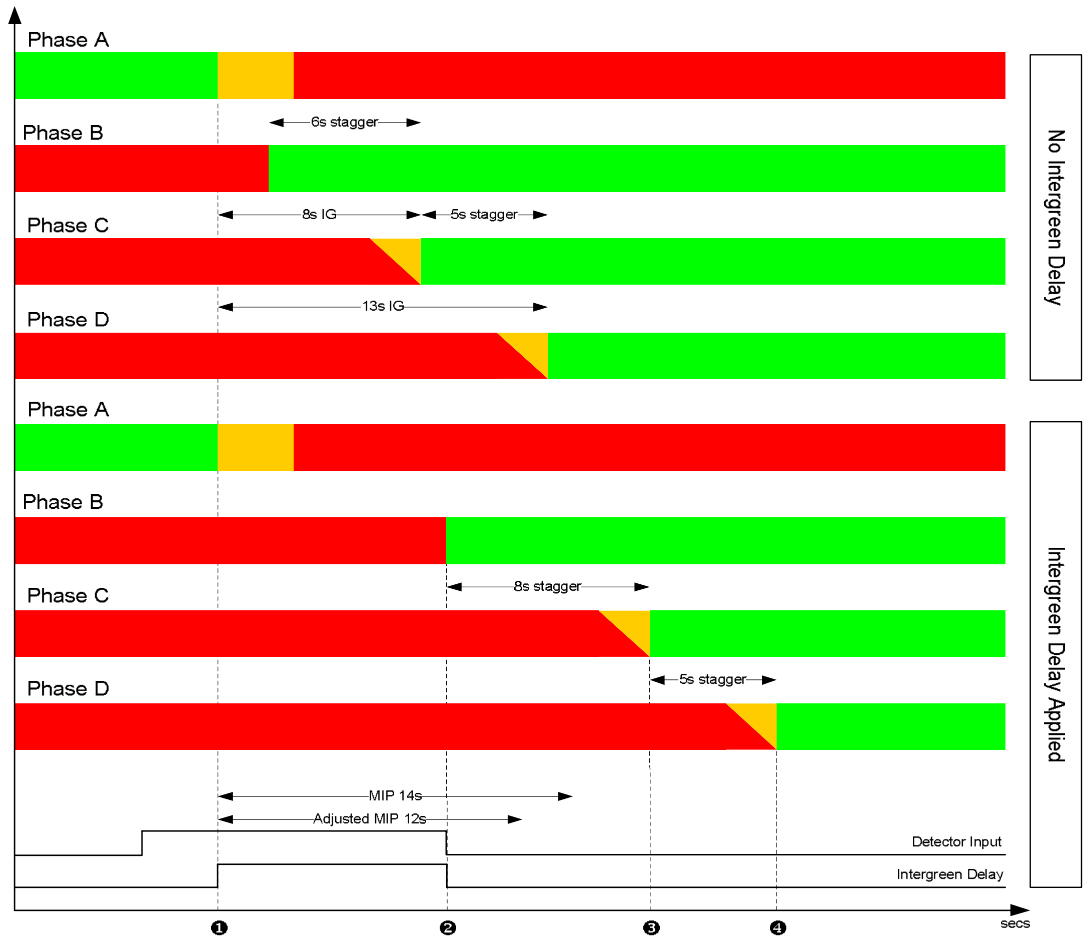
❶ Phase A loses RoW.
❷ The detector input is inactive.The RAT for phase C would have started for a normal stage movement, so the Intergreen Delay is disabled.
❸ Phase C gains RoW.
❹ Phase D gains RoW.

Figure 46 As for example 4 with a non-conflicting gaining ROW phase already at ROW.

17.2.10 Example 10

Intergreen Delay is associated with phase A losing ROW. Phases B, C and D are the phases gaining ROW in the stage movement. Phase B is a non-conflicting phase which is not at ROW when phase A loses ROW and consequently plays a part in the Intergreen Delay.

The detector input is active for an initial period of the Intergreen Delay. When the detector input deactivates, the Intergreen Delay is disabled (Rule 1). At this time, the phases gaining ROW do so in accordance with their normal intergreen times. The stagger between phases C and D gaining ROW is maintained. The phases gaining ROW have been delayed by a total of 9 seconds.



❶ Phase A loses RoW.
❷ The detector input is inactive and since phase B is about to gain RoW, the Intergreen Delay is disabled.
❸ Phase C gains RoW.
❹ Phase D gains RoW.

Figure 47 As for example 4 with a non-conflicting gaining ROW phase already not at ROW.

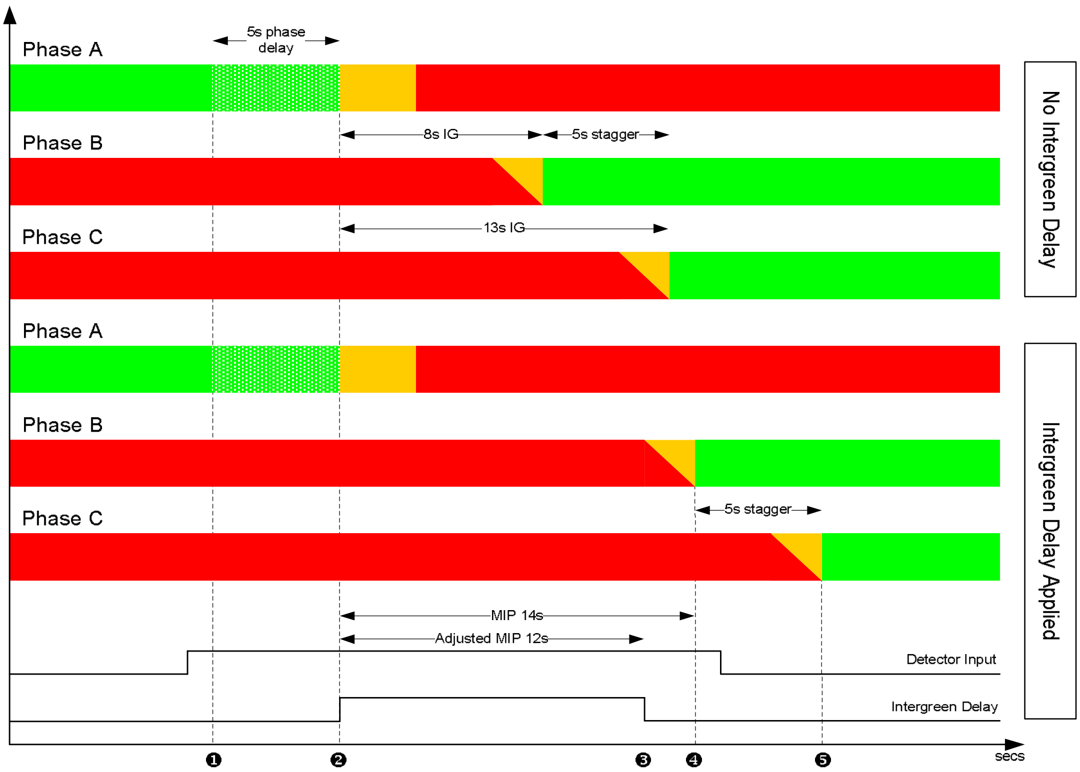
17.2.11 Example 11

There is an Intergreen Delay associated with phase A losing ROW. Phases B and C are the phases gaining ROW in the stage movement.

Phase A has a losing phase delay of 5 seconds which prevents the phase from losing ROW for this period.

The associated detector input is active for at least the duration (12 seconds) of the Intergreen Delay. When the Intergreen Delay is disabled (Rule 3), the phases gaining ROW do so in accordance with the their normal intergreen times. The 5 seconds stagger between phases B and C gaining ROW is maintained.

The phases gaining ROW have been delayed by a total of 6 seconds.



❶ Phase A should lose RoW but has a phase delay which prevents the phase from losing RoW.
❷ Phase A loses RoW so Intergreen Delay is enabled.
❸ The detector input is inactive. The RAT for phase B would have started for a normal stage movement, so the Intergreen Delay is disabled.
❹ Phase B gains RoW.
❺ Phase C gains RoW.

Figure 48 As for example 3 with a phase delay applied to the losing ROW phase.

17.2.12 Example 12

There is an Intergreen Delay associated with phase A losing ROW. Phases B and C are the phases gaining ROW in the stage movement.

Phase B has a gaining phase delay of 10 seconds which prevents the phase from gaining ROW for this period (6 seconds longer than the normal intergreen).

The associated detector input is active for at least the duration (12 seconds) of the Intergreen Delay. When the Intergreen Delay is disabled (Rule 3), the phases gaining ROW do so in accordance with the their normal intergreen times. The 4 seconds stagger between phases B and C gaining ROW is maintained.

The phases gaining ROW have been delayed by a total of 8 seconds.

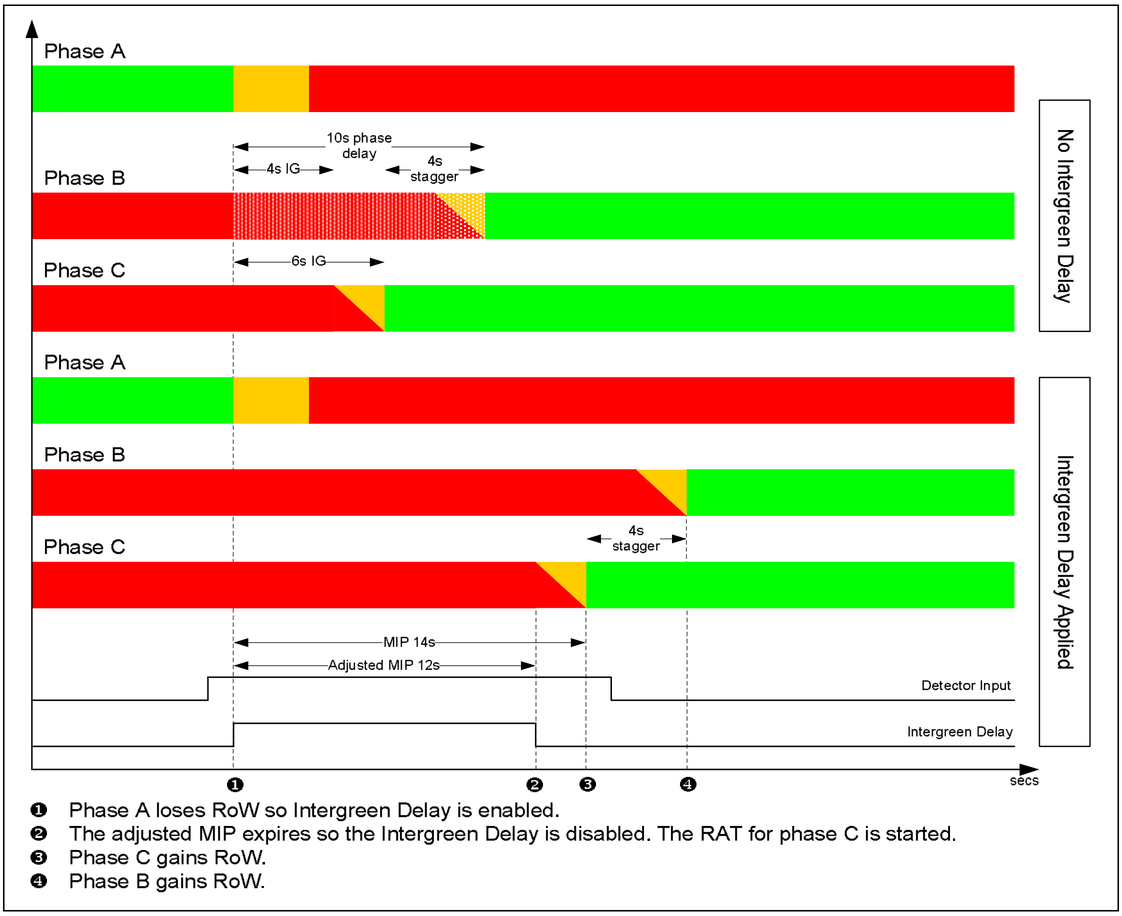


Figure 49 As for example 3 with a phase delay applied to a gaining ROW phase.

17.3 A Simple Practical Example

Single file traffic application such as a narrow bridge:

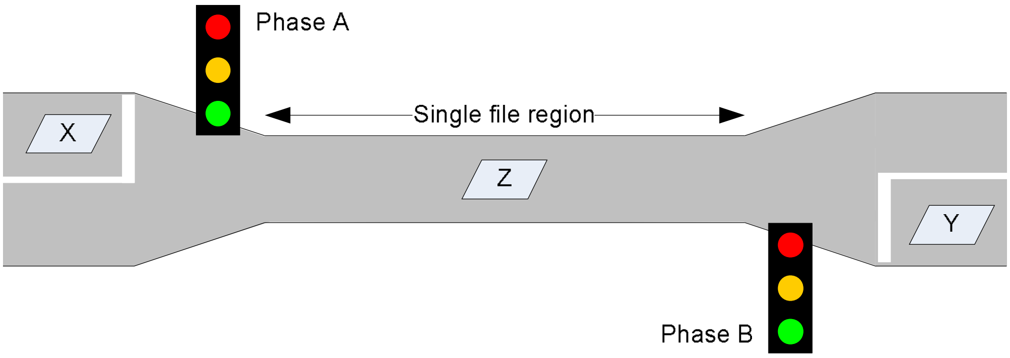


Figure 50 Single file bridge example

Phases A and B appear at ROW in stages 1 and 2 respectively. Loop X activation issues a demand for phase A, loop Y activation issues a demand for phase B. Intergreen from phase A to B and phase B to A is 5 seconds. This means that an activation of loop X will bring phase A to ROW in 5 seconds (assuming phase A is at no ROW). Similarly an activation of loop Y will bring phase B to ROW in 5 seconds (assuming phase B is at no ROW).

If there were vehicles travelling to the left when loop X demand was received, then it is highly likely that phase A will gain ROW before the vehicle flow has cleared the single file region. Similarly, if there were vehicles travelling to the right when loop Y demand was received, then it is highly likely that phase B will gain ROW before the vehicle flow has cleared the single file region.

In either case, we need a means of delaying the appearance of the requested phase at ROW until approaching vehicles have cleared the single file region.

This can be achieved via the use of a pair of Intergreen Delays and an additional loop(s) Z sited within the single file region.

Intergreen Delay 0 is configured with phase A as the losing ROW phase, phase B as the gaining ROW phase and a MIP of 14 seconds. This extends the intergreen by a maximum of (14 – 5) = 9 seconds.

Intergreen Delay 1 is configured with phase B as the losing ROW phase, phase A as the gaining ROW phase and a MIP of 14 seconds. This extends the intergreen by a maximum of (14 – 5) = 9 seconds.

Loop Z acts as the detect input to both Intergreen Delays. If two or more detector inputs are required for the single file region, then all the detector inputs can be combined together in Special Conditioning to set a single scratch bit that is specified as the input to both Intergreen Delays, e.g.

```
; Combine the detectors that control both Intergreen Delays
(DETZ1_EXT + DETZ2_EXT + DETZ3_EXT) = SCRT0
```

18 MODES

18.1 Modes Available

The following modes are available:

- Start Up
- Part-time (all signals off or flashing period)
- Hurry Call
- Urban Traffic Control
- MOVA
- Emergency Vehicle and (Bus) Priority Modes
- Light Rail Transit (LRT)
- Manual Operation
- Manual Step-On
- VA, CLF or FT Operation (selected via mode switch)
- Cableless Linking (CLF)
- Vehicle Actuated (VA)
- Fixed Time (FT) / Fixed Vehicle Period (FVP)

18.2 Mode Priorities

The mode priority facility allows for the mode with the highest priority for which operating conditions are active (e.g. force bits from the UTC computer or a hurry call demand) to be the current mode. When the operating conditions become inactive, the next highest priority mode with operating conditions active will become the current mode. It need not necessarily be the next one in line. If at any time operating conditions for a higher priority mode become active, that mode will become the current mode. If more than one set of operating conditions is active, the mode with the highest priority will become the current mode.

The following factors influence the selection of the modes:

- Part-time requests
- The status of the incoming ‘hurry call’ signals
- The status of the UTC and MOVA force signals
- The status of the Priority and LRT Inputs
- The status of the manual select buttons
- Time switch/CLF signals
- Conditioning signals
- Integrity of the hardware/software

The mode priorities are defined during controller configuration with the following restrictions, assuming all stipulated modes are utilised:

- Signals off / flashing periods during the Part-time cycle have highest priority after start-up mode.
- Cableless linking mode must be higher priority than VA mode.

- Either VA or FT mode is always the lowest priority, with VA mode configured above FT unless Vehicle Actuated operation is not required.

With the mode priorities defined, the controller adopts the highest priority mode for which the following conditions of entry apply:

- Part-time off (or flashing) period: Part-time off selected by master time clock or special conditions such as queue detectors.
- Hurry call mode: Hurry call applied and any call delay expired.
- UTC and MOVA modes: When the controller has received force bits.
- Manual Control selection: MANUAL selected on the Manual Panel.
- Cableless linking mode: A valid CLF plan is selected by the master time clock.
- Bus/LRT/Emergency Vehicle Priority mode: Entered if a request exists for priority from a special vehicle detector, (e.g. LRT request).
- Vehicle actuated or fixed time mode: Entered if a request does not exist for a higher priority mode.

Several different stage change conditions for different modes may be active at the same time, but the controller will only respond to the ones of the highest priority mode. When a change of mode occurs, the controller will respond to the current stage change conditions of the new mode. For example, during UTC mode a CLF plan will continue to run with the group influences having no effect. When the mode changes to CLF the current group influences will become effective.

The changing of modes cannot override minimum green and intergreen timings.

Note: The controller must never be without a mode requested. Therefore, either VA or FT must always be configured in the mode priority.

19 START-UP MODE

19.1 Introduction

The start-up mode provides a safe 'signals on sequence' when any of the following conditions occur:

- The AC supply to the controller is switched on or restored following a failure.
- The signals are switched on by means of the SIGNALS ON/OFF switch or the signals isolating switch (if fitted). This option is enabled by default. The alternative option is that the signals turn on immediately at whatever point in the cycle the controller has reached when the SIGNALS ON/OFF switch is switched on.
- The signals are switched on (by the master time clock for example) after a period of Part-time off / flashing.
- A second red lamp failure that has extinguished one or more streams is manually cleared allowing the stream back on.
- Other failures that are configured to switch off the signals or to send streams into their part-time flashing state are cleared.

19.2 Default Start-Up Sequence

The standard start-up sequence normally consists of the three periods below, although other start-up sequences can be configured:

(a) Start-up Period

The start-up time is a period of 7 seconds which commences at the start of the 'signals on' request. During this period all signals for all phases are off.

(b) Amber Leaving / Red Display

Following the start-up blackout period:

- An amber-leaving signal is shown to all traffic phases not in the start-up stage.
- All traffic phases in the start-up stage continue to show blackout.
- All pedestrian phases show red.

(c) Starting Inter-green

At the end of the 3 seconds amber leaving, the traffic phases not in the start-up stage change to red, the traffic phases in the start-up stage continue at signals off and all pedestrian phases continue at red.

This state continues until the end of the starting inter-green, when the traffic phases in the start-up stage change straight from signals off to green and any pedestrian phase in the start-up stage change from red to green as normal. Any green arrow phases in the start-up stage will also illuminate as normal.

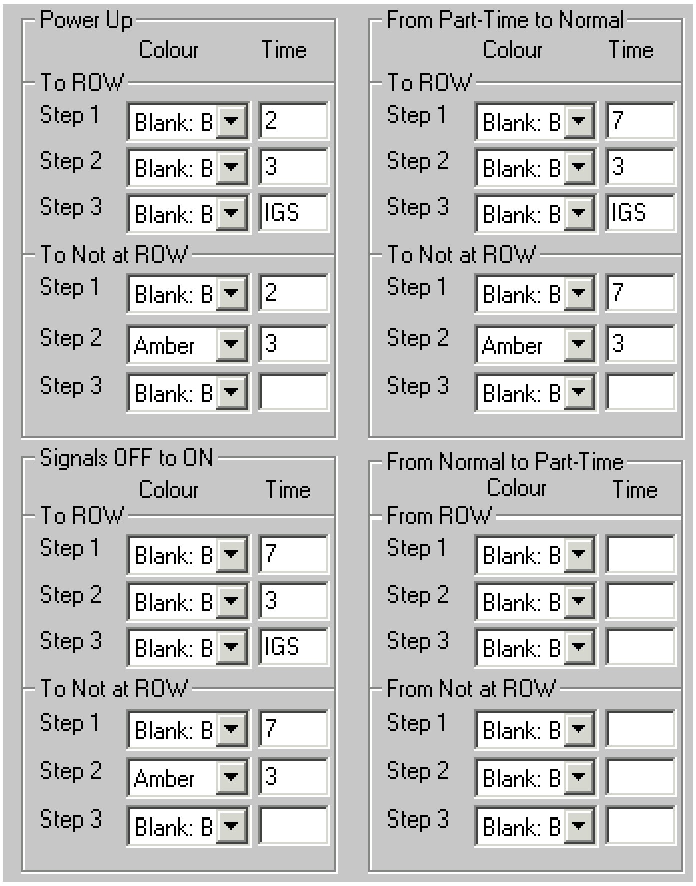
The start-up mode is now finished and the controller will assume the highest priority mode. During the start-up sequence demands are inserted for all phases to prevent any vehicles being trapped against a red signal.

19.3 Power-up, Signals OFF to ON and Part-Time

For each phase type (i.e. for each lamp sequence), six start-up sequences can be configured.

These cover the three start-up scenarios of Power-Up, Signals Off to On and exit from the Part-Time state. For each of the three scenarios there are two sequences: one sequence for a phase that gains ROW in the configured start-up stage and one sequence for a phase that does not.

A switch off sequence from normal operation to the part-time state can also be configured.



Each of these sequences can consist of up to three timed steps, e.g. blackout for 7 seconds, amber for 3 seconds and red for the configured starting intergreen (IGS) period. Note that the final step to illuminate a phase at Green (ROW) or Red (not at ROW) in the start-up stage is not normally included in the three start-up sequence steps - the ROW and Not At ROW states are defined elsewhere in the lamp sequence.

19.4 Start-Up Sequence and Demand-Dependant Phases

Phases configured as 'fixed' (not optional) in the start-up stage use the To ROW sequence and appear at ROW (Green) when the start-up completes.

Phases configured to not gain ROW in the start-up stage use the To Not at ROW sequence and appear at no ROW (typically Red) when the start-up completes.

Phases that are configured as optional in the start-up stage use the To ROW or To Not at ROW sequence depending on whether an internal start-up demand is configured (except for Pedestrian phases when Red Lamp Monitoring is configured - see section 19.5).

An optional phase configured with an internal start-up demand uses the To ROW sequence and appears at ROW (Green) when the start-up completes.

An optional phase configured with no internal start-up demand uses the To Not at ROW sequence and appears at no ROW (typically Red) when the start-up completes.

For legacy operation, an option is available so optional phases with no internal start-up demand appear at ROW, not no ROW. This setting can be changed on the Controller - Stages - Settings web page or by using the PMV or OPT handset commands.

19.5 The Start-Up of Pedestrian Phases with Red Lamp Monitoring

With Red Lamp Monitoring configured, then after power-up, part-time or signals off/on, pedestrian phases in the start-up stage will not follow the 'To ROW' sequence, but will always follow the 'To Not at ROW' sequence, normally ending with the phase showing Pedestrian Red.

This allows the controller to check for any red lamp faults on conflicting vehicle phases before moving a pedestrian phase to ROW (Green) when the traffic phases also appear at ROW (Green) at the beginning of the start-up stage.

If RLM faults are present and are configured to inhibit the pedestrian phases, the pedestrian phases will remain at no ROW (i.e. normally Red).

If RLM faults are present and are configured to extinguish phases rather than inhibit, the phases are extinguished as soon as the fault is confirmed, regardless of the lamp sequence.

19.6 Start-Up into Part-Time Mode

If part-time it is requested at start-up (by the current time of day for example) and the first step of the start-up sequence matches the part-time state (e.g. both lamp sequences request blackout or the same flashing pattern), the controller will immediately enter the part-time state on start-up.

However, if the first step of the start-up sequence does not match the part-time state, or the request for part-time mode is received too late, the controller is forced to complete the start-up sequence and then enter part-time mode as normal.

19.7 Start-Up Parallel Stage Streaming Facilities

Start-up mode works on a stream basis, i.e. a stream can be restarted without affecting the other streams. Thus start-up mode can be active on any or all of the streams. The start-up stage for each stream is configurable.

Example: Individual streams can be extinguished by part-time mode or by the red lamp monitor. The stream is required to resume when the timetable indicates that part-time mode is no longer required or the red lamp fault has been cleared. When the stream is required again, the stream will perform its start-up sequence and run start-up mode.

Meanwhile the other streams will each continue to run their highest priority modes unaffected by the stream performing its start-up sequence.

When the stream completes its start-up, it will run the highest priority mode required as normal.

20 PART-TIME MODE

Note: For 'Fail to Part-Time', refer to the separate subsection.

20.1 General Description

When a stream is in 'part-time' mode, all the signals in the stream are usually extinguished allowing the traffic to flow normally. For example, it may only be necessary to control the traffic on a roundabout during peak times, but not during the rest of the day.

The normal method of switching between normal operation and part-time mode is by means of the master time clock at specified times of the day.

An alternative method is by means of queue detectors. If a queue of traffic is detected, normal traffic operations are introduced for a certain period, e.g. 20 minutes. At the end of this period, Part-time mode is re-introduced unless a queue is still being detected, in which case the normal traffic operations will continue until the queue is not detected for a certain length of time.

Alternative signal sequences, e.g. flashing amber for traffic phases during the night may be configured if required (for Non UK Controllers ONLY).

Part-time mode may be introduced by the following methods.

- Queue detectors (using Special Conditioning)
- Time switch event from the timetable
- Handset (SWS handset command)
- Manual Panel switches (SW1, 2 or 3 as configured, via Special Conditioning)
- Red or Last Lamp Faults (to flashing part-time state for non UK only)
- Correspondence Faults (for non UK only)

It is a requirement in the UK that part-time mode may only be used if accompanied by the Red Lamp Monitoring facility.

20.2 Entering and Exiting Part-Time Mode

When part-time mode is requested (by time of day for example), the controller moves immediately to its configured switch off stage, subject to any delays caused by minimum greens or inter-greens timing off and also subject to any stage movement restrictions.

When it reaches the switch off stage and all the minimum greens timers of all the phases at right of way have expired, the signals are sent to their configured part-time state via an optional 'normal to part-time' 3-step lamp sequence.

By default, no 'normal to part-time' sequence is defined and the part-time state is blackout, so the signals are simply extinguished when all the minimum green times expire in the switch off stage.

When part-time mode is no longer requested, i.e. when it is time for the controller to switch back on, the controller enters start-up mode to ensure normal operations resume in a safe manner.

The documentation on the start-up sequence and start-up mode covers the lamp sequence in more details.

20.3 Part-Time Mode Parallel Stage Streaming Facilities

Part-time mode can be active on any or all of the streams. Those streams not in part-time mode will continue to run a lower priority mode.

If some streams are required to enter part-time mode while some are not, special conditioning must be used to either disable part-time mode on particular streams or only request part-time mode on certain streams.

Each stream requested to switch off will then independently move to its configured switch off stage as normal. However, only when all the streams requested to enter part-time mode have reached their switch off stages and all their minimum greens have expired, will all the signals on those streams be sent to their configured part-time state. This ensures that all of the streams switch off at the same time, not when each reaches its own switch off stage.

The part-time switch off stage for each stream is specified in configuration. The part-time signal state and the sequences to and from the part-time state are configured by the phase type (Lamp Sequence).

If red lamp monitoring is configured, consideration also needs to be given as to whether additional streams need to be extinguished when a second red lamp fault is confirmed.

21 URBAN TRAFFIC CONTROL (UTC) MODE

21.1 UTC Introduction

In UTC mode, operations are controlled and monitored by the central computer of an Urban Traffic Control system.

Stage changes are effected by the application of forces and demands. The demands may either be local or simulated by the computer. During UTC mode maximum green timers normally have no effect and are held in a RESET state.

Instation equipment at the central computer office communicates either directly with the controller or to an Outstation Transmission Unit (OTU) housed within the controller cabinet.

Control signals are normally transmitted as two 8-bit control words and monitoring signals are returned as two 8-bit reply words.

21.2 UTC Interface

Interfacing of the control and reply signals between an OTU and the controller may be via physical parallel inputs and outputs.

Communication between a semi-integral Siemens Gemini unit and the controller is via the enhanced serial link through the RS232 handset port. Communications between the internal UTMC-OTU application and the controller application are direct, but the IC4 configuration is the same as with the serial link. These interfaces do not use controller digital I/O for the UTC interface, but the control/reply bit principle is still used.

The logic states of the control and reply bits at the controller are as follows:

	CONTROL	**REPLY**
ACTIVE:	CLOSED (1)	OPEN (0)
INACTIVE:	OPEN (0)	CLOSED (1)

(Any unused reply bits are usually set to the inactive state)

Note that since the controller's outputs are 'normally open-circuit', the reply bit outputs are energised by the controller when they are inactive in order to close the output contacts. They are then released when, for example, the associated stage is active in the case of 'G' bits, see section 21.3.2, or when the controller is switched off.

However, the reply bits on a stand-alone pedestrian stream (section 21.3.6) must use 'normally closed-circuit outputs' so that they are inactive when the controller is switched off. The controller has a number of 'change-over' type outputs that include both a 'normally open contact' and a 'normally closed contact', such that when the output is energised, the 'normally open contact' is closed and the 'normally closed contact' is opened. Therefore, if the controller's normal stage confirm outputs are used to generate the GX and PC confirms, the output sense needs to be inverted so that the 'normally closed contact' is only opened (i.e. energised) when the required stage is at right of way.

21.3 Control and Reply Bits

UTC Control Bits			UTC Reply Bits		
Bit	**Section**	**Title**	**Bit**	**Section**	**Title**
F1, F2…	21.3.1	Forces	G1, G2…	21.3.2	Stage confirm
DX	21.3.3	Demands: Common	SD1, SD2…	21.3.4	Stage demand confirm
D1, D2…	21.3.3	Demands: Stage			
PX	21.3.3	Demands: Ped stream	WI	21.3.6	Wait indicator confirm
PV	21.3.5	Ped stream hold vehicle	GX, PC	21.3.6	Ped stream confirms
SF1, SF2	21.3.7	Switch facility	SC1, SC2	21.3.8	Switch facility confirm
SO	21.3.9	Solar override	SOC	21.3.10	Solar override confirm
SG	21.3.11	CLF group sync.	CS	21.3.12	CLF group sync. confirm
LO	21.3.13	Lamps on / off	LE	21.3.14	Lamps off
			FR	21.3.15	Signals flashing
LL	21.3.16	Local link inhibit	LC	21.3.17	Local link inhibited
FM	21.3.18	Fall back mode	FC	21.3.19	Fall back confirm
TS	21.3.20	RTC set	CC	21.3.21	RTC set confirm
–	–	(No control bit for RT)	RT	21.3.22	RTC at configured time
TS1	21.3.23	RTC synchronisation	CC1	21.3.24	RTC sync. Confirm
TO	21.3.25	Take over	TOR	21.3.26	Take over confirm
TC	21.3.27	Transmission confirm	–	–	(No confirm bit for TC)

Miscellaneous UTC Reply Bits		
CF	21.4.1	Controller fault
DF	21.4.2	Detector fault
LF	21.4.3	Lamp fault
MC	21.4.4	Manual control mode
RR	21.4.4	Remote reconnect
GR1	21.4.5	First group confirm
CYC	21.4.6	Start of CLF cycle
HC	21.4.7	Hurry call confirm
TF	21.4.8	Test Facility

Table 3 Summary of UTC Control and Reply Bits

21.3.1 Forces (F1, F2 etc.)

An ‘F’ control bit forces the controller to make an immediate move to the specified stage, subject to any minimum green or inter-green periods timing off and any stage movement restrictions.

An ‘F’ bit may be demand dependent if required. If it is, the move will only occur if there is a demand for a phase within the specified stage.

If an ‘F’ bit remains active for longer than a configurable period (UWD), a fault (FLF60) is logged and UTC mode will be disabled until the bit goes inactive. This is to prevent the controller being held in one stage indefinitely

21.3.2 Stage Confirm (G1, G2 etc)

A single ‘G’ reply bit is returned when the specified stage is active, i.e. all fixed phases within the stage are at green.

If required, the controller can be programmed so that more than one stage returns the same ‘G’ bit whenever the different stages are active. In this case the ‘G’ bit will not stay active during any interstage between two stages with the same ‘G’ bit unless the controller is specifically programmed to do so.

All the ‘G’ bits can be forced inactive, except the first two ‘G’ bits (normally ‘G1’ and ‘G2’) which are forced active, to indicate any of the following conditions:

a. Manual mode operating.

b. Manual mode selected.

c. No lamp power.

d. ‘Normal’ mode select button not selected, i.e. Manual, FT or VA selected.

e. ‘RR’ button pressed on the Manual Panel (if configured).

The G1/G2 reply bits are set independently for each stream, so that one stream can set G1/G2 while another continues to return the correct ‘G’ bits. G1/G2 are assumed to be the first two ‘G’ reply bits used on the stream, ignoring any 'G' reply bits for 'all red stages' (i.e. stages where no real phases gain ROW). Therefore, if ‘G’ bits are assigned to stages 0, 1, 3 and 4, but not to stage 2, and stage 0 is the all-red stage, the ‘G’ bits for stages 1 and 3 would both be set if the signals are off.

The condition ‘no lamp power’ is also true if the Red Lamp Monitor or Part-Time Mode has extinguished the stream, while the condition ‘manual operating’ is true only if the stream is actually running manual mode.

When ‘G1/G2’ is received at the central office the computer releases control immediately. When ‘G1/G2’ stops being sent the computer will not normally regain control until reset by the operator.

Normally ‘G1/G2’ is used to indicate no lamp power, i.e. condition c. If it is used to indicate any other conditions, the modes that are selected may not be a higher priority than UTC and would cause the computer to release control unnecessarily and then require computer operator intervention to restore UTC control.

Ideally the other conditions should be used with an ‘MC’ or ‘RR’ reply bit (see section 21.4.4) although the availability of bits in the reply words will be the deciding factor.

21.3.3 Demands - Common (DX), Stage (D1, D2 etc.), Pedestrian (PX)

The demand control bits simulate local demands, i.e. detectors or pedestrian push buttons.

The ‘DX’ control bit normally demands all phases and extends all extendible phases, although mapping is configurable.

The ‘D1’, ‘D2’, etc., control bits normally demand and extend (where required) the phases within the specified demand dependent stage.

On a stand-alone pedestrian stream, the ‘D’ bit that demands the pedestrian stage is usually named ‘PX’.

The demands may be latched or unlatched as required, although normally they are latched.

Demands for pedestrian phases normally illuminate the WAIT indicators, although they may be programmed not to if required.

Timing delays associated with call/cancel facilities are not applicable, although demands may still be unlatched.

Any demands dependent on other demands may still be effective.

The demands may be programmed so that they are only effective if the appropriate 'F' bit is present with the 'D' or 'DX' bit.

If required, it is possible to program the controller so that demands for phases may be ignored for certain stages.

'D' bits may be used during CLF, VA, Bus Priority or Emergency Vehicle modes as well as UTC mode.

21.3.4 Stage Demand Confirm (SD1, SD2 etc.)

An 'SD' reply bit may be returned to indicate the presence of a demand, either locally or from a 'D' bit, for a phase within the specified demand dependent stage, ignoring demands for phases which are inhibited by red lamp monitoring.

Any phase that appears in more than one demand dependent stage will cause the 'SD' bit for each of the stages to be returned whenever a demand is present, unless the demand has been programmed to be ignored.

Note that the demand confirm bit for the pedestrian stage on a stand-alone stream is usually named 'WI' and returns the state of the wait indicator, see section 21.3.6.

21.3.5 Hold Pedestrian Stream Vehicle (PV)

The 'PV' control bit is used on a stand-alone pedestrian stream to hold the vehicle stage at right of way.

When the 'PV' control bit is de-activated, the UTC Inhibit Extension window time is started. During this window period, even if the 'PV' bit is subsequently activated, the controller will inhibit vehicle extensions and will move to the pedestrian stage if there is a pedestrian demand is present. The UTC Inhibit Extension window time can be viewed and modified using the UIE handset command.

21.3.6 Pedestrian Stream Confirms (GX, PC, WI, PR)

To meet UK requirements, the following UTC reply bits should be used on a stand-alone pedestrian stream:

GX - Open circuit when the vehicle is at right of way
PC - Open circuit when the pedestrian is at right of way
WI - Open circuit when the wait indicator is illuminated
PR - Open circuit during the Puffin clearance period

Unlike other reply bits, the above are required to be closed circuit when the signals or the controller is switched off, see section 21.2.

The 'GX' and 'PC' confirm bits can be configured as normal stage confirm bits (see section 21.3.2) but instead of being named 'G1' and 'G2' are named 'GX' and 'PC' (assuming stage 1 is the vehicle stage and stage 2 is the pedestrian stage). The condition 'no lamp power' should still be configured to affect the 'G'-bits, but in order to meet UK requirements, the first two stage bits for a stand-alone stream are not set by the firmware; both reply bits are de-activated.

21.3.7 Switch Facility (SF1 and SF2)

An 'SF' control bit may be programmed to simulate any one of the facilities provided by the Event Timetable.

21.3.8 Switch Facility Confirm (SC1 and SC2)

An 'SC' reply bit may be returned to indicate that its associated 'SF' control bit has introduced its facility of the Event Timetable.

21.3.9 Solar Switch Override (SO)

An 'SO' control bit may be programmed to override the Signal Dimming facility and switch the signals to the BRIGHT condition.

21.3.10 Solar Override Confirm (SOC)

An 'SOC' reply bit may be programmed to indicate that the signals are in the BRIGHT condition due to any of the following sources:

- the solar cell input
- the dim override switch on the Manual Panel (if configured)
- the 'SO' control bit being active

To allow flexibility, this reply bit must be implemented using Special Conditioning.

21.3.11 CLF Group Synchronisation (SG)

An 'SG' control bit may be programmed to reset the current CLF plan's cycle time.

The synchronisation code is transmitted four times at 0101 levels, each level of 1-second duration. The reset is actioned within 300 ms of the leading edge of the second '1' bit.

21.3.12 CLF Group Synchronisation Confirm (CS)

A 'CS' reply bit may be returned to confirm synchronisation of the current CLF plan's cycle time. The 'CS' bit is maintained for a pre-set period, configurable in 1 second steps, normally set to 3 seconds.

Also see the reply bit 'GR1' (section 21.4.5).

21.3.13 Lamps On/Off Control Bit (LO)

If Part-time mode is configured it may be programmed to be introduced and the signals switched off (or overridden and the signals brought on) by the presence of an 'LO' control bit. The 'LO' bit should be programmed so that it has to be present for at least 10 seconds before it is actioned and then absent for at least 10 seconds before being cancelled.

Part-time may be configured as signals flashing for non UK controllers.

21.3.14 Lamps Off Reply Bit (LE)

An ‘LE’ reply bit may be returned to confirm that an ‘LO’ control bit to introduce Part-time mode has been actioned. Alternatively, the ‘LE’ reply bit can indicate that the signals have been extinguished for any reason, not just due to the ‘LO’ bit.

21.3.15 Signals Flashing Reply Bit (FR)

An ‘FR’ reply bit may be used instead of ‘LE’ to indicate signals flashing rather than Lamps Extinguished.

21.3.16 Local Link Inhibit (LL)

An ‘LL’ control bit may be programmed to override the local link to an adjacent controller. Normally other control bits from the computer would then operate the link.

21.3.17 Local Link Inhibit Confirm (LC)

An ‘LC’ reply bit may be returned to indicate that the Local Link is inhibited.

21.3.18 Fall Back Mode (FM)

An ‘FM’ control bit normally causes the controller to disable CLF mode whilst the ‘FM’ bit is active. Thus if UTC mode is not active, it prevents the controller running CLF mode as the ‘fall back’ mode, forcing it to run a lower priority mode such as VA or FT (assuming a higher priority mode is not active).

21.3.19 Fall Back Confirm (FC)

An ‘FC’ reply bit may be returned to indicate that an ‘FM’ control bit has been received and actioned.

21.3.20 RTC Set to Stored Value (TS)

A ‘TS’ control bit may be programmed to cause the time in the Real Time Clock to be set to the value stored in the configuration.

The ‘Time Sync’ signal is transmitted four times at 0101 levels, each level of 1-second duration, with the clock being set at the start of the second ‘1’.

	The signal can set either:	This will allow synching either:
a)	minutes and seconds	once an hour
b)	hours, minutes and seconds	once a day
c)	day, hours, minutes and seconds	once a week

This ‘TS’ time sync input bit can be configured without needing to configure UTC mode so that it can be used by a local link.

Note: The ST950 includes two real time clocks: Controller Time and System Time. These may be configured to run independently or for one to follow the other. The RTC UTC bits always relate to Controller Time. An NTP server can be used to maintain the System Time. Refer to the ST950 documentation on Time for more information.

21.3.21 RTC Synchronisation to Stored Value Confirm (CC)

A ‘CC’ reply bit may be returned to indicate Real Time Clock load signal (TS) has been received and actioned. The signal is maintained for a pre-set period, configurable in 1-second steps, but is normally set to 3 seconds.

21.3.22 RTC at Configured Time (RT)

A ‘RT’ reply bit may be returned at a specified time configured within the controller. When this time is reached the reply bit is activated for a pre-set period, configurable in 1-second steps, but normally set to 3 seconds.

21.3.23 RTC Synchronisation (TS1)

A ‘TS1’ control bit may be programmed to cause the master time clock to be synchronised at 8, 18, 28, 38, 48 or 58 minutes past each hour. The synchronisation code is transmitted at 0101 levels, each level of 1-second duration.

The central office computer has to be programmed to send the synchronisation code when its system clock indicates any of the times shown below. The central office computer must be programmed such that the final “1” bit of the synchronisation code is sent on the 30 second boundary, i.e. start sending code at 27 seconds past with first ‘0’ bit.

Hour	Minutes	Seconds
Any	08	30
Any	18	30
Any	28	30
Any	38	30
Any	48	30
Any	58	30

When the controller receives the second “1” bit (at the end of the code), it checks to see if the real time clock is within 29 seconds of the synch time. If it is, the controller sets the clock to 30.0 seconds past the minute. The hour is disregarded by the controller check.

For example, if the synch code is sent at the time “06:08:30” and real time clock is between “06:08:01” and “06:08:59”, it will be re-synchronised to “06:08:30” and the confirm bit ‘CC1’ is activated, see section 21.3.24.

If the real time clock in the controller is more than 29 seconds out, i.e. the minutes is not one of those listed above, e.g. the time in the controller is “06:09:02”, the synchronisation code is ignored and synchronisation confirm (‘CC1’) is not returned.

21.3.24 RTC Synchronisation Confirm (CC1)

A ‘CC1’ reply bit may be returned to confirm the synchronisation of the RTC (see section 11.3.23 above). The ‘CC1’ confirm signal is maintained for a pre-set period, configurable in 1-second steps, but is normally set to 3 seconds. If the clock synchronisation fails, the ‘CC1’ reply bit remains inactive.

21.3.25 Take Over (TO)

A ‘TO’ control bit may be programmed so that no ‘F’ bits will be effective unless ‘TO’ is present. The ‘TO’ can also be programmed to inhibit the local link to an adjacent controller for example. Also see section 21.5.

21.3.26 Take Over Confirm (TOR)

A ‘TOR’ reply bit may be returned to indicate that UTC mode is active.

21.3.27 Transmission Confirm (TC)

The 'TC' input is not a transmitted control bit but an output from the OTU to the controller. Its presence indicates that valid transmission is being received from the central computer. No control bits are actioned unless 'TC' is active. Also see section 21.5.

21.4 Miscellaneous Reply Bits

21.4.1 Controller Fault (CF)

A 'CF' reply bit may be returned to indicate that there is an entry in the controller fault log. If 'DF' and 'LF' reply bits are also configured, the 'CF' reply bit can be configured to ignore DFM faults and lamp faults.

21.4.2 Detector Fault (DF)

A 'DF' reply bit may be returned to indicate that the Detector Fault Monitor has detected a faulty detector.

21.4.3 Lamp Fault (LF)

An 'LF' reply bit may be returned to indicate that the controller has confirmed one or more lamp faults.

21.4.4 Manual Control Mode (MC) and Remote Reconnect (RR)

Either an 'MC' or 'RR' reply bit may be returned to indicate any of the following conditions:

- Manual mode operating.
- Manual mode selected.
- 'Normal' mode select button not selected, i.e. Manual, FT or VA selected.
- 'RR' button pressed on the Manual Panel (if configured).

When 'MC' or 'RR' is active, the central office the computer releases control. When 'MC' or 'RR' is no longer active, the computer will regain control without having to be reset by the operator, unlike 'G1/G2' (see section 21.3.2).

Normally 'MC' and 'RR' are used to request the computer to release control or to inform it that the controller has adopted a higher priority mode by selection, i.e. Manual, Fixed Time or Vehicle Actuated.

If Manual mode is a lower priority than UTC mode, 'RR' bit is activated when manual mode is selected and is used to request the computer to release control so that the controller may be operated manually. When NORMAL is selected on the mode buttons, 'RR' will stop being sent and the computer will automatically regain control.

21.4.5 First Group Confirm (GR1)

A 'GR1' reply bit may be returned to indicate that the first group, i.e. Group 0, of the current CLF plan is active, regardless of whether CLF is the current mode or not. Note that the first CLF group influence may not be configured to start at the beginning of the CLF cycle; compare and contrast GR1 with CYC which follows.

21.4.6 Start of CLF Cycle (CYC)

A 'CYC' reply bit may be returned to indicate the start of the CLF cycle, regardless of whether CLF is the current mode or not. The reply is activated for three seconds, starting when the CLF cycle timer (CCT) returns to zero.

21.4.7 Hurry Call Confirm (HC)

An 'HC' bit may be returned to indicate that a Hurry Call is being actioned.

21.4.8 Test Facility (TF)

A 'TF' reply bit may be returned to indicate that the handset has been plugged in.

21.5 UTC Mode Conditions

Any one of three conditions may be used to indicate UTC control:

a. Force bits present (any one of the 'F' bits present)

b. Force bits and TC/TO present (any one of the 'F' bits and 'TC' or 'TO' present)

c. TC/TO present (any control bit and 'TC' or 'TO' present)

The above conditions may not cause UTC mode to become the current mode due to the mode priority structure. UTC may be active without being the current mode and certain control bits may have an influence in the current mode.

Conditions a or b will cause the UTC ACTIVE indicator on the Manual Panel to be illuminated, if configured.

21.6 Methods of Control

There are two options which govern the method of control: The references following each option are the UK Highways Agency specifications that may be consulted.

Option 1

Under Option 1, a stage change will not occur unless the 'F' bit for the current stage is lifted and there is an 'F' bit (with a demand if necessary) for the next stage. (MCE 0105/0106)

Option 2

Under Option 2, all stages are demand and extension dependent. A stage change will not occur unless there are no extensions for the current stage or the 'F' bit is lifted and there is a demand for the next stage with or without an 'F' bit. (TCD 316)

21.7 Method of Plan Introduction

Certain contracts require that the controller must synchronise with the Plan quickly. To achieve this, the following constraints are placed on the UTC facility:

The Stage movement restraints table used by UTC should not have purely prohibited moves or Ignore moves configured. They should either be allowed moves or, if this is not acceptable for safety reasons, alternative moves should be specified. If alternatives are specified, it is preferable for the alternative stage to be one or two stages ahead in cyclic order of the original target stage, for example:

If the move 1-2 is not to be allowed,
Then the alternative could be 1-3 or 1-4.

21.8 Special UTC Requirements

Special UTC requirements that can be programmed using special conditioning may include (but are not limited to) the following:

- One 'G' bit for more than one stage. Normally the 'G' bit does not stay active during the interstage between the stages. If this is required, a dummy phase is allocated to all the stages that are to return the 'G' bit. The dummy phase will then remain active during the interstage and is programmed to return the 'G' bit instead of the stages active.
- UTC mode active disables selection of VA or Fixed Time mode.
- Fixed Time mode or Manual mode active returns 'G1/G2' and the current 'G' bit.
- Special stage change conditions.

21.9 OTU Links

A Gemini OTU connected to a controller may also control and monitor an adjacent controller over a cabled link.

21.10 UTC Parallel Stage Streaming Facilities

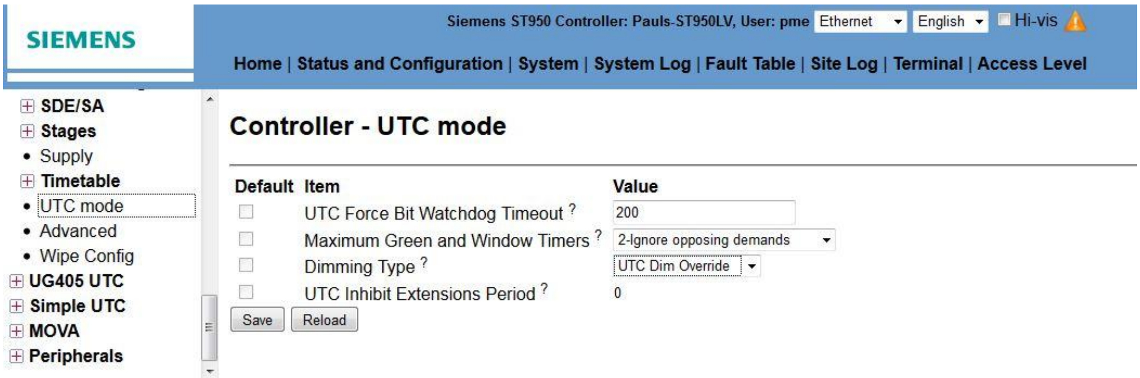
UTC mode can be active on any or all of the streams. Each stream will normally enter UTC mode and respond to the force bits configured for stages in that stream independently of the other streams. If there are force bits present on any stream, the UTC active lamp will illuminate on the Manual Panel, if configured.

The stage confirm bits, including the G1/G2 condition, are also stream based, see section 21.3.2.

However, if it is required to have Master-Master UTC Linking (i.e. if UTC mode is to operate on any stream, force bits are required to be present for all streams) special conditioning is required. It can disable UTC mode on the relevant streams until force bits are available on all the required streams.

21.11 Monitoring and Modifying

UTC mode can be modified using the Controller - UTC mode web page.



22 MOVA MODE

22.1 Introduction

A MOVA Mode has been introduced to better integrate MOVA into the controller. This section covers the new 'MOVA Mode' facilities of the ST950, and explains how this differs from the ST800/ST900 'Serial MOVA' facility. Serial MOVA is available on the ST950 for use with a semi-integral Gemini, but cannot take advantage of the new MOVA Mode features.

In summary, the ST950 includes a new separate mode for its fully integrated MOVA. This mode has its own unique mode number* and position in the mode priority table. The definition of the Force and Confirm Bits for MOVA can be configured differently to that used by UTC mode. The method of operation is to configure UTC mode higher priority than MOVA mode, so that UTC mode runs if there are any UTC Force Bits active, otherwise MOVA mode will be permitted.

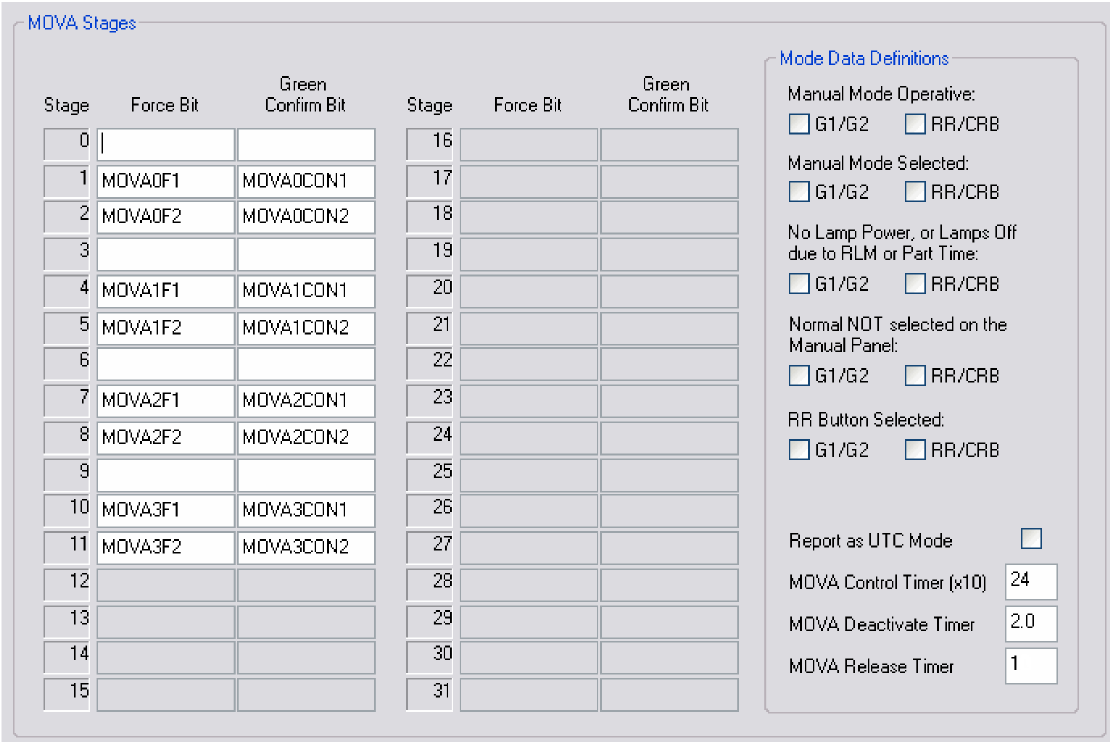
This enhancement aims to solve the following issues with having one mode for both UTC and MOVA:

- Special Conditioning is required to map the MOVA force and reply bits to the UTC bits.
- Special Conditioning is required if the mode priorities are different.
- UTC may use different control and reply bits.
- UTC may want to use demand-dependent force bits (MOVA never does).
- The priority between Serial-UTC and Serial-MOVA is handled by the Gemini unit, but free-standing UTC with Serial-MOVA requires this to be done by the controller - inconsistent.

* For compatibility with older external equipment, the ST950 includes an option to report MOVA mode as mode number 6 (UTC mode) rather than its new number. This only affects the "MOD" handset command and the mode number in the status message sent to a Serial OMU. Other features, such as the "STS" handset command and Special Conditioning, continue to see the new mode number. This compatibility feature can be enabled and disabled in the IC4 configuration, on a web page or by using the handset command MVU.

22.2 MOVA Force / Confirm Bits

Configuration of the MOVA mode Force and Confirm Bits is through a new IC4 screen, which is similar to the standard UTC stage and mode definition screen.



In place of the names F1, F2… and G1, G2…, which for UTC would be user defined names from the UTC control and reply word screen, for MOVA the user enters special MOVA mnemonics MOVA0F1, MOVA0F2… and MOVA0CON1, MOVA0CON2… to identify which MOVA stream (e.g. “MOVA0”) and MOVA force/confirm bit (e.g. “F1”) relates to each Controller stage.

Instead of a MOVAxxx mnemonic, any Special Conditioning scratch bit mnemonic can be entered in any force or confirm bit box to allow the function to be modified by Special Conditioning. For example, where one MOVA force bit selects one of two stages in the Controller depending on local conditions.

Limitation: Special Conditioning must not simultaneously activate more than one stage force bit in a stream. MOVA mode only expects MOVA to activate one force bit at a time.

Special Conditioning can write to any MOVAxCONx mnemonic not entered on this screen to control those additional MOVA confirm bits. This can be used to create any phase confirm bits required by MOVA or any other special functions.

The G1/G2 and RR/CRB options in the Mode Data Definitions area of the MOVA version of this screen remain. These options on the MOVA version of this screen are specific to MOVA mode and thus can be set different to the options for UTC mode.

The G1/G2 options allow the user to configure the conditions to set all MOVA confirm bits active.

The RR/CRB options allow the user to configure the conditions to drop the CRB signal to MOVA, and works in addition to the automatic mode priority control described later. This mirrors the same operation used by Serial MOVA.

Important: The automatic generation of the CRB bit to each MOVA kernel assumes a one-to-one mapping of MOVA kernels (0-3) to the controller streams (0-3). If this is not the case, Special Conditioning is required to generate the correct CRB bits for the MOVA kernels.

22.3 MOVA Mode vs. UTC Mode

MOVA mode is enabled and assigned a mode priority on the Modes and Facilities IC4 Screen. This screen gives the user the following options:

- Facilities:
    - Serial/Internal UTMC-OTU
    - Free-Standing OTU
    - Integral TC12 OTU (Integral OTU is not available on the ST950)
    - Serial MOVA
- Modes:
    - UTC (mode)
    - MOVA Mode

When MOVA mode is selected, Serial MOVA will be unavailable, and vice versa. MOVA Mode always uses the built-in MOVA applications and Serial MOVA always uses an external Gemini.

UTC mode is automatically selected when any OTU/MOVA facilities are selected. UTC mode is **NOT** automatically selected when MOVA Mode is selected. If only MOVA Mode is required, there is no need to select UTC mode (or one of the facilities).

With MOVA Mode selected, the user can also select Serial/Internal UTC and/or Free-Standing OTU. These two facilities are configured using the original UTC screens and work as on the ST900.

On the ST950, Serial UTC interface can either use an external Gemini (for DUSC for example) or the built-in UTMC application. However, if MOVA Mode is selected, then only the built-in UTMC application can be used because the ST950 does not support internal MOVA and Serial UTC communications simultaneously.

22.4 MOVA Mode Priority

The Mode Priority table is extended to include MOVA mode. Its position in the table is below UTC mode and above CLF, VA and FT. This implies the default priority to the user, but the user can rearrange the priority as required.

The Controller automatically controls the Controller Ready Bit (CRB) to each MOVA Stream, such that the CRB will only be activated if MOVA mode is enabled and no higher priority mode is active. See the sub-section on MOVA CRB for more details.

IMPORTANT: Vehicle Actuated or Fixed Time mode must be still be configured as the **lowest** priority modes; do not disable those modes and rely solely on MOVA mode as the 'fallback' mode. When the mode priority table determines that MOVA mode is permitted to run, MOVA will receive the 'Controller Ready' indication but MOVA will not immediately take control / activate a Force Bit. Until MOVA activates a Force Bit, MOVA mode will not become active in the Controller. Therefore, the Controller should be configured to run Vehicle Actuated or Fixed Time mode until MOVA takes control and activates a Force Bit, which is when MOVA mode will become active and VA or FT mode will cease.

22.5 MOVA CRB

The Controller automatically controls the Controller Ready Bit (CRB) to each MOVA Stream, such that the CRB will only be activated if MOVA mode is enabled and no higher priority mode is active. The Controller will also de-activate the CRB bit if the configured G1/G2 or RR/CRB conditions have been triggered. Special Conditioning can also override the state of each CRB bit.

When MOVA mode is allowed, the CRB to MOVA will be activated by the Controller allowing MOVA to take control. MOVA mode will only become the active mode when MOVA sends an active force bit.

If MOVA has not taken control after 240 seconds, the Controller de-activates CRB for 2.0 seconds and then activates it again. These default periods can be modified, with values in the range 1 to 255 and 0.2 to 31.8 seconds respectively. If either value is zero, the feature is disabled; CRB remains active and is not 'pulsed'.

When MOVA mode is no longer permitted, the CRB to MOVA will be de-activated by the Controller, requesting MOVA releases control. The confirm bits to MOVA are frozen until MOVA releases its force bit. This avoids the situation where the controller makes an immediate stage change requested by the new mode, but this is unexpected to MOVA which raises a fault because it believes it is still in control. In case MOVA does not release control when requested, the confirm bits are only frozen for 1 second. This default period can be modified, with values in the range 0 to 255 seconds.

The automatic control of CRB is done on a stream basis and assumes MOVA Kernel #0 is associated with Controller Stream #0, MOVA Kernel #1 with Controller Stream #1, and so on. If this is not the case, Special Conditioning **MUST** be used to control the CRB indications.

This automatic control of CRB provides the following operation on individual streams.

MOVA mode is not permitted to run (CRB inactive and force bits ignored) if:

- MOVA mode is disabled,
- The Signals are switched OFF (using the RR/CRB conditions), or
- A higher priority mode is active, e.g.
    - Controller in the part-time off/flashing state
    - A Hurry Call is active
    - Manual Mode is selected and active
    - UTC Force Bits are active (from a UTC Instation or DUSC for example)
    - A CLF plan is active, e.g. requested by time of day
    - A vehicle needs special priority (e.g. Bus or Tram)

Note that there are options available for control of events such as Hurry Call and Priority. Both the Controller and MOVA include facilities to handle these events. The user can decide at configuration time which handles the event, or the priority between them. Examples:

- If the Controller is to action the event, configure the appropriate Controller modes higher priority than MOVA mode. This is the simplest to configure, but has the disadvantage that MOVA may not immediately regain control when the event ceases.
- If MOVA is to action the event, the Controller can also be configured to action the event in case is not on control. In this case, configure the appropriate Controller modes lower priority than MOVA mode. If these modes are already active, the CRB to MOVA can be forced inactive (using Special Conditioning) to delay MOVA taking control and allow the events to complete under the Controller's influence, if required.

22.6 UTC 'MO' Bit

The UTC 'MO' Bit is known as the MOVA Override Bit. When set by the UTC Instation, it permits MOVA to take control. In a combined UTMC OTU and MOVA unit, UTC has control and MOVA is disabled (using its CRB bit) while UTC communications with the Instation are active, unless the Instation sets this control bit, which allows MOVA to take control.

In a typical ST950 controller, there should be no need to provide or use a UTC 'MO' Bit. UTC mode will run when the Instation activates Force Bits and MOVA will usually run at other times (subject to higher priority modes). This is all taken care of by the ST950 controlling the CRB bit to MOVA.

However, if it is required that the UTC Instation controls when MOVA is to be disabled, an 'MO' Bit can be configured and, using controller Special Conditioning, this can be used to control the CRB to MOVA.

Unlike the software in a Serial or Free-Standing Gemini unit, which uses the UTC 'MO' Bit to directly control the priority between UTC and MOVA, the ST950 Controller software (including the UTMC OTU and MOVA applications) ignore the state of the UTC 'MO' Bit.

For Information: At the UTC Instation, the "MOVA" command, which allows the user to put a junction under MOVA control rather than UTC, will only be available if the MO bit has been configured. Also, an MO bit needs to be configured (to disable MOVA) if night-time timing checks are performed by UTC by inserting demands and running the phases to max.

22.7 MOVA Mode Status Flags

The following Special Conditioning mnemonics are new for MOVA mode - refer to the IC4 Help for more information.

- MOVAkESLIn – MOVA kernel 'k' (0-3): End of Saturation flow code for Link 'n' (1-60), referred to as 'ESLI' in the MOVA documentation and status messages.
- MOVAkSATLAn – MOVA kernel 'k' (0-3): Oversaturation on Lane 'n' (1-30).

22.8 MOVA Detectors

22.8.1 Serial MOVA and/or UTC

The IC4 screen allows the user to enter detector names for up to 64 MOVA Detectors and UTC SCOOT Detectors. Detector names entered on this screen are automatically added to the controller I/O screen, if not already present.

☑ Combined …

For multi-stream Serial MOVA, each MOVA kernel 'sees' the same 64 detectors, as does the UTMC-OTU.

22.8.2 MOVA Mode

For the MOVA mode on the ST950, this screen allows the detectors 'seen' by each MOVA stream and the OTU to be different.

On the screen is the option to select whether the detectors shown apply to 'all streams' (combined) or an individual MOVA stream, e.g. these MOVA Detectors apply to MOVA Kernel 0:

☐ Combined ○ UTC ⦿ MOVA 0 ○ MOVA 1 ○ MOVA 2 ○ MOVA 3

This allows a different combination of detector state to be presented to the OTU and to each MOVA kernel.

Although these screens allow up to 64 detectors to be configured for each of up to 4 MOVA kernels and the OTU, the limit on the maximum number of Controller inputs remains unchanged. In practice it means that all four MOVA kernels cannot each use 64 unique detectors.

By allowing each MOVA kernel freedom to use any of its 64 detectors, each MOVA data set can be configured in isolation. Detector numbers used by one MOVA kernel do not have to be avoided on other MOVA kernel. For example, two MOVA kernel can use MOVA Detector 1 for different purposes; a different detector can be used. The only proviso is that different detectors must have different names; if the same detector name is entered on these screens it is assumed to relate to the same detector input. In practice, this should not be an issue because MOVA detector names are usually named using the phase letter, loop type (e.g. 'X' or 'IN') and MOVA detector number, e.g. AX11. So with different MOVA kernel using different controller phases, the phase letter will uniquely identify different MOVA detectors.

22.8.3 Special Conditioning

Special Conditioning can read and modify the states of the MOVA Detectors before they are transmitted to MOVA:

MOVADETn - Serial MOVA, MOVA mode 'Combined' or UTMC-OTU
MOVA0DETn - MOVA mode Kernel 0
MOVA1DETn - MOVA mode Kernel 1
MOVA2DETn - MOVA mode Kernel 2
MOVA3DETn - MOVA mode Kernel 3

22.9 Monitoring and Modifying

MOVA mode can be modified using the Controller - MOVA mode web page.

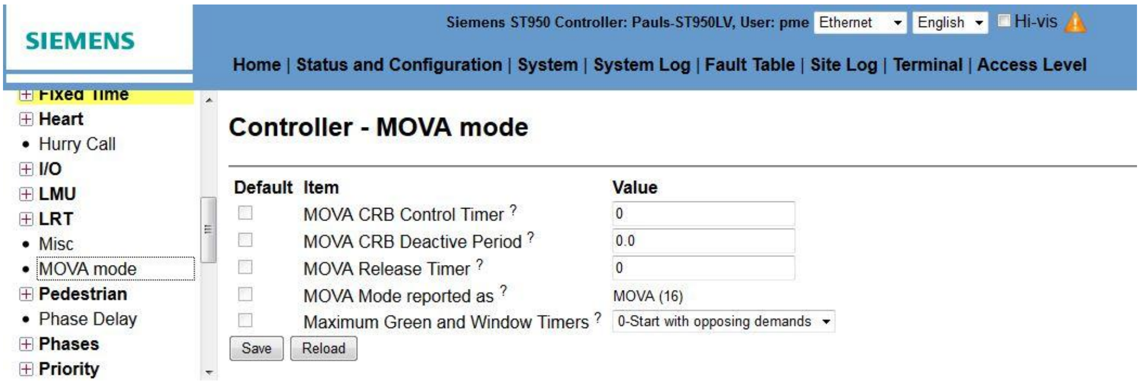


Figure 51 Controller - MOVA mode web page

23 PRIORITY AND EMERGENCY VEHICLE MODE

23.1 Introduction

Priority and Emergency Vehicle modes provide a facility in which appropriate vehicles have priority in gaining and holding ROW over other vehicles.

Selective Vehicle Detectors (SVD) or transponder interrogators which respond only to the appropriate type of vehicle, i.e. buses for Priority mode and ambulances or fire appliances for Emergency Vehicle mode, are used to distinguish the vehicles.

The output from the SVD or interrogator is used to insert a VA demand for the Priority Phase and also provides the input for the associated Priority Unit.

The VA demand ensures that the phase gains ROW if the Priority Unit is inhibited and also starts VA as well as priority maximum green timers.

The input into the Priority Unit is converted into a Priority Demand for a specified Priority Phase.

An operation of the priority vehicle detection equipment whilst the priority phase does not have right of way will, in addition to registering as priority demand, register as a normal demand. If a call/cancel unit normally calls the phase, a latching demand may still be registered.

The presence of a Priority Demand will cause Priority or Emergency Vehicle mode to become operational, subject to mode priority considerations. Right of way will then normally go immediately to the Priority Phase, subject to any delay caused by minimum green or inter-green periods timing off or any enforced stage sequences specified for safety or other reasons. Normally, all VA extensions will be curtailed and any VA demands will be skipped.

The Priority Unit will convert further outputs from the SVD while the Priority Phase has right of way into Priority Extensions. The Priority Extensions will hold the Priority Phase at right of way.

During Priority mode only:

- Any phases that have their VA extensions curtailed or their VA demands skipped may be compensated next time they have right of way.
- After a Priority Demand has been actioned, that demand and/or other Priority Demands may be inhibited for a specified period.

23.2 Monitoring and Updating

The priority mode settings can be reviewed and changed using web pages or handset commands. The following web pages are available.

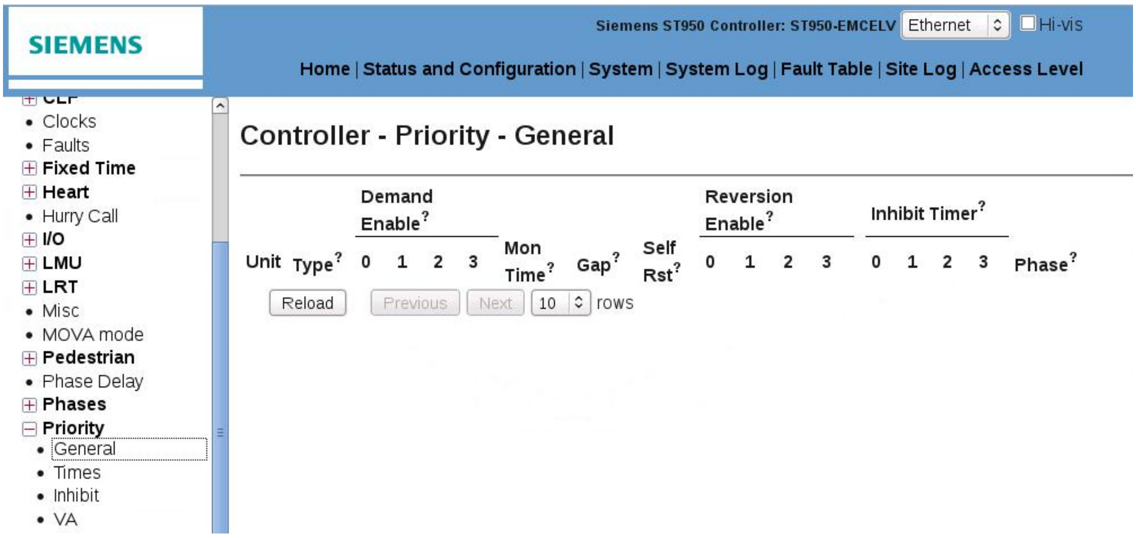


Figure 52 Controller - Priority - General web page

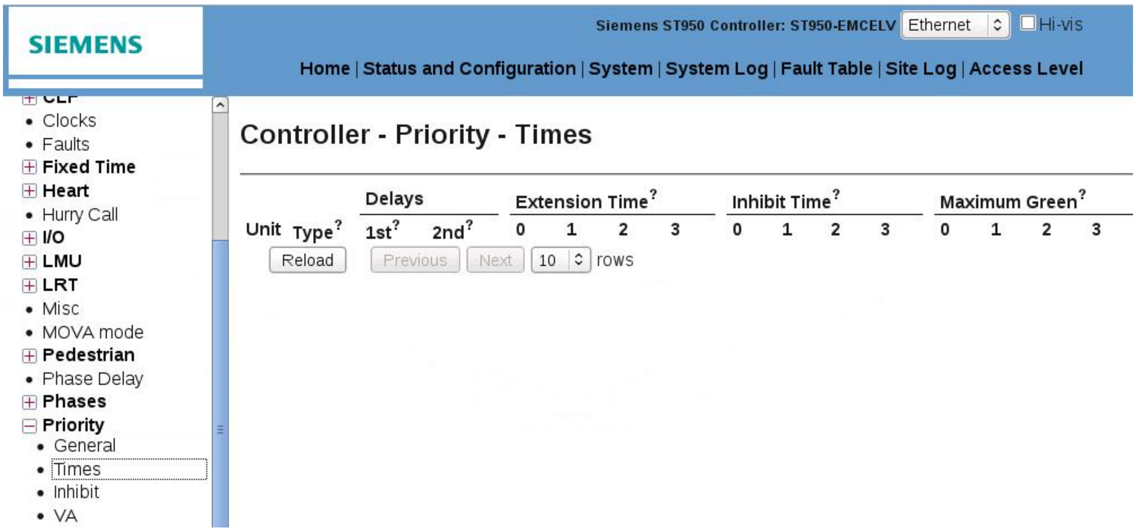


Figure 53 Controller - Priority - Times web page

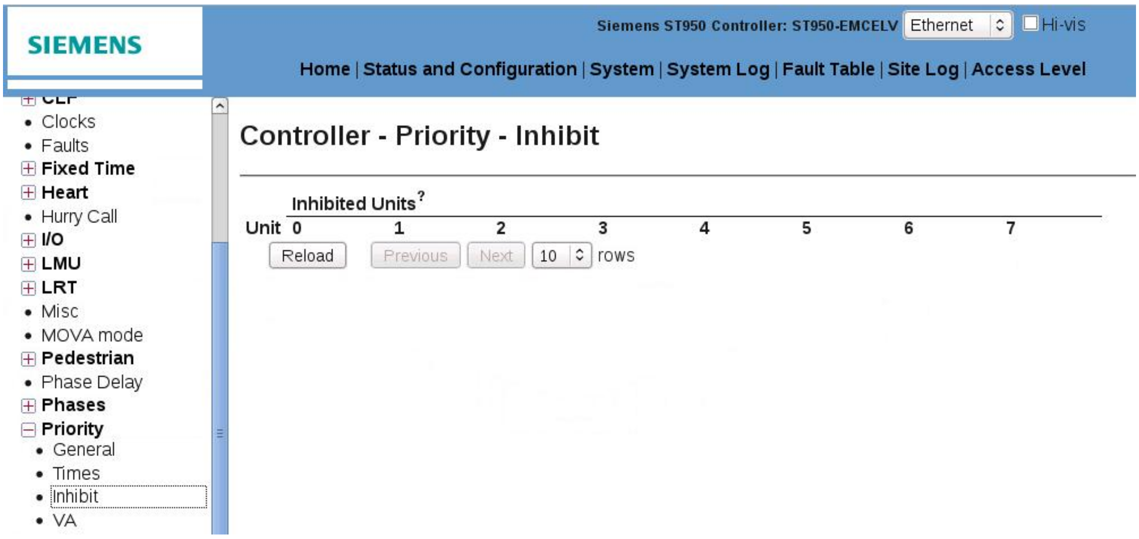


Figure 54 Controller - Priority - Inhibit web page

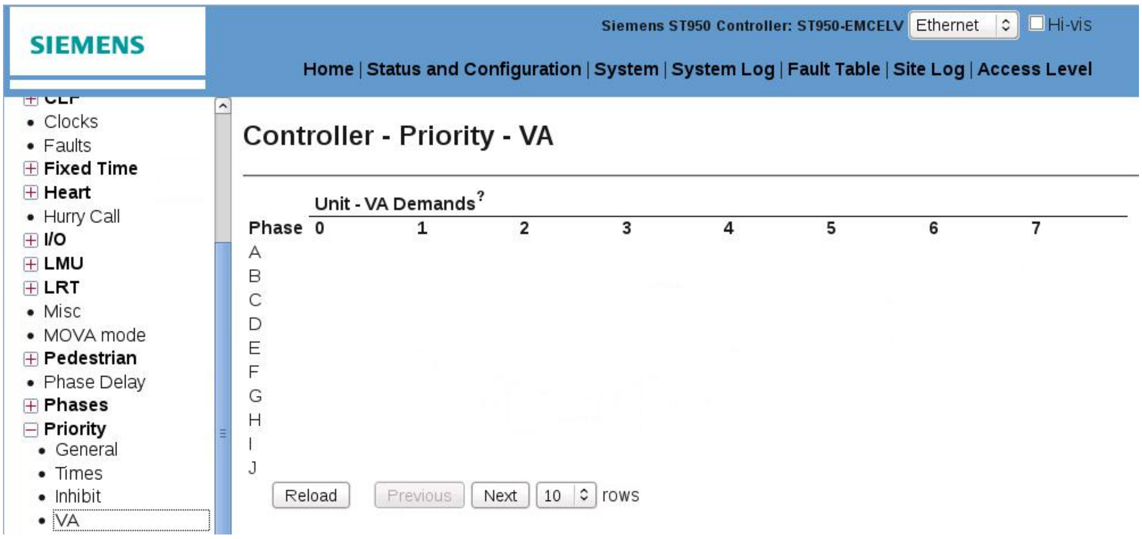


Figure 55 Controller - Priority - VA web page

23.3 Facilities

Both Priority and Emergency Vehicle modes have the same facilities unless otherwise stated. These facilities and timings are listed below and can be accessed by the web page or handset command in brackets.

23.3.1 Priority Units (Controller - Priority - General & PUT)

A Priority Unit can be regarded as a Priority Channel.

The required phase is allocated to a Priority Unit. The phase can then be regarded as a Priority Phase. The Priority facilities, e.g. Priority Timings or Priority Inhibits are set (via the configuration or the handset) for each Priority Unit. This in practice then affects the times, etc., associated with the Priority Phase.

There are 8 Priority Units available (numbered 0 to 7) which may be divided in any proportion between Priority and Emergency Vehicle Mode.

If both modes are used, the following conditions are applied:

- The Priority Units are allocated to Priority mode first.
- Emergency Vehicle mode is higher than Priority mode in the mode priority table.

23.3.2 Priority Phase (PUP)

A Priority Phase is a phase that is equipped with emergency vehicle and/or bus priority facilities. Each Priority Unit is allocated a Priority Phase.

The Priority Phase may either be a real phase or dummy phase (see example below) and may either be a phase in general use or used only for the priority facility.

Example: Consider an intersection where the phases overlap two or more stages. It may be required to demand a particular stage rather than one of the phases in order to guarantee free movement of the priority vehicle. Therefore, the priority phase could be configured as a dummy phase that is only configured in the required stage.

23.3.3 Priority Delay (Controller - Priority - Times & PFD & PSD)

A Priority Delay can be applied to a ‘Priority Input’ such that, when the Priority Input goes active, it does not apply a Priority demand on the controller until the Priority Delay Timer has expired. Also see Section 23.8.3.

23.3.4 Priority Demand (Controller - Priority - General & PDE)

A demand for an immediate right of way originating from vehicle(s) equipped to operate the priority vehicle detection equipment.

A Priority Demand for a Priority Phase is created by either its Priority Unit from an ‘SVD input’ or from the Revertive Priority Demand facility. The priority input may also be used to generate a V.A. demand for the same phase such that if Priority mode is unavailable for any reason the phase will still be serviced.

(N.B. Both priority demands and associated VA demands are latched. An Unlatched facility may be achieved by use of special conditioning.)

If a Priority Demand is not required, it may be disabled so that only Priority Extensions are created. This does mean that (although not Priority demanded), when the associated Priority phase reaches green, the controller will switch to Priority mode as Priority extensions are present and the Priority maximum timer will time off as normal.

If Priority mode is disabled, the associated VA demands will still be entered and serviced, and if the standard facility (which has latched Priority demands) is used, the Priority demands will be stored up until Priority mode is available again.

23.3.5 Priority Revertive Demand (Controller - Priority - General & PRE)

When a Priority Phase terminates with a Priority Extension still active, a Revertive Priority Demand is inserted for that Priority Phase, providing the Priority Demand facility has not been disabled.

If the Revertive Priority Demand facility is not required, it may be disabled without affecting the Priority Demand facility.

23.3.6 Priority Change

A Priority Change is a signal change that occurs as a result of a Priority Demand. As always, the signal change is subject to minimum green and inter-green periods.

23.3.7 Allowed VA Demands (Controller - Priority - VA & PSA)

When a Priority Demand is being actioned all VA demands are normally disregarded until after Priority or Emergency Vehicle mode has finished.

However, it is possible to specify phases that are to appear cyclically before the Priority phase (if VA demands are present).

The specified phases will only run for their minimum green period regardless of any VA extensions present.

Note: This facility is not compatible with priority phases of type 2 appearance, i.e. if the stage in which the priority phase appears is active when a priority demand is received, the priority phase appears immediately. At the same time unwanted “allowed” and “enforced VA demands” are entered, which may cause unnecessary timing of priority maximum and unnecessary stage changes when the priority phase terminates.

23.3.8 Enforce VA Demands (Controller - Priority - VA & PSE)

This facility works on the same basis as ‘Allowed VA Demands’ except that VA demands for the specified phases are inserted to ensure that the specified phases will run.

Note: This facility is not compatible with priority phases of type 2 appearance, i.e. if the stage in which the priority phase appears is active when a priority demand is received, the priority phase appears immediately. At the same time unwanted “allowed” and “enforced VA demands” are entered, which may cause unnecessary timing of priority maximum and unnecessary stage changes when the priority phase terminates.

23.3.9 Priority Extension (Controller - Priority - Times & PVE)

Outputs from the SVD while the Priority Phase is at right of way generate Priority Extensions. The Priority Extensions will hold the Priority Phase at right of way.

The timing range is 0 to 31.8 seconds in 0.2-second steps.

23.3.10 Priority Maximum Running Period (Controller - Priority - Times & PVM)

A further maximum running period which commences at the expiry of the normal maximum running period if a priority extension period is running or if a priority vehicle detector output is present.

The timing range is 0 to 255 seconds in 1-second steps.

23.3.11 Priority Units Inhibited (Priority Mode Only) (Controller - Priority - Inhibit & PUI)

When a Priority Phase gains right of way, it is possible to inhibit specified Priority Units (including the one at right of way) for a specified time.

23.3.12 Revertive Demands to Inhibit (Priority Mode Only) (Controller - Priority - General & PRI)

This facility allows the Priority Units inhibited facility to be activated when a Priority Phase gains right of way due to a Revertive Priority Demand being present.

23.3.13 Inhibit Period (Controller - Priority - Times & PVI)

A period following a priority change, during which priority changes originating from the same priority unit shall not occur, but priority extensions will still be serviced if the phase gains right of way through normal operation.

The Inhibit timer starts as soon as a priority phase gains right of way if it was a priority demand that requested right of way and if phases were curtailed or demands skipped in order for the priority phase to gain right of way.

A priority demand stored during the ‘inhibit period’ will be cancelled if the demanded phase is served at the normal VA level during the ‘inhibit period’ (this will also cancel the ‘inhibit period’).

The ‘Inhibit Period’ may be in the range 0 to 255 seconds in 1 second steps.

23.3.14 Compensation Period (PCA, PCB, …)

The compensation period is an extension to the normal maximum green time of the phase that will be introduced (next time the phase gains right of way) when the associated bus priority unit causes a priority change that curtails or skips the phase.

This gives the phase more green time after the priority change omitted or curtailed the phase. Note that a compensation period will only be introduced on a particular running phase if there is an outstanding vehicle extension present when the phase is curtailed.

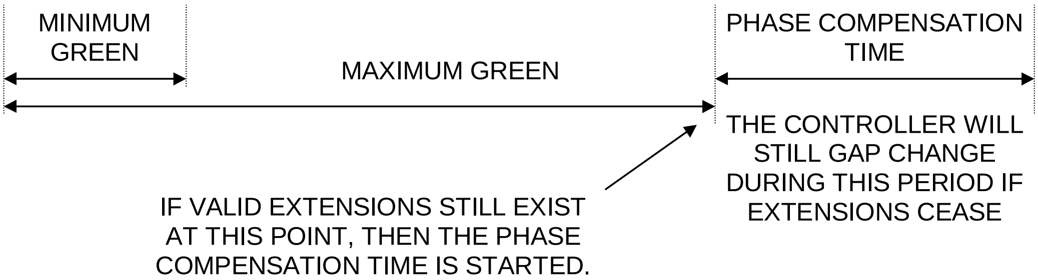


Figure 56 Phase Compensation

The timing range is 0 to 255 seconds in 1-second steps.

For every priority unit, up to four values can be specified for each phase, one for each priority timeset.

23.3.15 Emergency Vehicle DFM (Controller - Priority - General & PMT & PVG)

The operation of Priority DFM differs between Priority Units and Emergency Vehicle Units. See section 23.3.16 for Priority Vehicle Units.

The Emergency Vehicle Units may not operate for long periods due to their normal use and so are not considered for the Detector Fault Monitor (DFM). In order to monitor the input to an Emergency Vehicle Unit, a Monitor Time (PMT) is used. The ‘Monitor Time’ time range is 0 to 2550 seconds in 10-second steps.

If the input is active for longer than the configured Monitor Time (PMT), the input has been active for an abnormal amount of time and the unit is disabled, but no fault is logged.

For the purposes of Emergency Vehicle DFM, the input is not ‘confirmed’ as inactive until it has been inactive for longer than the configured Gap Time (PVG). The ‘Gap

Time' time range is 0 to 255 seconds in 1-second steps, and is sometimes referred to as the 'Detection Interrupt Period'.

If the input is inactive for less than the configured Gap Time, the timer for the Monitor Time continues to time, and the unit will be disabled if it expires.

Only when the input has been inactive for longer than the Gap Time, is the timer for the Monitor Time reset and the Emergency Vehicle Unit no longer disabled.

23.3.16 Priority Vehicle DFM (Controller - Priority - General & PMT & PVG)

The operation of Priority DFM differs between Priority Units and Emergency Vehicle Units. See section 23.3.15 for Emergency Vehicle Units.

The Priority Units may not operate for long periods due to their normal use and so are not considered for the Detector Fault Monitor (DFM). In order to monitor the input to a Priority Unit, a Priority Monitor Time (PMT) is used. The 'Priority Monitor Time' range is 0 to 2550 seconds in 10-second steps.

If the Priority Input is active for longer than the configured Monitor Time (PMT), the input has been active for an abnormal amount of time. When this occurs:

- The Priority Unit is disabled.
- A Priority DFM fault is logged.
- The Cabinet Alarm (if fitted) is illuminated.
- The count of 'good' activations is reset (see PDR below).

For the purposes of Priority Vehicle DFM, the input is not 'confirmed' as inactive until it has been inactive for longer than the configured Priority Vehicle Gap Time (PVG). The 'Gap Time' time range is 0 to 255 seconds in 1-second steps, and is sometimes referred to as the 'Detection Interrupt Period'.

If the input is inactive for less than the configured Gap Time, the timer for the Monitor Time continues to time, and the unit will be disabled if it expires. Only when the input has been inactive for longer than the Gap Time, is the timer for the Monitor Time reset.

The Priority Unit remains disabled until the fault is manually reset (by fault log reset or DFM reset) or automatically reset by the 'Priority DFM Reset' (PDR) feature, see section 23.3.17.

23.3.17 Priority Vehicle DFM Automatic Reset (Controller - Priority - General & PDR)

The 'Priority DFM Reset' (PDR) value specifies whether the priority DFM fault can only be reset manually, or whether it can be reset automatically by the controller. Automatic reset can be configured to occur when the input goes inactive (1 or 255) or after a number of good activations.

'Good' activations are activations of the priority input that do not remain active longer than the Monitor Time (PMT), each separated by a duration longer than the Gap Time (PVG). The values for priority DFM reset (PDR) are as follows:

Zero means manual reset.
1 or 255 means Automatic Reset when input goes inactive.

Any other value specifies the N'th activation on which the fault will be cleared and a priority demand accepted, e.g. the value of 16 should be used to clear the fault after the 15th activation (UK default for automatic reset).

23.4 Precedence Levels

For isolated operation, the normal order of precedence for the differing levels of priority (in descending order) shall be:

Emergency Vehicle Priority Mode
Hurry Call Mode
UTC Mode
Manual Mode
Manually Selected VA or FT Mode
CLF Mode
Bus Priority Mode
VA Mode
FT Mode

23.4.1 Servicing of Multiple Priority Requests

This section details how the facility normally handles requests from two or more Bus Priority Units or two or more Emergency Vehicle Priority Units. The following sections detail the interaction between a Bus Priority Unit and an Emergency Vehicle Priority Unit.

If two or more priority demands are stored at the termination of a minimum running period, the priority demands will be serviced in the normal cyclic order and not necessarily in order of receipt.

Note that if one stage can service both requested priority phases, the controller will move to that stage rather than service both phases one at a time. This is the same movement strategy as used in VA.

The presence of an output from a priority vehicle detector will, while the priority phase is running, hold the green signal. The cessation of the output will initiate a priority extension period. If one priority unit is extending one phase, a priority demand for another phase from another priority unit will be stored and serviced when the proper extension or priority maximum period expires.

Each signal phase omitted or curtailed by either priority change will always be serviced in the normal cyclic order following the priority changes. If the compensation periods are required on a phase as a result of two separate priority changes, these compensation periods will run concurrently.

23.4.2 Changes from a Lower to a Higher Priority Level

A change from Bus Priority mode to Emergency Vehicle mode will occur on receipt of a priority demand or extension for an Emergency Vehicle priority unit.

A change from other lower priority modes to either Bus Priority or Emergency Vehicle mode (as required) will occur on receipt of a priority demand or extension for the priority unit.

Emergency vehicle priority demands and/or extensions which are received whilst an ‘inhibit period’ on a bus priority unit is running, will be serviced immediately, subject to normal safety periods.

On a change from the bus priority level to the emergency vehicle priority level, all stored priority demands for phases, inhibit and compensation periods, at the bus priority level may be cancelled as the controller cycles to service the emergency vehicle request. Normal VA demands will be stored as usual.

Should an emergency vehicle priority extension request be received for the running phase whilst a bus priority extension period is running, the priority maximum period for the emergency vehicle priority level will commence from the expiry of the normal maximum running period as normal. However, should the emergency vehicle priority extension request be received after the normal maximum period has expired and the bus priority maximum has started, the emergency vehicle priority maximum running period will commence from the receipt of the emergency vehicle level priority extension.

23.4.3 Changes from Emergency Vehicle to Bus Priority Level

When all the conditions and requirements pertaining to the emergency vehicle priority facilities have been serviced, the controller will return to normal operation, or to bus priority mode if bus demands have been stored.

If a change from the emergency vehicle priority level occurs after the normal maximum running period has expired, a ‘max change’ to the next demanded stage in cyclic order will then occur, unless a bus extension is present or a bus demand stored for another phase.

If the change from the emergency vehicle priority level occurs while a phase is at right of way and before the normal maximum running period has expired, the receipt of a bus priority extension request on the phase will introduce a bus priority extension and priority maximum running period.

23.4.4 Other Changes of Level

If the required Bus or Emergency vehicle priority mode is configured higher than UTC mode in the mode priority table, force signals from the UTC Instation will be ignored while the priority mode is active.

If the priority mode is configured lower priority than UTC mode, while force signals from the UTC instation are being received and the controller is in UTC mode, requests for the priority mode will be ignored.

However, if the priority mode is already active when force signals are received from the UTC instation, the controller can be configured to operate in either of the following ways:

- (Default) The controller immediately enters UTC mode as normal, ignoring the request for priority mode and terminating any of its actions.
- However, if the ‘Introduction of UTC to be disable by Priority Mode’ (see the general UTC screen in IC4), the priority change is allowed to complete before the controller enters UTC mode.

23.5 Priority and Emergency Vehicle Parallel Stage Streaming Facilities

Each stream will move around its own stages according to its own Priority or Emergency Vehicle demands and extensions independent of any other streams.

However, if two or more priority units are configured on phases within the same stream they will interact, see section 23.4.

23.6 Visual Indications

A separate indicating light emitting source is normally provided, behind the Manual Panel door of the controller. Whilst a priority vehicle is detected, the handset may be used to determine which priority unit has been demanded.

For each priority stage equipped with an ‘inhibit period’, a display is available on the handset to indicate that an ‘inhibit period’ is running.

For each priority stage equipped with a compensation period, a display is available on the handset to indicate a compensation period is running.

Handset facilities are provided at the controller to enable:

- A permanent priority demand to be inserted.
- The priority facility to be permanently disabled.
- Insertion of a priority demand pulse.

23.7 Interfaces

23.7.1 Inputs

An input channel may be provided such that Condition ‘0’ will cause the bus priority facilities to be isolated. Bus priority demands need not be stored. The input will take effect irrespective of the state of computer control force bits.

23.7.2 Outputs

An output channel will be provided to indicate that stage confirmation signals may not be as required by the computer/linking plan. Condition ‘0’ will be returned to indicate that the controller is operating at a priority level (either bus or emergency vehicle).

A separate output channel for each bus priority stage may be specified. Condition ‘0’ will be returned to indicate the presence of a bus demand or extension.

A separate output channel for each emergency vehicle priority phase may be specified. Condition ‘0’ will be returned to indicate the operation of an emergency vehicle detector. (This may be used to synchronise a “green wave”).

23.8 Use of Priority Mode for Control in Light Rail Transit Systems

The separate LRT facility should be used when configuring for Light Rail Transit systems - refer to the LRT documentation for details. However, existing configurations using Priority mode in the way described here may be used on the ST950 (after conversion from ST900 to ST950 for example).

Below is a block diagram of the additional features available in Priority mode that may be used when controlling Light Rail Vehicles.

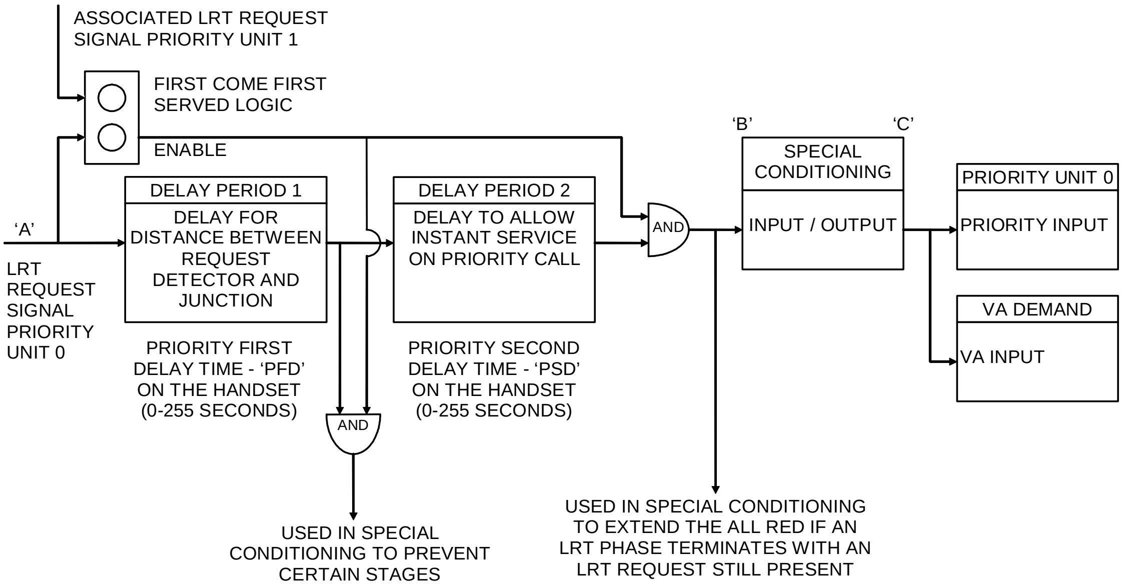


Figure 57 Priority Demand Order

23.8.1 Serving Priority Demands in Order of Receipt

In general the controller will serve the Priority Demands cyclically. On receipt of one or more 'Priority Demands' the controller will move to the next stage cyclically which serves a demanded Priority Phase. If another stage further round the cycle can serve this Priority Phase and another Priority Phase, the controller will move there instead. This is the same movement strategy as used in VA.

However, when using Priority Mode with a LRT System, in deciding which Priority Demand the controller will serve next, the controller needs to take into account that one LRV approach may be used by 2 LRV's which turn in different directions at the intersection.

When a signal is received indicating that the LRV Request for Unit 0 is active, a decision has to be made as to whether this Unit is one of a pair requesting ROW on the same approach. If they are, they must be served in order of receipt relative to each other. If they are not the same approach, they can be served cyclically. The information specifying which LRV units have to be treated as pairs is entered at configuration "associated priority unit".

When the LRV Request for Unit 0 goes active, the state of the LRV request for Unit 1 is tested. If this is not active, Unit 0 will be enabled, such that when its First Priority Delay timer has expired, it will set a flag readable by Special Conditioning.

This flag can be used during the 2nd delay period to inhibit moves other than to specified stages if required. This is to enable immediate servicing of the Priority Demand after the Second Priority Delay by avoiding the controller being caught in a stage change.

After expiry of this second delay timer, the request gets passed to special conditioning ('B') provided that Unit 0 request is enabled by the "first come first served logic", i.e. provided that a request for Unit 1 is not already present. If a request for Unit 1 is already present, the request for Unit 0 is stopped until the request for Unit 1 clears. If the request for Unit 0 clears before 1 clears, the request for Unit 0 is ignored.

The Priority Inputs at ‘B’ are inputs to the special Conditioning. The outputs from the Special Conditioning are shown at point ‘C’. The Special Conditioning outputs ‘C’ connect to the inputs of the Vehicle Priority Software. If the Priority signal does not require conditioning, point ‘B’ can effectively be connected directly to point ‘C’ without passing through Special Conditioning.

23.8.2 Extend All Red Option

It is also possible to use priority demand inputs to special conditioning (see ‘B’ on Figure 57) to extend the all red period between stages should a priority phase terminate with a priority demand input still active. This facility provides time to ensure that the LRV clears the junction. This is again achieved using the special conditioning facility.

23.8.3 Request Delays

There are two delay times that can be configured to allow for the travelling time of the LRV from the request detector to the junction.

The first delay covers the time that is not needed to process the priority request. This is normally due to the detector not being in the ideal position (for instance due to an intervening stop). During the first delay, the controller takes no action on the demand.

The second delay, which forms the later part of the overall delay before the priority vehicle actually reaches the junction, allows the controller to be prepared to give instant service to the vehicle. This is usually done by using special conditioning to prevent any stage moves except to a stage which will serve the requested phase.

This ensures that the inter-greens caused by the stage change and then the minimum green times of the phases in the new stage do not delay the required stage move.

There are 8 sets of (1st and 2nd) delay periods (0 - 7) these are normally associated with the respective priority units 0 to 7.

However, it is possible to allocate two or more sets of delays (2 or more inputs) to one priority unit in special conditioning. See the figure below.

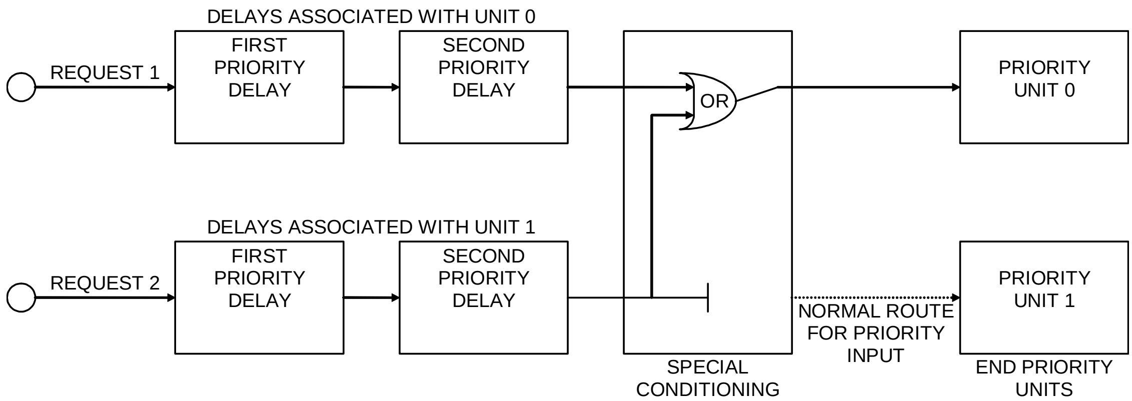


Figure 58 Two delays set for one Priority Unit

24 Hurry Call Mode

24.1 Introduction

A 'hurry call' demand gives precedence to a particular stage to ensure that a green signal is given to certain vehicles.

Hurry calls may be used at junctions, e.g. near to fire or ambulance stations, to ensure that certain vehicles are given right of way, or in conjunction with queue detectors, to prevent blocking of a junction.

Immediately a valid hurry call is received, the HURRY ACTIVE indicator on the Manual Panel illuminates and remains illuminated until the end of the hold period. A hurry call is valid provided its prevent timer is not active due to a previous hurry call and the delay timer for any higher priority hurry call is not active. A cancel input for each hurry call enables the process to be terminated any time during the delay, hold or prevent periods.

24.2 Detailed Operation

There are eight hurry call units available on the controller (numbered 0 to 7) and the facilities described below exist for each individual hurry call unit.

The hurry call for a stage is normally generated from a remote push button or special detectors, but other calling conditions can be used if required.

On receipt of a hurry call request, the controller will go into Hurry Call Mode after a pre-set delay, the hurry call delay period, providing the request should not be rejected, see below:

The reasons for a request being rejected may be:

- The controller is in a higher priority mode,
- The prevent timer being active,
- The delay timer for a higher priority hurry call being active (see section 24.5),
- The prevent timer on another hurry call unit is active (see section 24.5).
- Hurry Call mode being disabled (see section 24.3 for some examples).

On expiry of the hurry call delay period, the controller moves immediately to the requested stage, subject to stage movement restrictions, provided the inter-green timings and minimum green timings associated with phases in the currently running stage have expired. Extensions for running phases are ignored.

If the requested move to the hurry call stage is not permitted directly, the controller can be programmed to move via the all red stage or other specified permitted stage movements to the hurry call stage. If the move is accomplished via one or more alternative stages, these stages terminate when their phase minimum green timings expire. During the move to the called stage, any active inter-green / all-red extensions are implemented.

With the hurry call stage active, the condition is held for a pre-set period, the hurry call hold period, irrespective of the condition of the minimum, extension and maximum green timers for phases in the stage. At the end of the hold period, the controller returns to a lower priority mode. Caution: Hurry call mode must be allocated a higher priority than VA.

Note that if the movement is cut short by a higher priority mode, the hurry call request remains active and is serviced after the higher priority mode unless, in the course of operating in the higher priority mode, the cancel input is activated (see section 24.3).

The hurry call prevent time allows programming of the minimum period between repeats of the same call. With the prevent timer for a call running, incoming calls are rejected. The ‘PHC prevent time’ starts at the same time as the ‘HHC hold time’.

24.3 Additional Facilities

The following additional facilities can be configured using Special Conditioning:

Hurry call request watchdog

A request for a hurry call unit persisting for longer than the request watchdog period will cause hurry call mode to be unavailable and an entry made in the fault log. Hurry call mode will be unavailable until hurry call fault log entries are cleared.

Hurry call watchdog

A period for which the controller may remain in a hurry call mode. If the controller remains in hurry call mode for longer than the watchdog period, the hurry call mode will become unavailable and an entry made in the fault log. Hurry call will be unavailable until hurry call fault log entries are cleared.

Cancel input

A separate input can be configured to cancel the hurry call. If the cancel input becomes active during the hold period, the controller will drop out of hurry call mode. If the cancel input becomes active during the hold period, the prevent timer is also reset, thus the same hurry call can cause hurry mode to become active again immediately, without waiting for a prevent time to expire. However, if a ‘prevent time’ is still required, this may be implemented in special conditioning.

Hurry call ‘call/cancel’ facility

When the hurry call input goes inactive, this is taken by special conditioning to be a cancel signal and the special conditioning then sets the cancel input for the hurry call ‘true’.

Acknowledge/Confirm output

An output can be configured to confirm that a valid hurry call request has been received and accepted. If the request were not accepted due to any of the reasons mentioned in section 13.2, the output would not become active. This output may be used to activate a switching mechanism which illuminates an indicator at the origin of the hurry call request, e.g. Fire station, or it may be used as a confirm signal for a UTC system.

24.4 Hurry Call Parallel Stage Streaming Facilities

Eight Hurry Call units are available, numbered 0 to 7. Each is assigned to one stage and thus only affects the stream in which the stage resides.

If 2 or more hurry call units are allocated to different stages but in the same stream, they will be actioned on the basis of hurry call unit 0 being the highest priority and unit 7 being the lowest, see section 24.5 below.

However, if they are allocated to stages in different streams, they will be actioned simultaneously, neither having precedence over the other nor affecting each other in any way.

24.5 Priority of One Hurry Call Over Another

There are eight hurry call units available 0 to 7 that can be allocated over the eight streams.

If two or more hurry calls are allocated to stages in the same stream, they are actioned on the basis that hurry call unit 0 has the highest priority and hurry call unit 7 has the lowest. If they are allocated to stages in different streams, see section 24.4 above.

If a request for lower priority hurry call occurs while the delay period of a higher priority hurry call is timing, the request for the lower priority hurry call is rejected (it is not latched in by the controller).

If a request for higher priority hurry call occurs while the delay or hold period of a lower priority hurry call is timing, the request for the lower priority hurry call is interrupted and the controller moves to serve the higher priority hurry call.

After serving the higher priority hurry call, the controller will return to the stage requested by the lower priority hurry call. However, if the lower priority hurry call was interrupted during its hold period, the hold period will have continued to time whilst the higher priority hurry call was being serviced. If it has expired by the time the controller returns to the stage requested by the lower priority hurry call, no hold will be applied. Thus, the controller may only stay in the stage for the duration of the minimum greens for the phases in the stage.

Special Conditioning may be used to further enhance this priority of Hurry Calls. For example, Special Conditioning may be written to prevent the lower priority hurry call input whilst the higher priority hurry call prevent timer is active. This may then be used to ensure a gap between hurry calls so that a controller is not unduly held up.

Note: If the Hurry Call is inserted from a momentary push-button it is advisable to use a Hurry Call Confirm output in the above instances, so that the sender knows if the Hurry Call has been accepted.

24.6 Control from a Remote Push-Button

If, on pressing the hurry request button, the confirm indication does not illuminate, then this indicates that the request has been rejected due to either:

- The controller is in a higher priority mode,
- The prevent timer being active,
- The delay timer for a higher priority hurry call being active (see section 24.5),
- The prevent timer on another hurry call unit is active (see section 24.5).
- Hurry Call mode being disabled (see section 24.3 for some examples).

The fact that the HURRY ACTIVE indicator is illuminated following the request only indicates that the hurry request has been accepted and latched into the controller. The servicing of the request may be delayed because a higher priority mode is active or a higher priority hurry call is requested.

In the case where UTC mode is a higher priority than the Hurry Call mode, on receipt of a valid hurry call request, the confirm indication will normally be transmitted to the central office for action. The central office would then either relinquish UTC control (allowing the controller to service the request) or by introducing a special hurry call plan under UTC control itself.

24.7 Control from a Queue Detector

Normally, the signal for the queue detector is processed by a call/cancel facility. While the output of the call/cancel is active it may be required to force and hold the hurry call stage indefinitely. To achieve this, the prevent period is set to zero and the hold period is set at some small value, say five seconds. When the hold period expires, the hurry call stage is immediately requested.

When the hurry call request from the call/cancel facility goes inactive, this is taken as a cancel request and the hurry call stage is terminated. (This requires special conditioning.)

The hurry call may be interrupted by a higher priority mode and on terminating this mode the hurry call is serviced again only if it is still requested.

24.8 Reviewing and Modifying

The Hurry Call parameters can be reviewed and modified using the Controller - Hurry Call web page. The range of all timings is from zero to 255 seconds in one second steps.

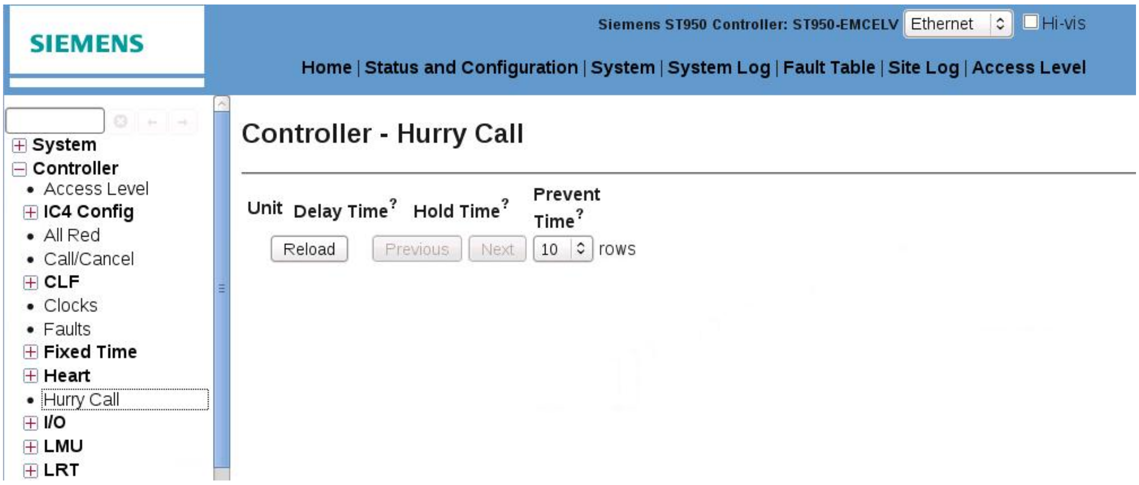


Figure 59 Controller - Hurry Call web page

Alternatively the following handset commands can be used to view and update the data items:

- DHC - Hurry Call delay period
- HHC - Hurry Call hold period

- PHC - Hurry Call prevent time

25 SELECTED MANUAL CONTROL MODE

25.1 Manual Mode

Manual mode selected on the Manual Panel is recognised as a mode for priority purposes. With the 'MANUAL' button pressed, manual mode will be selected providing there are no operating conditions for a higher priority mode.

During Manual mode, only 7 stages and the all-red condition (normally stage 0) are available to be selected by means of buttons on the Manual Panel.

No stage changes may be made until the last phase minimum green in the current stage has timed off. When the controller is ready to accept a selection, the 'AWAITING COMMAND' indicator illuminates and any subsequent button selection is actioned unless:

- A prohibited stage move is requested.
- The requested stage is deleted by the master time clock.

If any of these conditions occur, the 'PROHIBITED MOVE' indicator illuminates. In the case of (a) the stage can be selected via another stage change which is allowed, e.g. to the all-red stage, but in the case of (b), the stage cannot be selected until the master time clock inhibit is removed. Any phases deleted by the master time clock will not be active during Manual mode.

Note that if the requested stage move is configured to move via an alternative stage, that intermediate stage will run for just its minimum green times and then the controller will move to the requested stage.

When Manual Mode ceases, demands may be automatically inserted for selected non-running phases. These demands are normally inserted to ensure no vehicles are trapped against a red light, unless otherwise requested by a customer.

25.2 Allocation of Stages to Buttons

The all-red stage (Stage 0) is always allocated to the 'ALL RED' button.

Up to 7 of the remaining stages may be allocated to any of buttons 1 to 7. Button numbers would normally coincide with stage numbers although this is not necessarily so.

If the stage allocated to one of the buttons is active, the indicator by the button on the Manual Panel will illuminate. During the preceding interstage, the indicator will flash.

If a stage not assigned to any button is active, none of the indicators will be illuminated. If this is the case when manual mode is first selected, the stage will continue until a new stage is selected.

25.3 Manual Control Parallel Stage Streaming Facilities

For parallel Stage Streams, each stage button on the Manual Panel is configured to call a combination of stages, one from each stream. The associated indicator only illuminates when all of the streams reside in the configured stages.

Manual mode can be disabled on certain streams (using special conditioning) and those streams then run a lower priority mode, e.g. VA mode. Some streams can also be running a higher priority mode such as part-time or hurry call, while others run manual mode.

The Manual Panel only affects (and shows the state of) those streams actually running manual mode. If no stream is running manual mode, the indicator by the manual mode button on the Manual Panel will flash.

The Awaiting Command lamp will only illuminate when all phase minimums on all streams running in Manual Mode have expired and consequently allow further moves to be made using the Manual Buttons. A change is accepted as valid even if only one of the streams changes while the other streams are already in their required stages.

25.4 Manual Mode Enable/Disable Facility

Manual mode may be configured to be disabled until enabled by the user. Manual mode may be enabled and disabled using the Controller - Misc web page.

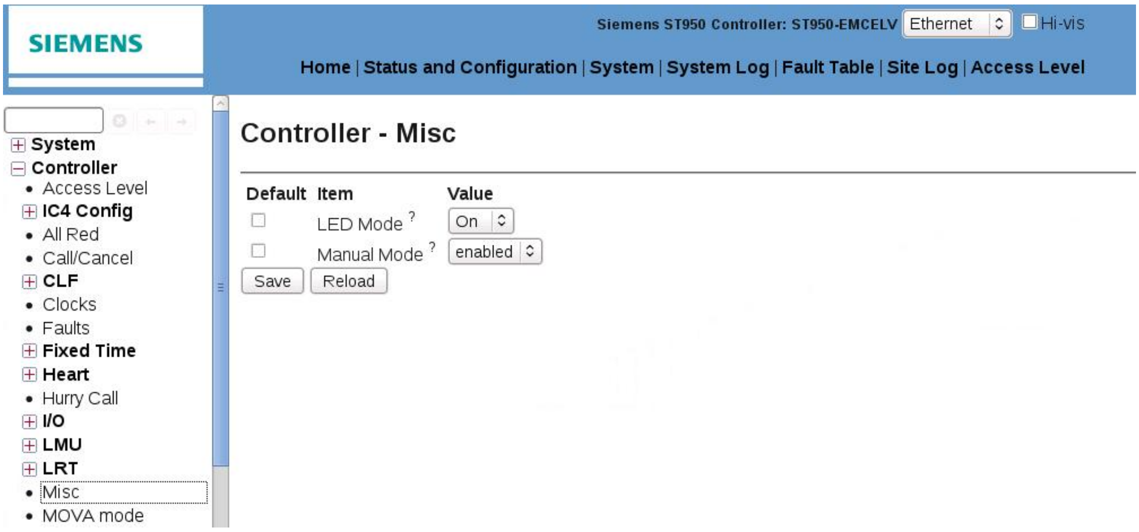


Figure 60 Controller - Misc web page

Manual mode can also be enabled and disabled using the MND handset command (MND=0 will enable manual mode and MND=1 will disable manual mode)

If manual mode is selected on the Manual Panel but manual mode is not running on any of the streams for any reason (including the above), the indicator by the MANUAL button will flash. In this case the controller runs the highest priority mode requested as though the NORMAL button had been pressed.

26 MANUAL STEP-ON MODE

26.1 Introduction

‘Manual Step-on mode’ can be configured instead or in addition to the ‘Manual mode’.

Manual step-on provides a single ‘step-on’ button rather than a number of individual ‘stage select’ buttons. When the ‘step-on’ button is pressed, the controller moves to the next stage in a pre-defined sequence.

Manual step-on also provides an ‘all-red’ button which is normally configured to put all the signals to their ‘not at right of way’ state, normally red.

A separate ‘manual step-on enable’ button or switch usually enables the mode.

26.2 Panel Buttons / Switches

If a Manual Step-On Panel is used and located behind the Manual Panel door, the normal Manual Panel facility is typically located inside the controller cabinet.

However, since the ‘all-red’, ‘step-on’ and ‘enable’ inputs to the facility are controlled using special conditioning, they can be configured to use any controller digital inputs or spare buttons on the normal Manual Panel for example.

Thus, as an alternative to using a separate ‘Manual Step-On Panel’, the controller can be configured to use the normal intersection Manual Panel for both manual and manual step-on modes. For example, Spare Switch 1 (SW1) can be configured to enable the facility, Spare Switch 2 (SW2) used to provide the ‘step-on’ button and the normal ‘All-Red’ button used to select the all-red stage.

26.3 Description

When Manual Step-on has been selected, i.e. enabled, the controller will go into Manual Step-on Mode, subject to the mode priority table.

It is then possible to request a stage change by operation of the ‘step-on’ push button.

The order in which stages are introduced in Manual Step-on is predefined in configuration (site data). The ‘step-on’ push button is operated to make the controller move on to the next designated stage. Having arrived at the next stage the controller may do one of two things depending on the option selected.

(a) Remain in that stage indefinitely, the controller being ready to respond to another operation of the ‘step-on’ push button, which if operated will send the controller to the next predefined stage,

OR

(b) Stay in one stage for a fixed period defined in the configuration and then automatically move to another pre-defined stage. The controller is then ready to respond to a further push button operation.

The user may change the operation between (a) and (b) as required, by means of the handset.

When the ‘all-red’ push button is operated, the controller will, subject to any safety periods, change to the All Red stage. The controller will stay in the All Red stage until the ‘step-on’ push button is operated when the controller will move to the next stage in the cycle following the stage prior to the call to the All Red stage. Alternatively, if the manual mode is switched off the controller moves to the stage required by the new mode.

Manual Step-On mode can be configured to be switched off when the ‘enable’ button is pressed again or the Manual Panel door is closed.

26.4 Manual Step-On Mode Parallel Stage Streaming Facilities

Each step is allocated a combination of stages, one from each stream, which will run simultaneously.

Note that this means the controller may need to make a few stage changes to become synchronised with the Manual Step-On facility when it is initially enabled.

27 SELECTED FIXED TIME, CLF OR VA MODE

27.1 Description

For priority purposes, "Selected FT or VA or CLF" mode is considered as one mode and is separate from those independent modes. The requests for this mode are the FT, VA and CLF buttons on the manual panel.

Example:

Mode Priorities:

1 Manual
2 Selected FT, VA or CLF
3 Hurry
4 Priority
5 UTC
6 CLF
7 VA
8 FT

This allows VA and FT modes to be configured as the lowest priority mode, i.e. the one in which the controller will operate if no higher priority modes are requested, while "Selected FT or VA or CLF" mode can be configured higher up the mode priority table, so that if necessary, the controller can be forced to operate in FT or VA mode, even if there are requests for modes of higher priority than the normal FT or VA or CLF mode.

This will allow the controller to be forced to operate in the selected mode even if any of modes 3-6 are requested to be active.

To select FT, VA or CLF, the appropriate mode select button on the Manual Panel must be selected.

Similarly to select Manual mode the MANUAL mode select button is selected and if Manual Control mode is a higher priority than the current mode, manual mode will become operational.

If when FT, VA, CLF or Manual has been selected and it is not a higher priority than the current mode, no change of mode will occur. The mode LED on the manual panel flashes to indicate that the mode has been requested but is not active (on any stream).

(N.B. Priority demands and associated VA demands are latched and will affect the operation if VA is selected. However Priority mode will not become operative and Priority maximums will not take effect.)

28 CABLELESS LINKING FACILITY (CLF) MODE

28.1 CLF Introduction

The ‘Cableless Linking Facility’ (CLF) allows a method of linking traffic intersections along routes within an area using timing information derived from the ‘Master Time Clock System’ in their controllers. Different Plans are used during the day to cater for varying traffic patterns.

Each CLF Plan has its own configurable ‘cycle time’. At configured times (known as ‘group times’) within this cycle time, ‘group influences’ are programmed to affect the operation of the controller.

Thus, at a particular time of day, a pre-defined plan can be introduced to enforce a set of fixed duration effects on the controller.

Therefore, several controllers can each have ‘Plans’ designed for them. If they are all introduced at pre-determined times and synchronised by an accurate Master Time Clock System in each controller, it can be seen that the actions of the controllers can be co-ordinated, so as to create a fixed time form of control for a whole area.

New features are available from Issue 6 onwards:

- Smooth CLF – available for basetime CLF and provides smooth entry into and between CLF plans (see section 28.10).
- CLF Step Size – allowing either a cycle time of up to 250 seconds in 1 second steps, or a cycle time of up to 500 seconds in 2 second steps.

28.2 Plan and Group Organisation

The configuration values described here can be viewed and modified using the Controller - CLF web pages.

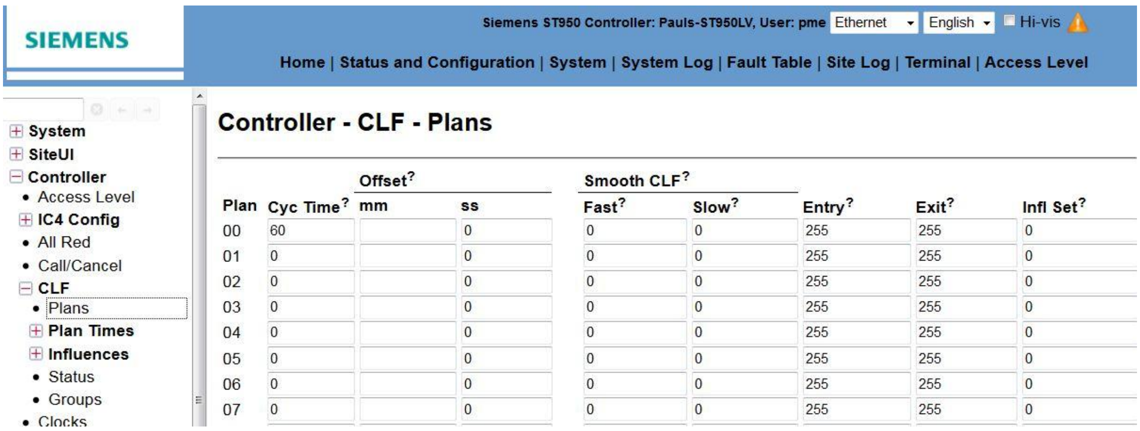


Figure 61 Controller - CLF - Plans web page

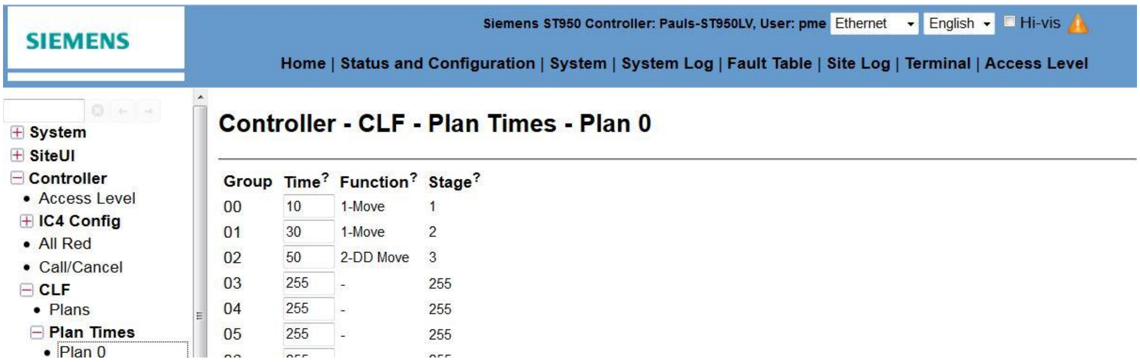


Figure 62 Controller - CLF – Plan Times web page

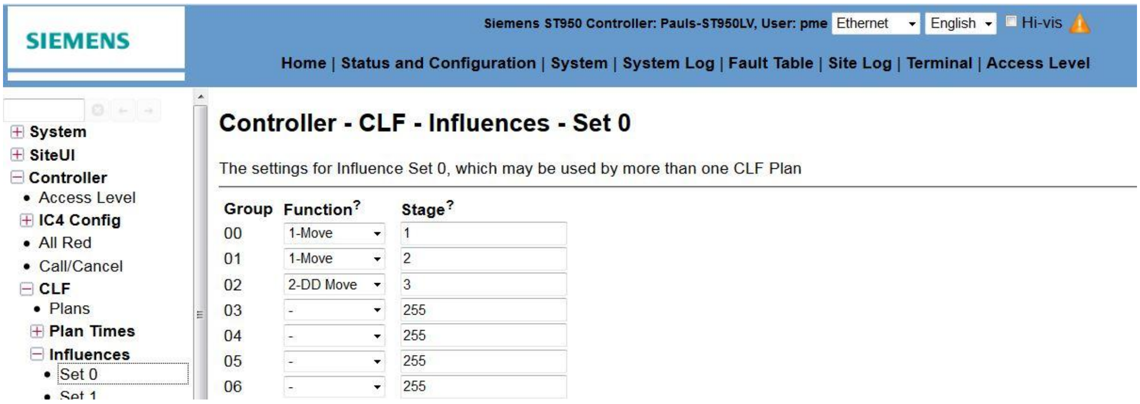


Figure 63 Controller - CLF – Influences web page

It is also possible to view and modify the items using the handset commands shown in brackets.

Operations in CLF mode are performed under control of up to 16 fixed time plans (numbered 0 to 15) and each plan consists of up to 32 groups (numbered 0 to 31).

The range of the (CYC) cycle time is 1 to 254 seconds in 1-second steps, or if the CLF Step Size is 2, the values are doubled allowing a cycle of up to 508 seconds in 2-second steps. The values 0 and 255 indicate that the plan is not configured.

The range of the (PLT) group times is 0 to ‘the cycle time minus 1’, in 1-second steps. Thus if the cycle time is configured as 60 seconds, the group times must be in the range 0 to 59 seconds. A value of 255 indicates that the group is not used.

Each CLF plan is assigned to an influence set (PLI).

Each influence set contains up to 32 group influences (see section 28.3).

More than one CLF plan can be assigned to the same influence set if the functions they are required to perform are identical and only the group times are different.

A CLF plan is normally introduced by a timetable setting with a function number of ‘1’. The setting consists of the day of week and time at which the change is to be effected and the plan number to be brought into operation. A timetable setting with function number of ‘0’ ‘isolates’ the controller, i.e. stops the current CLF plan so the controller reverts to a lower priority mode, such as VA mode.

The timetable settings that are programmed may be changed via the handset using the TSW or TTB command.

If the group timings, group influences and/or timetable settings are not known at the time that the controller is configured, they may be added at a later date using the handset.

28.3 Group Influences

Each group influence consists of a function (listed below) and an associated stage (or any stage within the stream). These can be modified using the IFN and IFS handset commands respectively and the CLF – Influences web pages:

0. ***GO VA (Isolate)*** - allows vehicle actuation to operate on the stream except that phase maximums have no effect and phases may only terminate on a gap change. The controller is still in CLF mode. This influence should not be confused with the facility to isolate from CLF mode using a timetable setting when full VA facilities with maximum timings will be operative.
1. ***IMMEDIATE MOVE (Move)*** - requests an immediate move to a specified stage subject to minimum green and inter-green timings and stage to stage movement restrictions.
2. ***DEMAND DEPENDENT MOVE (DD Move)*** - requests an IMMEDIATE MOVE to a specified stage providing a demand exists for a phase within that stage.
3. ***HOLD*** - does not allow any stage change to occur in this stream. ROW will remain on the current stage at the time of the group change. Care should be taken if this influence follows a move that goes via an alternative stage, e.g. all-red, as the controller could then be held in all-red.
4. ***PREVENT EXCEPT*** - prevent all moves except to a specified stage providing a demand exists for a phase within that stage and providing no extensions exist for terminating phases. This can used to prevent any stage changes (after a Demand Depend Move for example) and prior to an Immediate Move event (to the same stage specified here) to ensure that the controller is ready to action the Immediate Move event when the plan requests it.

Functions 5 to 7 are not normally required:

5. ***ADD IMMEDIATE MOVE (Add Im)*** - add an IMMEDIATE MOVE to the existing influence so that either influence may be actioned.
6. ***ADD DEMAND DEPENDENT MOVE (Add DD)*** - add a DEMAND DEPENDENT MOVE to the existing influence so that either influence may be actioned.
7. ***IGNORE*** - continue with previous influence.

Functions 8 and 9 only apply to stand-alone pedestrian streams:

8. ***INHIBIT PEDESTRIAN PHASE*** - prevent the appearance of the pedestrian phase and hold the vehicle phase at right of way. Specify any stage in the stream.
9. ***ALLOW PEDESTRIAN PHASE*** - allow the pedestrian phase to appear at right of way if demanded. Specify any stage in the stream.

Each group influence function continues to affect the stream containing the specified stage until the group time of a group influence that affects the same stream is reached in the CLF cycle. Meanwhile, influences that affect other streams may be actioned as their group times are reached. Also see section 28.7.

28.4 The Base Time CLF System

28.4.1 Base Time CLF Description

In the base-time CLF system, all plans are synchronised to a 'base time', regardless of when the plan is requested to take effect on the controller.

Typically the base time would be configured as 2.00am every day. However, the base time can be configured to include a date so that the CLF plans can be synchronised to midnight on January 1st for example, either every year or for a specified year, e.g. 1980.

Note that it is essential that all controllers that are required to run synchronised CLF plans must be configured with the same base time.

Therefore, the base time can be expressed in three different ways:

XX/XX/XX HH:MM:SS, e.g. XX/XX/XX 02:00:00

The 'base time' is a particular time today, e.g. 2am today (or 2am yesterday if the current time is before 2 o'clock in the morning).

DD/MM/XX HH:MM:SS, e.g. 01/01/XX 02:00:00

The 'base time' is a particular time on a particular date this year, e.g. 2am on January 1st. If the current time is 1am on January 1st, the base time will be set to January 1st last year.

DD/MM/YY HH:MM:SS, e.g. 01/01/80 00:00:00

The 'base time' is the specified time and date, e.g. midnight on January 1st 1980. Note that all years are assumed to be in the range 1970 to 2069.

The time of day in conjunction with the time switch settings determines which plan is controlling the intersection under CLF mode.

When a new plan is requested to start, the plan does not necessarily start at the beginning of its cycle time. Instead, the plan effectively resumes at the correct point within its cycle time as though it had been running since starting at the base time.

Because every controller is introducing plans as though they have all been running since the same base time, the actual time that a plan is requested to start is not critical.

28.4.2 Base Time CLF Example

Consider a controller configured with a base time of 2am, a cycle time for the plan of 70 seconds, and a request to start at 7:30am.

When the CLF plan is requested to start, the controller determines that 5½ hours have elapsed since the base time and the CLF plan would have effectively been repeating every 70 seconds since starting at 2am.

Therefore, dividing 5½ hours, which is 19800 seconds (5½x60x60), by 70 seconds gives 282 and a remainder of 60 seconds.

This means that the CLF plan would have completed 282 cycles and would be 60 seconds into the next cycle.

Therefore the CLF plan 'resumes' at time '60' within its 70-second cycle time and introduces the influences that would have been present if the plan had been running since starting at 2am.

28.4.3 Entry and Exit Times

Base Time CLF Plans can also be configured with 'Entry' and 'Exit' times:

- If the CLF plan requested to start has an 'Entry' time configured, the plan will not actually take effect until that point in its cycle time. The controller will continue to run a lower priority mode, e.g. VA mode.
- If the controller is requested to isolate, and the current CLF plan has an 'Exit' time configured, the plan will continue until it reaches that point in its cycle time. Only then will the controller revert to a lower priority mode, e.g. VA mode.
- If the controller is requested to start a new CLF plan while currently running a different CLF plan, the controller checks to see if the current plan has an Exit time configured and if the new plan has an Entry time configured:
    - If the current plan does not have an Exit time configured and the new plan does not have an Entry time configured, the new plan is introduced immediately.
    - If the current plan has an Exit time configured, the plan continues until that point in the cycle has been reached. The new plan will then start unless it has an Entry time configured. In this case, the controller reverts to a lower priority mode, e.g. VA mode, until the new plan reaches its configured Entry time and takes control.
    - If the current plan does not have an Exit time configured, but the new plan has an Entry time configured, the current plan continues until the new plan reaches its Entry time and takes control.

Always allow plenty of time between the Entry Time and the next group request in the Plan. For more consistent stage timings, Entry Times should not be set too close to the next stage request. If the Entry Time is set to a time towards the end of a Stage, the Stage will only be requested for a short time before the next stage is requested, which could result in stages running too short.

Examples: Stage 1 is called by an instruction at time 20 and Stage 2 at time 40. If the Entry Time is set to 20, Stage 1 is requested for 20s before Stage 2 is then requested, just like it is when the Plan is running normally. If the Entry Time is set to 30, Stage 1 is only requested for 10s before Stage 2, with the result that Stage 1 is likely to be still running minimum green periods when the request for Stage 2 is made.

The range for the (PLE) Entry time and the (PLX) Exit time is 0 to 'the cycle time minus 1', in 1-second steps. A value of 255 indicates that no entry/exit time is required.

28.5 Non Base Time CLF System

The non-base time CLF system is a configurable alternative to the base time CLF system.

This system does not use a 'base time'. When a CLF plan is requested to start, it starts at the beginning, i.e. at time '0', of its CLF cycle.

Therefore the time that a plan is requested to start (i.e. the time in the controller's timetable) is critical to ensure that the CLF plan is synchronised with other controllers in the same area. Also see section 28.6.

28.6 Offset Times and Linked Installations

28.6.1 Introduction to Offset Times

The CLF facility allows a number of controllers in an area to be synchronised allowing the traffic flowing between them to move more freely. Consider the following simple example:

The figures below show a simple linked installation covering three intersections on a main road into a city. The CLF facility is used at the controllers at each of the three intersections 'A', 'B' and 'C'.

Note that the plan start times are shown for a non-base time CLF system option described in section 28.6.3. For all other ways of working (as described in the rest of section 28.6), all the controllers will start running the plans at 08.30.00 and 16.15.00.

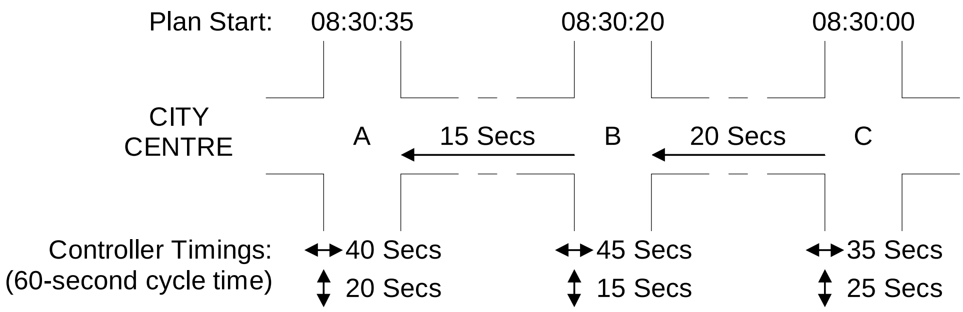


Figure 64 Simple Linked Installation (Morning Peak – Plan 0)

During morning peaks, traffic flowing into the city centre (C-B-A) is required to meet a succession of signals at green (a 'green wave'). Typically, free flowing morning peak traffic takes 20 seconds to travel from 'C' to 'B' and 15 seconds to travel from 'B' to 'A'. The main road lights at 'B' should therefore change to green 20 seconds after those at 'C', and those at 'A' a further 15 seconds later.

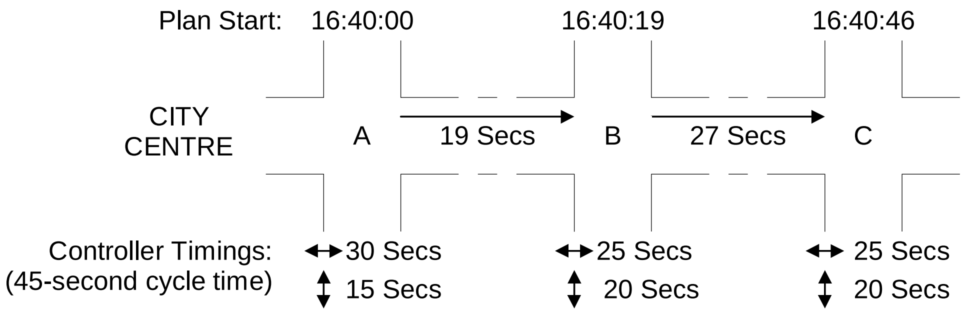


Figure 65 Simple Linked Installation (Evening Peak – Plan 1)

During evening peaks, traffic flowing out of the city centre (A-B-C) is also required to meet a succession of signals at green (a 'green wave'). Typically, free flowing evening peak traffic takes 19 seconds to travel from 'A' to 'B' and 27 seconds to travel from 'B' to 'C'. The main road lights at 'B' should therefore change to green 19 seconds after those at 'A', and those at 'C' a further 27 seconds later.

The required offsets between the controllers can be achieved several ways. These are described in the following sections:

- Section 28.6.2 "Using Plan Offset Times (Base Time CLF Only)"
- Section 28.6.3 "Using Different Start Times (Non Base Time CLF Only)"
- Section 28.6.4 "Using Different Group Times (Either CLF System)"

The group timers in each controller are fully synchronous and, provided the specified cycle time at each intersection is the same, the offset between controllers at the start of a particular plan is maintained until the next plan is selected.

28.6.2 Using Plan Offset Times (Base Time CLF Only)

The offset between the controllers is achieved by specifying 'offset' times at each controller. Note that 'offset' times are only available with the Base Time CLF system.

If this system is used, all the plans at each controller can request the main road to appear at green at time '0' within the cycle time for example. Therefore, the controllers would be configured as follows:

Plan 0	A	B	C
Group 0 (Main Road)	0	0	0
Group 1 (Side Road)	40	45	35
Cycle Time	60	60	60
Offset Time	35	20	0

Plan 1	A	B	C
Group 0 (Main Road)	0	0	0
Group 1 (Side Road)	30	25	25
Cycle Time	45	45	45
Offset Time	0	19	46*

* See Note 2

Thus, when all the controllers start plan 0 at 8:30:00 in the morning:

- The plan at controller 'C' has an offset time of 0 seconds configured and so starts at time 0 within its cycle time as normal (see note 1).
- The plan at controller 'B' has an offset time of 20 seconds configured and so starts 20 seconds behind, i.e. starts at time '40' in the cycle and reaches time '0' 20 seconds later.

- The plan at controller ‘A’ has an offset time of 35 seconds configured and so starts 35 seconds behind, i.e. starts at time ‘25’ in the cycle and reaches time ‘0’ in 35 seconds.

Similarly for the evening peak, all the controllers start plan 1 at 16:50:00, but the plan at controller ‘B’ starts 19 seconds behind the plan at controller ‘A’, and the plan at controller ‘C’ starts 46 seconds behind the plan at controller ‘A’.

Note 1

The above example for plan 0 can ignore the base time and assume that the plan starts at time ‘0’ to aid clarity. This is because the plan’s 60-second cycle time repeats every 60 seconds and thus returns to time 0 on each minute boundary of the real time clock, including at the start time of 08:30:00 (assuming the base time is set to 02:00:00 for example).

However, for plan 1, its 45-second cycle time means that even though the offset time for the ‘A’ is zero, it still starts part way through the cycle. This is because the start time of 16:10:00 minus the base time (assumed to be 02:00:00) divided by 45 seconds, equals 1133 cycles and a remainder 15 of seconds. Therefore, the plan at starts at time ‘15’ in the cycle.

Note 2

The offset time for plan 1 at controller ‘C’ is configured as ‘46’ seconds even though the cycle time for the plan is only 45 seconds. The controller automatically adjusts the offset time internally; in this case calculating that an offset of just ‘1’ second is actually needed (the difference between the offset and cycle times).

28.6.3 Using Different Start Times (Non Base Time CLF Only)

This system defines the offset between the controllers by altering the time at which the plan starts. If this system is used, all the plans at each controller can request the main road to appear at green at time 0 within the cycle time for example.

Note that this alternative is only available with the Non Base Time CLF system, since in the Base Time CLF system, all plans are synchronised to a ‘base time’ so the time that the plan is introduced does not synchronise the plan.

Figure 64 illustrates the offsets for the introduction of Plan 0 (morning peak), which is introduced at ‘C’ at 08:30:00, at ‘B’ at 08:30:20 seconds, and at ‘A’ at 08:30:35 seconds.

Similarly, during the evening peak (Figure 65), Plan 1 is introduced at ‘A’ at 16:40:00, at ‘B’ at 16:40:19, and at ‘C’ at 16:40:46.

28.6.4 Using Different Group Times (Either CLF System)

This system defines the offset between the controllers by modifying the group times, i.e. the start times of each group influence. It can be used with the Base Time CLF system or the Non Base Time CLF system. However, with the Non Base Time CLF system, the CLF plans should all be configured to start at exactly the same time, e.g. 8:30:00 or 16:10:00.

The plans at each intersection all reach time ‘0’ within the cycle time at the same time, and the cycles at each intersection remain synchronised until the plan is requested to finish.

Normally the group times would be configured as follows:

Plan 0	A	B	C
Group 0 (Main Road)	0	0	0
Group 1 (Side Road)	40	45	35
Cycle Time	60	60	60

Plan 1	A	B	C
Group 0 (Main Road)	0	0	0
Group 1 (Side Road)	30	25	25
Cycle Time	45	45	45

However, to provide the required offsets between the controllers, the group times should be modified as follows:

Plan 0	A	B	C
(Required Offset)	(35)	(20)	(0)
Group 0 (Main Road)	35	20	0
Group 1 (Side Road)	*75* **15**	*65* **5**	35
Cycle Time	60	60	60

Plan 1	A	B	C
(Required Offset)	(0)	(19)	(46)
Group 0 (Main Road)	0	19	*46* **1**
Group 1 (Side Road)	30	44	*71* **26**
Cycle Time	45	45	45

Note that where the original group time plus the required offset exceeds the cycle time (see those entries in italics), the group time has to be manually adjusted so that it always specifies a time within the cycle (see those entries in bold).

28.7 CLF Parallel Stage Streaming Facilities

The controller has up to 16 plans but only one plan can be in operation on the whole controller at a time.

CLF can run on all streams or on some streams if the others are running higher priority modes, e.g. Hurry Call mode.

If CLF is disabled on a stream, or the plan does not affect any stages in that stream, that stream will run a lower priority mode, e.g. VA or FT mode.

Within a plan, each group influence (see section 28.3) is only associated with one of the controller's streams, identified by the stage that the group influence is configured to affect. When the time within the cycle arrives to start a new group, that group only affects the stream in which the specified stage resides. The other streams continue to run the previous group influences that affected those streams. Therefore, each stream will be running a different group influence.

28.8 Quicker Plan Synchronisation

Certain contracts require that, when using the base time method of Plan Introduction mentioned above, the controller must synchronise with the Plan quickly.

To achieve this, the following constraints are placed on the CLF facility:

1. The Stage movement restraints table used by CLF should not have purely prohibited moves or ignore moves configured. They should either be allowed moves or if this is not acceptable for safety reasons, alternative moves should be specified. If alternatives are specified, it is preferable for the alternative stage to be one or two stages ahead in cyclic order of the original target stage.

For example:
If the move 1-2 is not allowed
Then the alternative could be 1-3 or 1-4.

2. The use of the 'Hold' and 'Prevent' group influences should be avoided if possible, but if not their use, i.e. the group time and Group position within the plan, must be considered carefully.

   The "GO VA" influence should not be used at all, as this will nearly always cause disruption to the Synchronisation of Controller and Plan, even when used in CLF in general.

3. Group times should be a minimum of the maximum inter-green between the stage associated with the group influence and the stage associated with the previous group influence. Plus the longest minimum green of the phases appearing in the stage associated with the group. Longer Group times will obviously aid synchronisation.

   For example, consider if Group 0 is an immediate move to stage 1 and Group 1 is an immediate move to stage 2. The minimum time for group 1 should be longer than the longest phase inter-green between Stage 1 and 2 and longest minimum green of phases appearing in Stage 2.

28.9 Synchronisation of Cableless Linking Equipment

Synchronisation of Cableless Linking Equipment (i.e. maintaining required offsets for the running plan) in adjacent controllers can be achieved either by the UTC computer or by operators locally adjusting the real time when no link to the UTC computer exists, or is not required.

UTC systems:

The UTC computer can correct small errors in the real time clock by sending the TS1 command at one of the following minute boundaries past an hour 8, 18, 28, 38, 48, 58. This would correct the Real Time Clock if the error were no more than 29 seconds.

The UTC computer can set the real time in the controller to a pre-programmed system time and the computer will send the TS control signal at the time which is programmed.

For IP networks:

The controller clock can be synchronised by an NTP server - refer the Time documentation for the controller for more information.

In the absence of network communications:

The controller clock can be synchronised using a GPS clock module - refer the Time documentation for the controller for more information.

Relying on the mains synchronised clock - adjacent controllers can easily and accurately be synchronised by local operators setting the controller RTC using one controller as the master reference. No other adjustments are necessary to synchronise the controller to adjacent controllers running the current local co-ordinated mode system plan.

28.10 Smooth CLF (basetime CLF only)

Basetime CLF now provides "smooth" transitions between plans, where "smooth" means that stages in the plan will not be run "out of sequence". This was previously the case when a plan was introduced non-smoothly: a plan would start in the appropriate group for the current time. This took no account of the stage that was running on the controller just before the new plan was introduced. It could result in a change of stage that could skip over stages that would have run if the normal sequence of stages had continued.

With Smooth CLF, no stages will be skipped unless explicitly configured as demand dependant. The CLF plan is initially introduced at a point that continues the original stage sequence and then the CLF plan controls the stage sequence, although initially it will be run faster or slower in order to synchronise with the correct time.

When introducing a basetime CLF plan "smoothly" from a lower-priority mode, or moving from one plan to another "smoothly" in CLF, or moving from a higher-priority mode back to CLF, the introduction of the new plan is delayed until a stage change occurs that causes the new stage(s) at ROW to match a cycle point (i.e. group) in the new plan. The CLF plan begins by requesting the same stage that is already at or about to gain ROW.

If the new Plan has an Entry Time defined (section 28.4.3), this controls two things so the plan starts at this Entry Time. Not only does it define the time in the cycle the Plan begins when it eventually takes control, but it also restricts the stage transitions on which Smooth CLF will transfer control from the current plan to the new plan. Smooth CLF will ignore all other stage transitions and allow the current Plan to continue until it requests a move to the stage implied by the Entry Time. For example, if Stage 1 is normally active at the Entry Time in the Cycle, the Plan only takes control on the move to Stage 1 and the current cycle time (CCT) is set to match the defined Entry Time.

Having introduced a plan smoothly as described, it is highly likely that the plan is not at the correct cycle point for the current time of day. In order to re-synchronise the plan to its correct time, the plan runs faster or slower until it is properly synchronised.

The CLF "Slow" and "Fast" factors for each plan determine the percentage by which the plan can be made to run slow or fast. These factors can be configured for each CLF plan using IC4, the controller web pages and the handset commands PLS and PLF.

The "Slow" factor ranges from 0 to 150%, "Fast" ranges from 0 to 80%.

Setting both a plan's "Slow" and "Fast" factors to 0 (the default) will disable "smooth" introduction for that plan.

Example 1: A plan cycle time of 60 seconds will be reduced to 45 seconds with a fast factor value of 25% (100 - 25 = 75%) causing the plan to run faster.

Example 2: A plan cycle time of 60 seconds will be increased to 90 seconds with a slow factor value of 50% (100 + 50 = 150%) causing the plan to run slower.

If both factors are non-zero the facility will choose whether to run the plan faster or slower depending on which will result in the fastest re-synchronisation with correct timing.

Example 3: A plan is configured to move from Stage 1 to Stage 2 at time 30. Shortly after this plan is requested to take control, the controller makes the same stage movement. Smooth CLF detects this and the plan takes control with it cycle timer set to 30 to match the same stage movement. The plan now continues running from this point, keeping the stage changes consistent. However, it just so happens that the current time of day requires this plan to be at time 40, not time 30, so the plan is running 10 seconds behind. By running this plan slightly faster, the plan will ‘catch up’ with where it is supposed to be, with minimal impact on the traffic. It should be clear that in this example a small fast factor will allow the plan to synchronise quicker than a larger slow factor. However, if the time of day required the plan to be at 20 seconds, running the plan slower will allow the plan to synchronise quicker.

Note: Care must be taken not to reduce group times through application of a "Fast" factor to a point where the controller will not be able to action the stage requests because the duration of the reduced group time is less than the sum of the intergreen and minimum green time.

29 VEHICLE ACTUATED (VA) MODE

In VA mode the controller monitors all demands, extensions and maximum green timers every 200 ms to select a suggested stage in order to satisfy as many demands as possible without missing any stage containing a phase with a demand.

If each phase only resides in one stage, each stage will continue until there is a demand for a phase not at right of way (but also see the Arterial Reversion facility described in section 29.2).

Even when there is a demand, the stage will continue until all the phases that are at right of way can be terminated. If a phase still running its minimum green time or a phase is still being extended (and its maximum green time has not yet expired), the controller will remain in that stage.

If the same phase is given right of way in two or more stages, the operation of vehicle actuated mode is made more complicated. See the example below:

29.1 A Vehicle Actuated Example

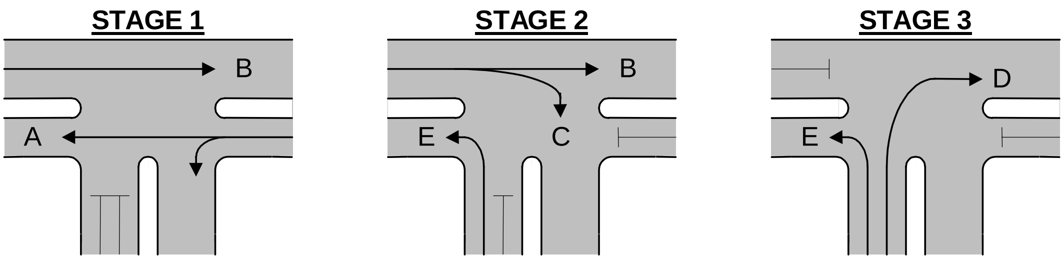


Figure 66 Example of VA Stage Changes

The descriptions below describe how the controller applies its next stage algorithm to the above junction. All the phases are assumed to be standard 3-aspect traffic phases. Indicative and filter green-arrows complicate the operation of this junction and so are discussed in the Green Arrow documentation.

The decisions in the next stage algorithm are summarised here, assuming no phases or stages are prevented or deleted and no stage demands exist.

Considering each stage in turn

a) Are there any demands for phases in this stage?

b) Do all phases that need to keep right of way appear in this stage?

c) Are all the demanded phases from previously checked stages in this stage?

d) Will additional demanded phases be given right of way?

When in Stage 1

Consider Stage 2…

a) If there are no demands for phases C and E, ignore stage 2 and check stage 3. Note that there can be no demands for phase B since it is already at right of way. Also note that the demand for phase C would usually come from a call/cancel detector.

b) If phase A is to keep right of way (due to extensions for example), ignore stage 2 (but remember if there are demands for phases C and E) and check stage 3. Since phase B also resides in stage 2, it does not matter if this phase has to keep right of way.

c) No previous stages have been checked so no demanded phases will be skipped.

d) No previous stages have been checked so a demand for either phase C or phase E will suggest the move to stage 2.

Now consider Stage 3…

a) If there are no demands for phases D and E, ignore stage 3.

b) If phases A or B need to keep right of way, ignore stage 3.

c) Stage 2 would service the demands for phases C and E. Phase E can be ignored since it also appears in stage 3. However, if there is a demand for phase C, ignore stage 3.

d) A demand for phase E can be serviced by both stages so if stage 2 has been suggested, its demands are ignored. Therefore, only a demand for phase D will suggest stage 3.

   Note that in this example it not possible for a demand for phase E to request stage 3 from stage 1. This is because the demand will either cause stage 2 to be suggested first (in which case stage 3 is no better) or neither stages can be suggested (because phase A must keep right of way for example).

If a stage has been suggested, the controller will move to that stage, otherwise it will remain in stage 1.

When in Stage 2

Consider Stage 3 first…

a) If there is no demand for phase D, ignore stage 3 and check stage 1. Note that there can be no demands for phase E since it is already at right of way.

b) If phases B or C need to keep right of way, ignore stage 3 (but remember if there is a demand for phase D) and check stage 1. Since phase E also resides in stage 3, it does not matter if that phase has to keep right of way.

c) No previous stages have been checked so no demanded phases will be skipped.

d) No previous stages have been checked so a demand for phase D will suggest the move to stage 3.

Now consider Stage 1…

a) If there are no demands for phases A and B, ignore stage 1.

b) If phases C or E need to keep right of way, ignore stage 1. Since phase B also resides in stage 1, it does not matter if that phase has to keep right of way.

c) Stage 3 would service demands for phase D whereas stage 1 would not, so if phase D is demanded, ignore stage 1.

d) If stage 2 has been suggested, it must have been due to a demand for phase D which would force stage 1 to be ignored (see previous statement). Thus to reach this statement, no stage has been suggested. Therefore, demands for either phase A or B will suggest stage 1.

   However, if phase C or phase E is a green-arrow, the move directly from stage 2 back to stage 1 may be prevented - see the Green Arrow documentation.

If a stage has been suggested, the controller will move to that stage, otherwise it will remain in stage 2.

When in Stage 3

Consider Stage 1 first…

a) If there are no demands for phases A and B, ignore stage 1 and check stage 2.

b) If phases D or E need to keep right of way, then ignore stage 1 (but remember if there are demands for phases A and B) and check stage 2.

c) No previous stages have been checked so no demanded phases will be skipped.

d) No previous stages have been checked so a demand for either phase A or phase B will suggest the move to stage 1.

Now consider Stage 2…

a) If there are no demands for phases B and C, ignore stage 2. Note that there can be no demands for phase E since it is already at right of way.

b) If phase D needs to keep right of way, ignore stage 2. Since phase E also resides in stage 2, it does not matter if that phase has to keep right of way.

c) Stage 1 would service demands for phases A and B. Phase B can be ignored since it also appears in stage 2. However, if there is a demand for phase A, ignore stage 2.

d) A demand for phase B can be serviced by both stages so if stage 1 has been suggested, demands for phase B are ignored here. However, if stage 1 has not been suggested*, a demand for phase B will suggest stage 2. Regardless, of whether there is a demand for phase B, a demand for phase C will always suggest the move from stage 3 to stage 2.

   * If there is a demand for phase B, the only way that stage 1 cannot be suggested is if phases D and E need to keep right of way. If phase D needed to keep right of way, it would also cause stage 2 to be ignored. However, if only phase E is to keep right of way, a demand for phase B can cause the move from stage 3 to 2 (assuming there are no demands for phase A).

If a stage has been suggested, the controller will move to that stage, otherwise it will remain in stage 3.

29.2 Arterial Reversion

Normally, after a phase has gained ROW, if there are no other demands, ROW will remain on that phase. The arterial reversion facility allows ROW to revert to a specified stage or phase in the absence of any demands and extensions, subject to any minimum green periods timing off and any stage movement restrictions.

If a stage is specified, the reversion will always be to that stage, but if a phase is specified, reversion will be to the next stage in cyclic order in which that phase appears.

The name of the facility is derived from its normal use, which is for intersections with a main (or arterial) movement. During quiet periods, especially at night, ROW will revert to the main movement after a side road has had ROW, so that isolated vehicles on the main movement will not have to demand ROW and then wait for an inter-green period from the side road to time off. In this case, a stage would normally be specified for reversion.

Another use of the facility is on bridges with shuttle working. If the all-red movement were reverted to, isolated vehicles from either direction would only have to wait for a red/amber period before gaining ROW. If more than one all-red stage is used with the same dummy phase in each stage, this phase would be specified for reversion allowing the next all-red stage in cyclic order to become active.

29.3 Vehicle Actuated Parallel Stage Streaming Facilities

Each stream will move around its own stages according to its own on street demands and extensions independently of any other stream.

There is an Arterial Reversion facility for each stream. If there is no demand or extension present for any phase in the stream, and no demand for any stage in the stream, an Arterial demand for a phase or stage in the stream will be inserted (if configured).

30 Fixed Time Working Mode

30.1 Introduction

There are four methods of fixed time working:

- Fixed Time mode (FT)
- Fixed Time to Current Maximums (FTCM)
- Fixed Vehicle Period (FVP) mode on a stand-alone pedestrian stream.
- Linked Fixed Time (LFT)

30.2 Fixed Time Parallel Stage Streaming Facilities

There are two options:

- Independent Fixed Time (FT, FTCM, FVP)
- Linked Fixed Time (LFT)

Exceptionally, a degree of stream linking can be achieved with FTCM and FVP modes using Special Conditioning.

30.3 Fixed Time Mode

Fixed Time Mode is requested:

- when ‘Fixed Time’ is selected on the mode select buttons subject to mode priority
- by default, if there is no higher priority mode is active and no VA

During Fixed Time mode, the controller cycles round a pre-programmed sequence of stages disregarding local demands and extensions. The stage durations are exclusive to the Fixed Time mode and do not include inter-green timings or phase delays. The stage duration can be changed via the handset but the stage sequence cannot. Not all stages need be included in the sequence.

Phases that appear conditionally will always appear in their corresponding stages, i.e. there will be permanent requests.

The range of the timing period for the stage duration is 0 to 255 seconds in 1-second steps. There is only one set of timings. The programmed values may be changed via the handset using the FIX command.

Any all-red extension periods are automatically extended up to the maximum value to ensure safe operation.

When Fixed Time mode ceases, demands may be automatically inserted for selected non-running phases. These demands are normally inserted to ensure no vehicles are trapped against a red light, unless otherwise requested by a customer.

The configuration of Fixed Time mode can be reviewed and altered using the Controller - Fixed Time - Standard web page.

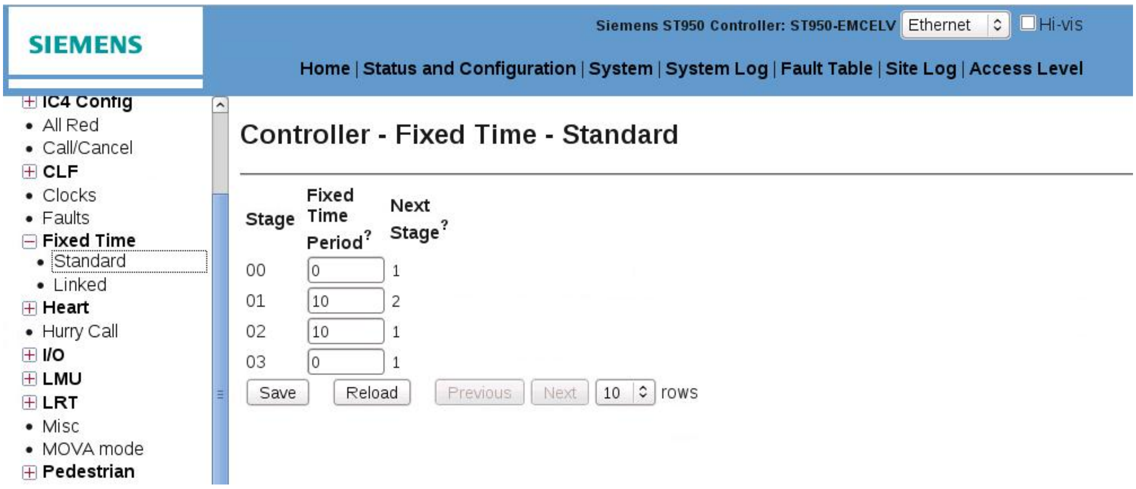


Figure 67 Controller - Fixed Time - Standard web page

30.4 Fixed Time to Current Maximums

If the FTCM (Fixed Time to Current Maximums) facility has been selected in the configuration, it operates:

- when ‘Fixed Time’ is selected on the mode select buttons subject to mode priority
- by default, if there is no higher priority mode is active and no VA

The controller will then operate to VA mode strategy and not to a pre-programmed sequence as in Fixed Time mode, but with Permanent Demands and Extensions.

This method of operation has been created so that the following are possible:

- Phases which appear conditionally may be excluded from having permanent demands and still rely on local demands for their appearance, e.g. pedestrian phases.
- Any set of maximum green timings may be introduced giving eight sets of fixed times switched by the master time clock.

During FTCM mode the controller will display fixed time mode on the handset (Mode 1).

With FTCM mode cease, there will still be demands present for all non-running phases, so no vehicles will be trapped against a red signal.

30.5 Fixed Vehicle Period (FVP) Mode

The vehicle phase of a stand-alone pedestrian stream appears at green for at least a fixed period. No vehicle detection equipment is required.

If the pedestrian phase is demanded while this period is still running, the vehicle phase remains at green. When the period expires, the vehicle phase loses right of way and the pedestrian phase subsequently appears at green.

If the pedestrian phase is demanded after this fixed vehicle period has expired, the vehicle phase immediately (subject to the pedestrian demand delay) loses right of way and the pedestrian phase subsequently appears at green.

When the pedestrian phase has completed its green period and the controller has executed the required ‘pedestrian to vehicle clearance period’, the vehicle phase returns to green.

The fixed vehicle period can be reviewed and set using the E, F, G, and H Maximum Time-Sets items on the Controller - Phases - Times web page. The E, F, G and H times are used with maximum sets A, B, C and D respectively.

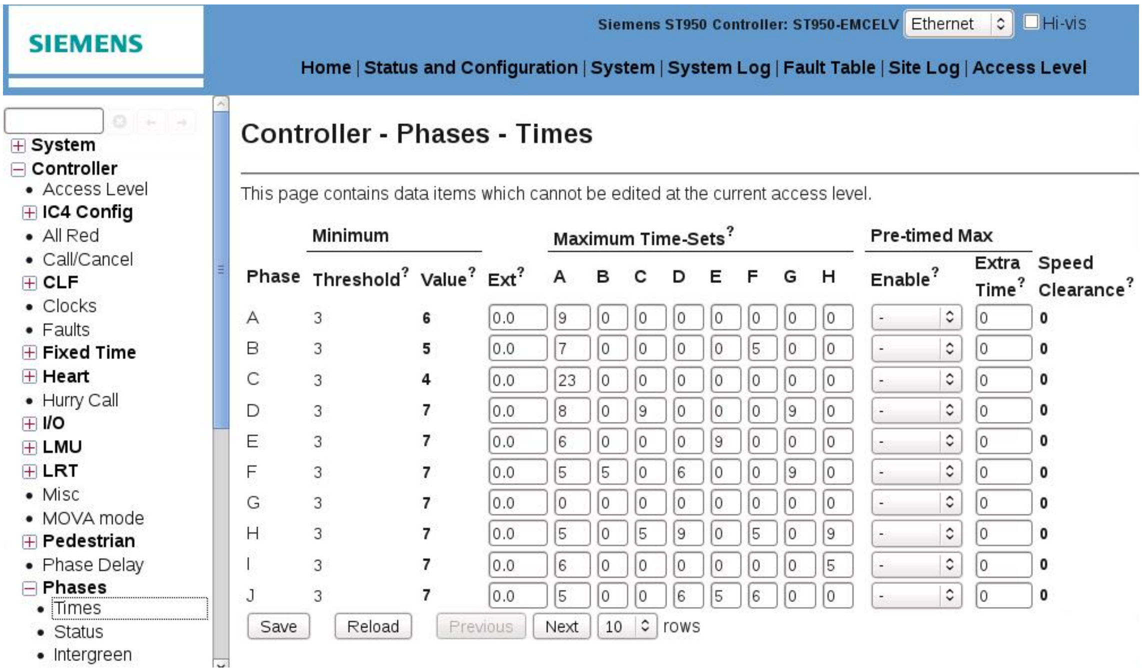


Figure 68 Controller - Phases - Times web page

The fixed vehicle period can also be specified using the handset commands MEX, MFX, MGX and MHX allowing four different times to be called up at different times of the week.

30.6 Linked Fixed Time

30.6.1 LFT Introduction

LFT (Linked Fixed Time) mode can be configured to provide linking between different streams as an alternative to ‘normal’ FT and FTCM modes that request moves on each stream independently.

During LFT mode, the controller will display fixed time mode on the handset (Mode 1).

A maximum of 32 fixed time steps will be provided. Specified for each of these 32 times will be a configured stage combination; one stage for each stream.

When the defined combination of stages has been at ROW for the configured time, the controller will move to the next stage combination in sequence. When all the stages in that combination are at ROW, the timer starts again. When the configured time expires, the next stage combination is requested. This process is repeated for each configured stage combination, until the last configured stage combination is reached, after which stage combination 0 will commence again.

Linked Fixed Time mode need not be active on all streams. Only the streams that have fixed time active will be demanded through the specified stage combination.

For example, streams configured as ‘Stand-alone Pedestrian’ will be ignored by the Linked Fixed Time facility and will typically run Pedestrian VA or FVP mode independently while LFT mode is active on other streams. If linking is still required, it can be implemented using Special Conditioning.

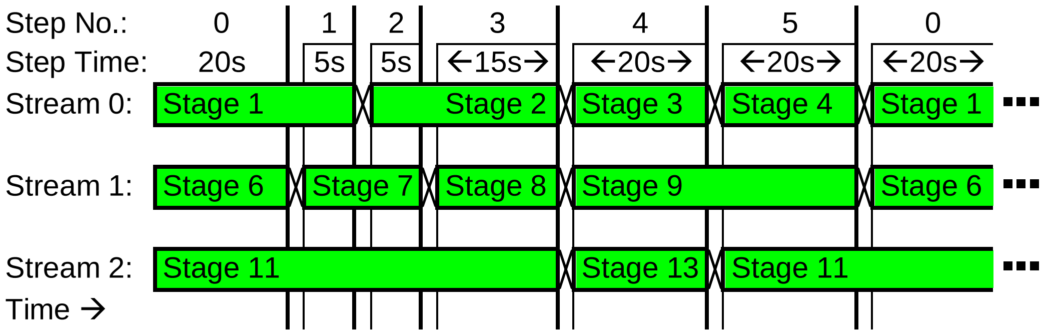
30.6.2 LFT Example

This maintains a strict relationship between the streams running LFT mode, as shown in the following example.

Configuration Data:

Step	0	1	2	3	4	5	…
Step Time	20	5	5	15	20	20	
Stages							
Stream 0	1	1	2	2	3	4	
Stream 1	6	7	7	8	9	9	
Stream 2	11	11	11	11	13	11	
…							

Stage Sequences:



30.6.3 Introduction of LFT

LFT by default uses an improved LFT introduction algorithm, which if not required can be disabled using the "Legacy Fixed Time Operation" option (‘PMV:128’) on the Stages - Settings page and LFT always begins by requesting stage combination step 0.

The improved introduction algorithm attempts to select a stage combination that best matches the combination of stages currently at ROW across the streams, minimising the impact on the traffic. The algorithm will ignore any stream on which LFT mode has been disabled, such as a stand-alone pedestrian stream.

If there is an exact match, the algorithm takes in to account the duration those stages have already been at ROW before LFT mode starts in order to calculate the remaining step time. In the example shown above, if stages 1, 6 and 11 had been at ROW for 15 seconds, LFT continues with those stages for the remaining time (20 – 15 = 5 seconds) before requesting stage combination step 1.

If there isn't an exact match, the algorithm selects a stage combination that requires the least number of stage movements and therefore will obtain synchronisation in the least amount of time so it should have the least impact on the traffic.

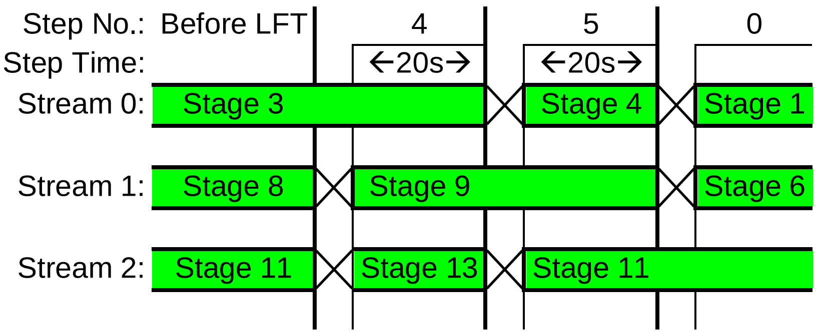
This algorithm also reduces the need for alternate stage moves, but these should still be configured where it is important stages are not omitted as LFT mode starts. The improved introduction algorithm allows a stream to make alternate stage movements ‘on the way to’ the stage requested by LFT.

If it is required that specific stage sequences are maintained during the introduction of LFT mode, alternate stage movements must be configured. For example, if stage 1 could be at ROW and there is a possibility that LFT may start with stage 3, an alternate move for LRT mode should be configured to force the stage sequence 1 - 2 - 3.

To select the best combination, the algorithm uses the configuration of its stage combinations as a guide to determine the stage sequences and the number of stage moves needed on each stream.

In the following example, stages 3, 8 and 11 are at ROW when LFT mode starts. This example uses the configuration data shown above.

The algorithm determines that there is no stage combination matching this and combination Step 4 (stages 3, 9 and 12) requires the least stage moves, just one stage move on both streams 1 and 2, and so will synchronise the quickest.



Note that although Step 3 includes the stages 2, 8, 11, which matches the stages at ROW on two streams, it is rejected by the algorithm because Stream 0 will have to move from Stage 3 ‘back’ to Stage 2 for Step 3, and then Stage 3 will be requested again when LFT naturally moves to Step 4.
The algorithm works by examining the stage sequences in the stage combinations to determine that three stage moves are required to get Stream 0 from Stage 3 to Stage 2, as it should ideally move via Stages 4, 1 and then 2.

If a stage at right of way does not appear in the configuration of the stage combinations, stage combination step 0 will be selected (same as the legacy operation). This is because the algorithm cannot determine the stage sequence and number of stage movements. This would be case when moving from Manual All Red to LFT mode for example and thus is normally acceptable.

In the above example, stage 12 never gains ROW in LFT mode but could when other modes are in control. If stage 12 were at ROW when LFT starts, stage combination 0 would be selected.

If this is undesirable, ensure that all stages are present in configured LFT stage combinations. If a stage combination step is added solely to resolve this issue and must not appear in the normal LFT sequence, set the step time to 255 seconds and the step will be skipped; it becomes a 'dummy' stage combination that is only used by the algorithm to help select the best combination during the introduction LFT.

Continuing with the same example, a new combination step has been added:

Step	0	1	2	3	4	5	6	…
Step Time	20	5	5	15	255	20	20	
Stages								
Stream 0	1	1	2	2	3	3	4	
Stream 1	6	7	7	8	9	9	9	
Stream 2	11	11	11	11	12	13	11	
…								

The stage combinations in the new Step 4 would never be requested to appear at ROW, but the step will assist the algorithm selecting the best start combination step.

30.6.4 LFT Configuration

The configuration of Linked - Fixed Time mode can be reviewed and altered using the Controller - Fixed Time - Linked web page or the LFT handset command.

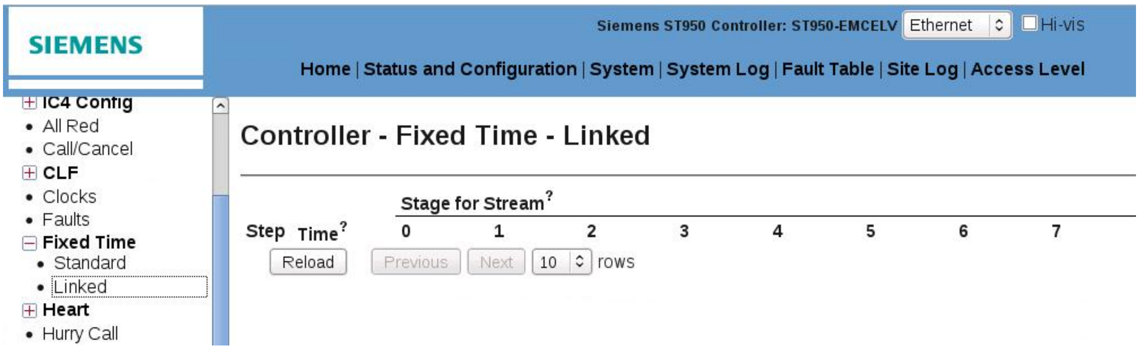


Figure 69 Controller - Fixed Time - Linked web page

31 STAGE MOVEMENT RESTRICTIONS

When a specific stage change is required not to occur for safety or traffic control reasons, it is possible to restrict the move.

The types of restrictions available are:

Prohibited Move

This is the most restrictive and the effect is for the controller to stay on the same stage and not look for other moves until the stage change conditions are altered.

Alternative Move

With this, the restricted move is not made but an alternative stage is specified and a move to that stage takes place.

Ignored Move

This is less restrictive than a Prohibited Move in that the restricted move is ignored, but the controller looks for another satisfactory stage change.

The above movement restrictions can apply in one or more modes, as specified in the IC4 configuration. Four sets of tables are available and each mode is allocated to one of these tables, or to no table, if there are no restrictions for that mode.

WARNING	To avoid the possibility of locking-up the controller, PROHIBITED MOVES should not be applied during modes other than Manual, UTC or CLF - IGNORE or ALTERNATIVE MOVES should be used instead.

If smooth plan changes are required in UTC and CLF Modes, (e.g. Hong Kong Controllers), Prohibited and Ignore moves should not be used.

31.1 Prohibited Moves

When a move to a stage is prohibited and there is a demand for the prohibited stage, the controller will not move to that stage and the current stage will remain active until one of the following happens:

(i) The stage change conditions alter and a move can be made to a stage before the prohibited stage.

(ii) The stage change condition is removed and replaced by another stage change condition.

(iii) The stage change restriction is removed due to a mode change.

In (i), after the stage change occurs, a move to the original prohibited stage might now be permitted.

In (ii), the only modes that could achieve this are:

- Manual mode by the operator seeing the prohibited move light illuminated and selecting another stage by means of the appropriate push-button.
- UTC mode by the force being removed and another one applied.
- CLF mode by another group influence becoming active.

31.2 Alternative Moves

When a move is not allowed it may be possible to specify an alternative move to a nominated stage. The stage may either be one that is in general use or one that is used only for the alternative move.

If the nominated stage is in general use, any move out of it will be subject to any current stage change conditions and may not go directly to the original required stage.

If the nominated stage is used only for the alternative move the only permitted move to it will be from the original current stage and the only move out of it will be to the original required stage. All other moves out of it will be restricted by specifying an alternative move to the original required stage. This will ensure that the original required stage is reached before any other stage change conditions are satisfied.

31.3 Ignore Moves

When a move is restricted and a nominated alternative stage is too restrictive, it is possible to programme the controller to ignore the restricted move and to look for another satisfactory stage to change to. The stage change conditions for the original restricted move will still be present and after another stage change has occurred they will be considered for any further stage changes.

The ignore move facility is normally only required during modes where it is possible to have stage change conditions present for more than one stage, i.e. VA, Priority, Emergency Vehicle and UTC mode.

31.4 Permitted Moves

Permitted moves are not programmed they are achieved by the lack of any stage movement restrictions.

Although a stage may be prevented from appearing in one mode, there will be occasions when the stage is active and the mode changes. Moves should therefore be permitted out of it during the other modes to allow for the stage change conditions of the new mode.

31.5 Prevented Stages/Phases

The deletion of a stage or phase, which may be achieved by use of the master time clock may be simulated by preventing them when certain conditions occur using Special Conditioning Software.

- If a stage is prevented it will be omitted from the cycle.
- If a real phase is prevented, the signals will remain at red whenever a stage that the phase normally appears in is active.
- If a dummy phase is prevented, any effect its appearance has on stage changes or timings will be cancelled.

The prevention of stages or phases is effective in all modes except Fixed Time mode.

Note that phases that are prevented under certain conditions should be configured as optional phases. If a fixed phase within a stage is prevented, the stage is effectively prevented.

32 TIME

The controller maintains two time references: Controller Time and System Time. The relationship between these two times depends on the Time Mode selected; the times may be locked together or run independently. The Time Mode must be set to match the use of the controller.

Important: Before setting the time, ensure that the Time Zone and Daylight Saving options have been set (section 32.4) - these default to the correct settings for the UK.

32.1.1 Uses of System Time and Controller Time

System Time

Used for:

- System log time stamps
- Site log time stamps
- Time of day in GVP applications (e.g. UTMC OTU)

Controller Time

Used for:

- CLF
- Timetable
- Holiday clock

32.2 Time Modes

The controller operates in one of three time modes. The mode determines whether Controller Time and System Time are locked together or are independent. The source and means of changing each time mode is summarised in the table below.

Time Mode	Controller Time		System Time	
	Source	Manual Set	Source	Manual Set
Controller Time Mode	Mains Crystal UTC TS / TS1 inputs	Web page TOD	Controller Time	N/A
System Time Mode	System Time	N/A	Network Time (NTP) GPS Clock	N/A
Dual Time Mode	Mains Crystal UTC TS / TS1 inputs	Web page TOD	Network Time (NTP) GPS Clock	N/A

32.2.1 Controller Time Mode

Controller Time Mode should be selected when synchronisation between adjacent controllers is required (e.g. for CLF operation) and no common external time source (e.g. NTP, GPS) is available to those controllers.

In this mode System Time is locked to Controller Time and only Controller Time can be set by the user. Time is set using the *Set Date* and *Set Controller Time* fields on the Controller - Clocks web page or using the TOD handset command.

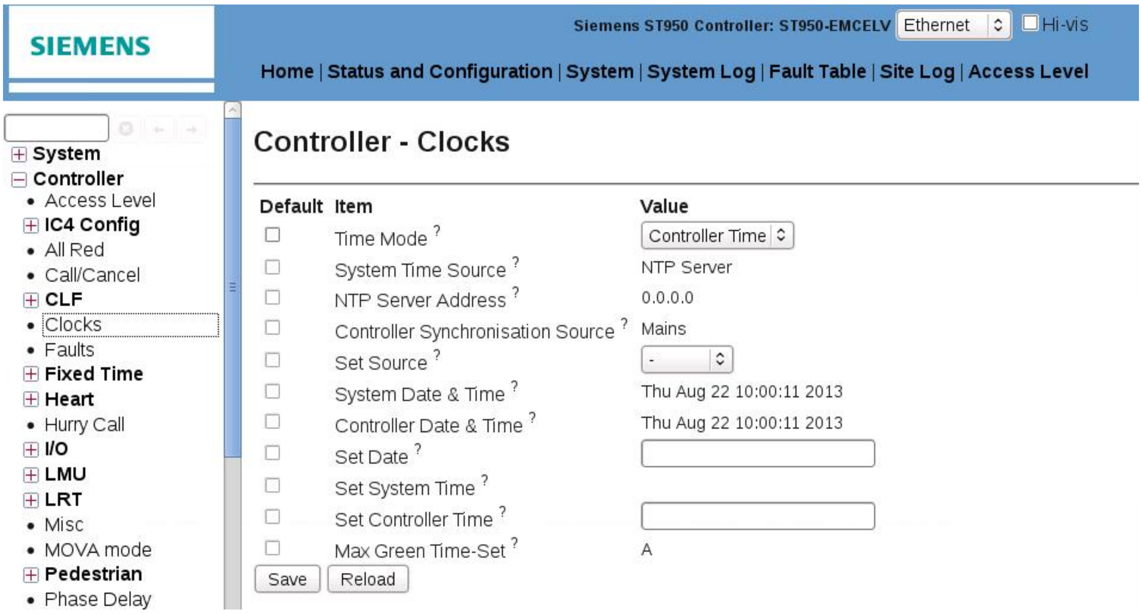


Figure 70 Clocks web page in Controller Time Mode

By default, the Controller Time is synchronised to mains frequency and will fall back to a crystal clock source if the mains cannot be monitored. When synchronised to the mains frequency, time synchronisation across neighbouring controllers can be maintained. The source of Controller Time can be changed using the *Set Source* field on the web page. Crystal source is subject to drift and permanent synchronisation between neighbouring controllers is not guaranteed.

UTC periodically synchronises Controller Time to UTC time.

32.2.2 System Time Mode

System Time Mode should be selected when it is important to be synchronised with an external time source such as NTP or GPS.

In this mode Controller Time is locked to System Time and only System Time can be set by the user. While the selected synchronisation source is present it should not be necessary to set the time manually but if the synchronisation source is lost and the time is incorrect then it can be set using the *Set Date* and *Set System Time* fields on the Controller - Clocks web page.

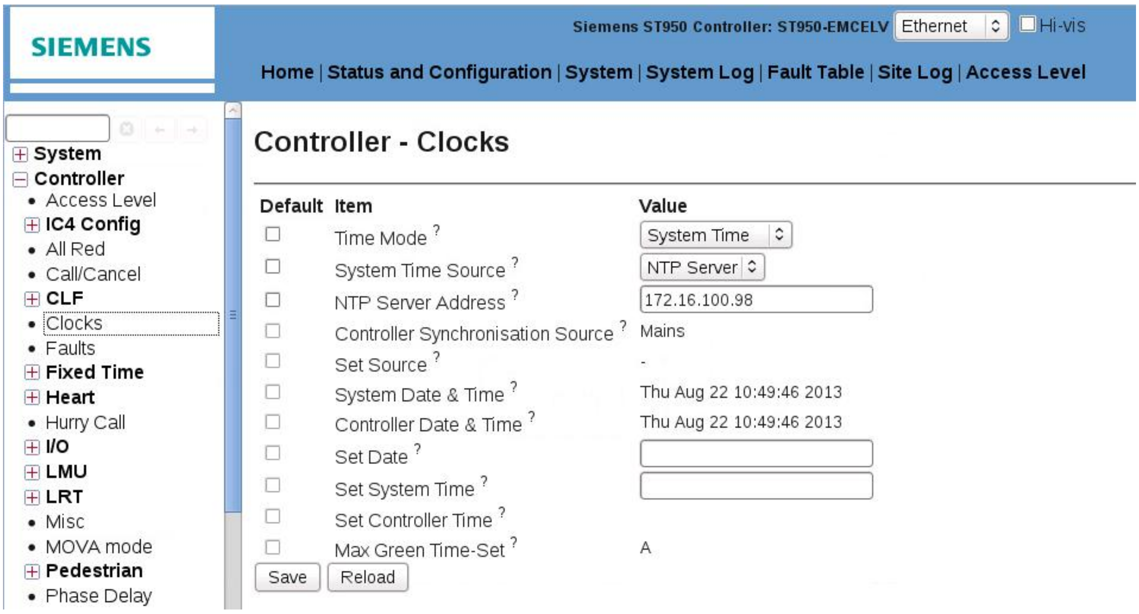


Figure 71 Clocks web page in System Time Mode

System Time can be synchronised to either a network NTP server or an attached GPS clock. If the selected time source is lost then the System Time is synchronised to a crystal clock source until the time source is restored.

32.2.3 Dual Time Mode

Dual Time Mode should be selected when both synchronisation to the mains (e.g. for CLF) and synchronisation to an external time source (e.g. network) is required.

In this mode Controller Time and System Time run independently and both can be set by the user.

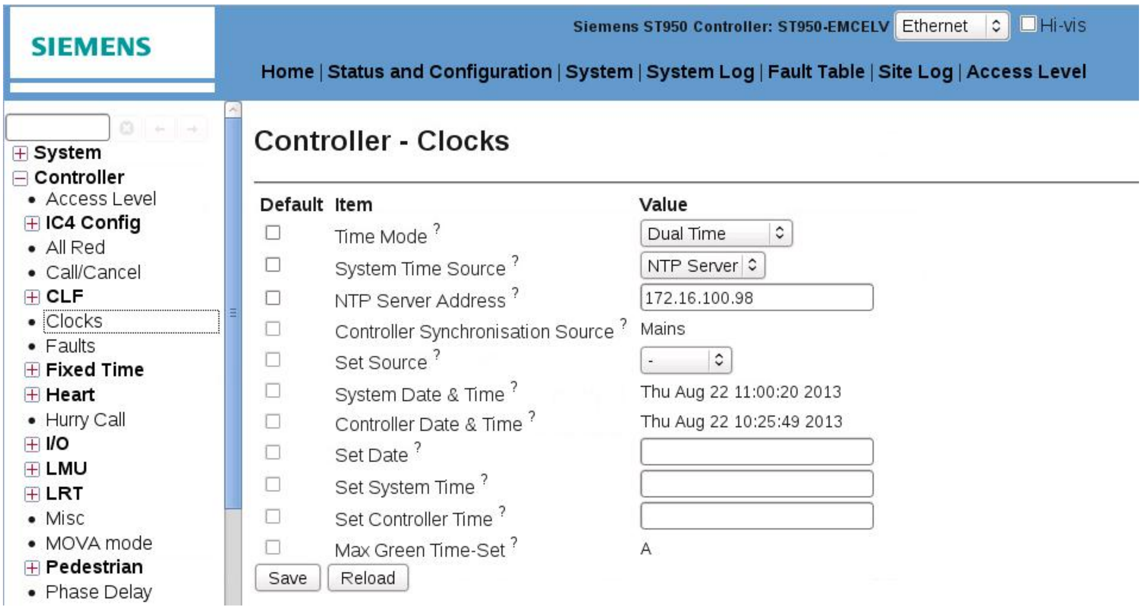


Figure 72 Clocks web page in Dual Time Mode

The synchronisation source for each time (Controller and System) can be set independently and each time behaves as in the mode where it is master. Owing to the independence of the clocks, they can drift apart over time so even if they are initially set to the same value they are likely to be different after a period of operation.

32.2.4 NTP

The IPv4 address of the NTP source is selectable via the Controller – Clocks web page when System Time Mode or Dual Time Mode is configured as the time mode. Additional advanced NTP options are selectable from the System – Advanced – Network – NTP web pages.

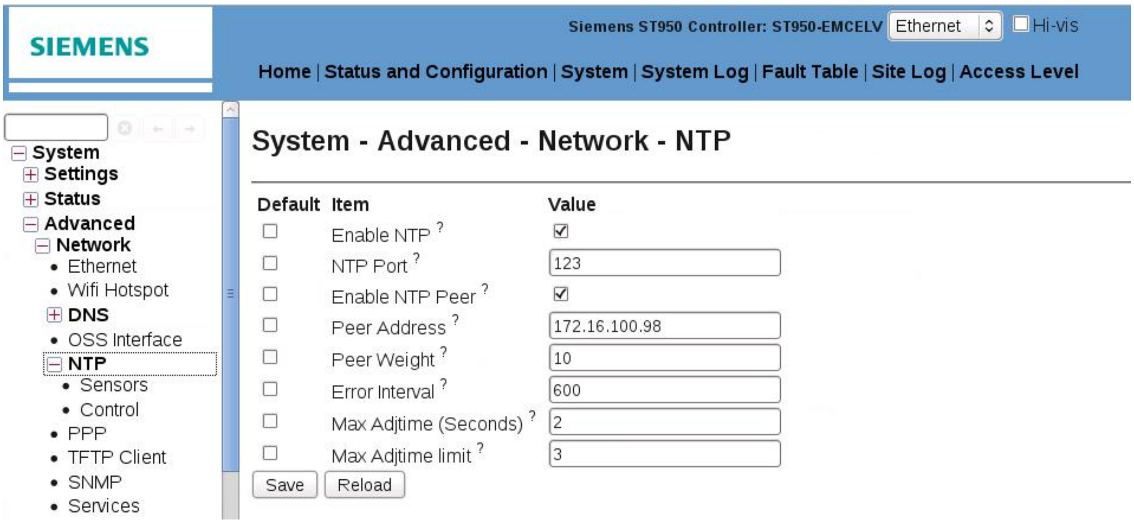


Figure 73 Advanced NTP web page

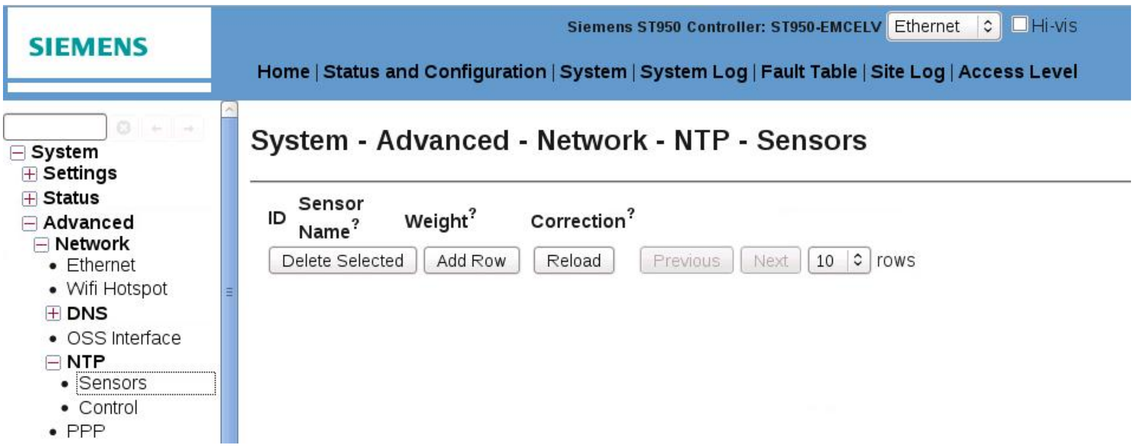


Figure 74 NTP sensors web page

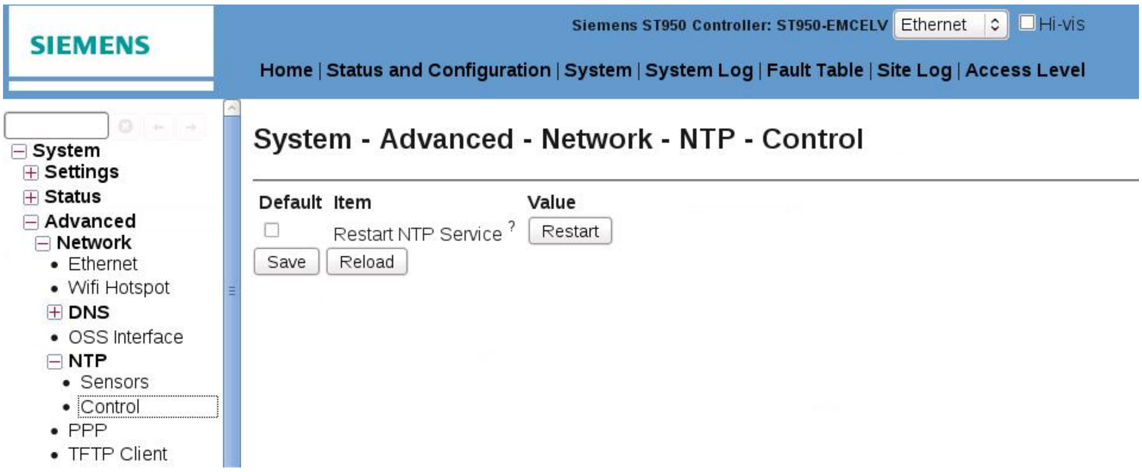


Figure 75 NTP control web page

32.2.5 GPS

GPS is selectable as a time source via the Controller – Clocks web page when System Time Mode or Dual Time Mode is configured as the time mode. Additional advanced GPS options (serial port, baud rate, logging) can be configured using the System – Advanced – GPS web page.

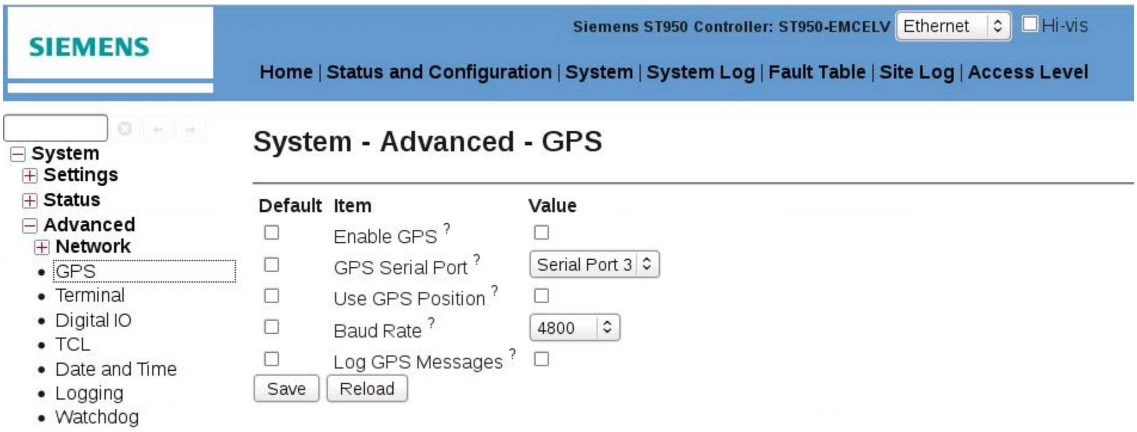


Figure 76 GPS advanced options web page

32.3 UTC Time Synchronisation

Where neighbouring controllers are synchronised to run CLF, UTC is used to periodically (typically once a day) synchronise each controller to UTC time. This is achieved via the use of the TS or TS1 inputs to the controller.

The correct activation of the TS bit causes the controller to assume a preconfigured time (default is 00:00:00).

The correct activation of the TS1 bit within 29 seconds of the next synchronisation time (HH:MM:30 where MM is 08, 18, 28, 38, 48 or 58) causes the controller to assume this synchronisation time.

Refer to the documentation on UTC mode for more information on these UTC control bits.

32.4 Time Zone and Daylight Saving Time

Select the required Time Zone, which also defines the Daylight Saving Time settings, using the System – Settings web page. This setting impacts all the clocks in the System, i.e. both the Controller Time and the System Time.

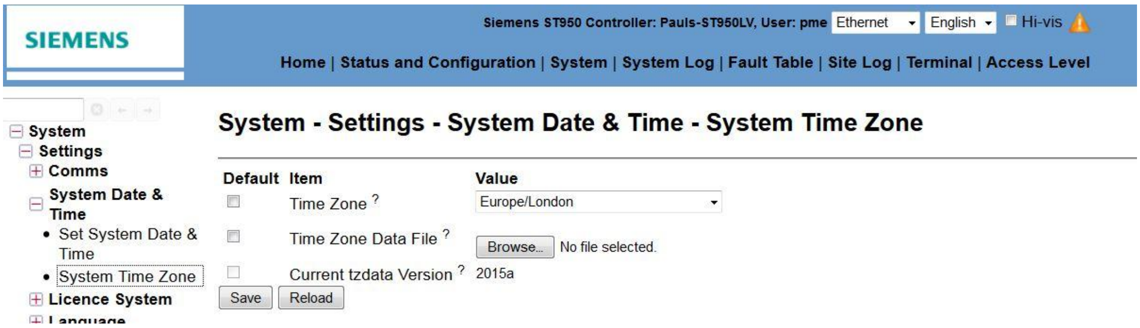


Figure 77 Time Zone selection

If required, this web page also allows a more up-to-date Time Zone data file to be loaded and used. The current version of the file is shown. Only use data files provided and approved by Siemens.

The specific Time Zone and Daylight Saving Time (DST) settings can be viewed and if necessary adjusted via the System – Advanced – Date and Time web page.

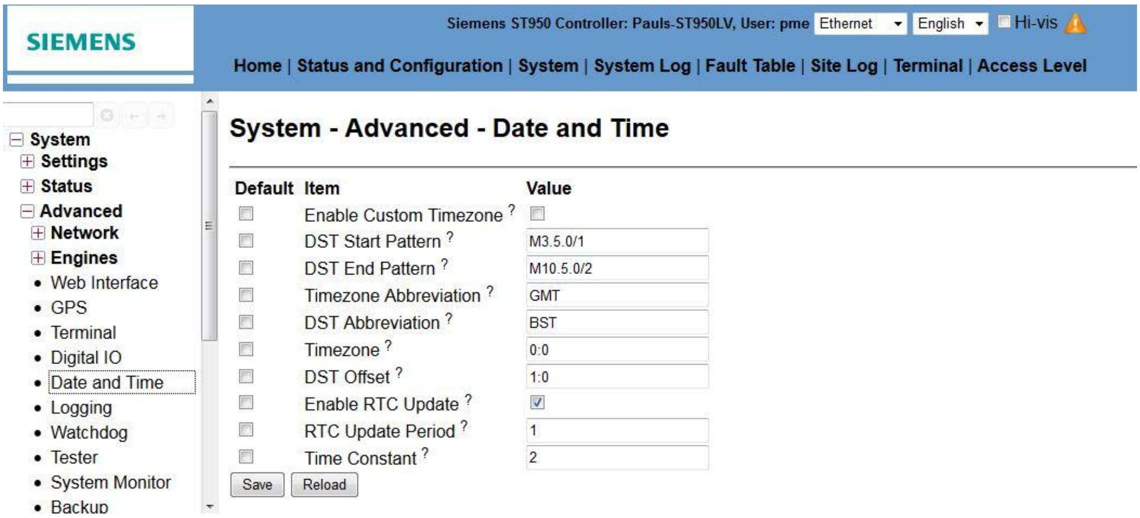


Figure 78 Advanced Date and Time settings

By default, the Time Zone adjustment is set to 0 hours 0 minutes offset from GMT.

By default, the DST start is set to 1am on the last Sunday in March and the DST End is set to 2am on the last Sunday in October. DST Offset adjustment is 1 hour with the abbreviation text "BST" applied when active and "GMT" when inactive.

Between the DST Start (March) and DST End (October) times, the configured DST Offset (1 hour) is applied to both the System Time and the Controller Time and the DST Abbreviation (BST) is applied. Outside these times, no offset is applied and the Timezone Abbreviation (GMT) is applied. (Default values shown in brackets)

32.5 Loss of Power

The controller CPU board is fitted with capacitors which will preserve the date and time during loss of power for up to 48 hours. Optionally, a battery can be fitted which extends this period to more than 30 days.

On restoration of mains power after a power break, the controller calculates the Controller Time and System Time using the power fail duration and battery backed records of the last known values of Controller Time and System Time.

Time will be lost when the controller is without power for a period beyond the capability of the capacitors / battery support. On restoration of power, the Controller Time and System Time are initialised to midnight on January 1st, 2000 and the controller raises a fault. This fault is also raised when the power fail duration exceeds the configured PFT duration (defaults to 30 days). This fault inhibits the Timetable and CLF systems.

If the System Time Mode is configured, then when System Time is automatically set by the NTP or GPS systems, this automatically sets the Controller Time and clears this fault, enabling the Timetable and CLF systems again.

33 THE EVENT TIMETABLE

33.1 Plan Change / Event Timetable

There are 64 entries in the Event Timetable. For each entry the following is specified.

Day Code

This is a configurable number that indicates the day or days on which this Event occurs. The default settings for the day code are as follows, although these can be changed at configuration time. The Holiday Clock, see section 33.5, can further enhance these day codes.

Number	Significance
0	Saturday
1	Sunday
2	Monday
3	Tuesday
4	Wednesday
5	Thursday
6	Friday
7	Every Day
8	Every Day except Sunday
9	Every Day except Saturday and Sunday

Time

The time at which the event is to be introduced on the days on which the above 'Day Code' is valid.

Timeswitch Setting Command Code and Argument Value

This indicates what function is to be performed when the time is reached. Possible Command Codes are:

- 0: Isolate; disable CLF mode, e.g. switch the controller from CLF to VA or FT operation. The additional Argument Value is ignored.
- 1: Introduce a CLF plan. The additional Argument Value specifies the number of the Plan to be introduced. See section 33.2.
- 2: Change multiple time switch events using the specified Event Parameter. The additional Argument Value specifies the event parameter. See section 33.3.
- 3: Sets an individual time switch event. The additional Argument Value specifies the time switch event number.
- 4: Resets an individual time switch event. The additional Argument Value specifies the time switch event number.

These entries can be reviewed and configured using the Controller - Timetable - Time Switch web page or the TSW/TTB handset commands:

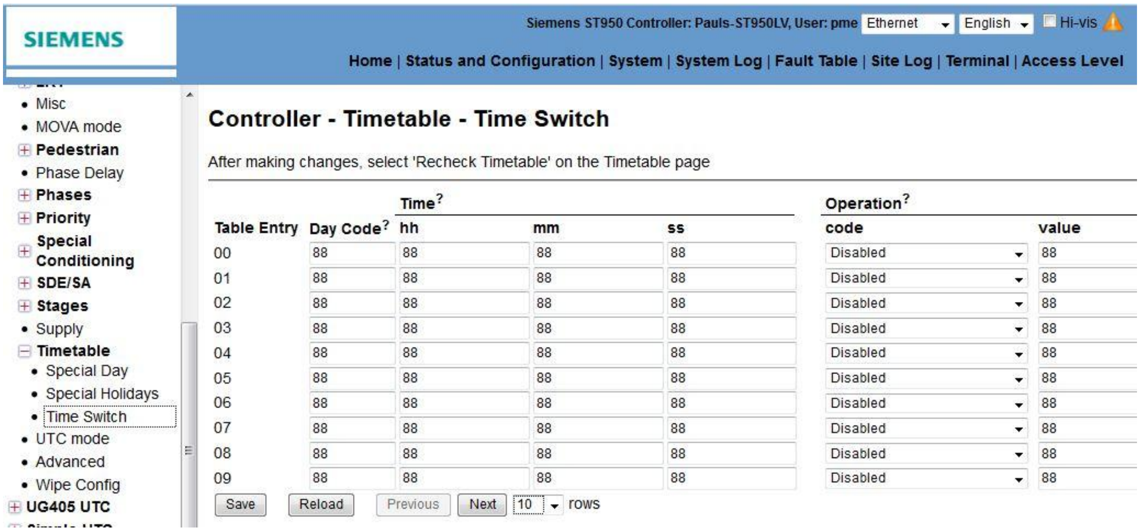


Figure 79 Controller - Timetable - Time Switch web page

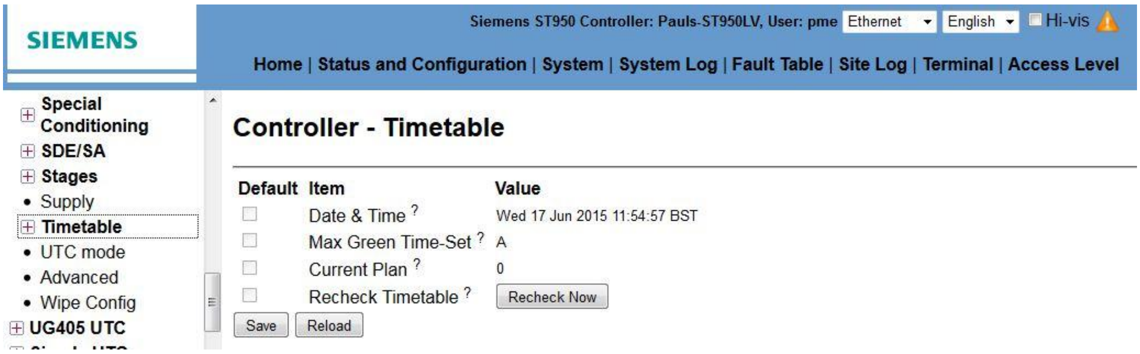


Figure 80 Controller - Timetable web page

33.2 Cableless Link Plans

See section on CLF Mode operation.

33.3 Event Switches

Individual time switch events can be set and reset directly. The timetable command code number ‘3’ sets an event and ‘4’ resets an event. The number of the time switch event is given by the additional Argument Value.

The use of the Command Code number ‘2’ and time switch Event Parameters to select a combination of event switches has been retained to allow easier upgrade of existing configurations. Their use on new configurations is not recommended. Instead, use the codes ‘3’ and ‘4’ to set/reset the individual time switch events.

In the event of a time clock failure, all the timetable switches are set to their default state (see section 33.4).

32 time switch events (numbered 0-31) are available to be defined in the IC4 configuration. Each one may be defined as any one of the following event types. The

current state of each timeswitch event can be viewed using the SWS handset command.

33.3.1 Switch an Input/Output Active/Inactive/Normal

An input or output will operate as normal until switched active or inactive by a timetable setting. Switching it active will set it permanently active, while switching it inactive will set it permanently inactive. The state will continue until another timetable setting switches it back to normal.

However, it is recommended that Special Conditioning be used to modify the operation of the controller rather than these time switch functions, see 33.3.6. These functions have been retained to allow easier upgrade of existing configurations. Their use on new configurations is not recommended.

33.3.2 Introduce Alternative Maximum & Priority Timesets

The standard maximum green times for phases (Set A) and standard Priority times (Set 0) will be effective until switched by a timetable setting.

There are eight maximum green timesets (A to H) and four Priority plans (Sets 0 to 3) available. Switching an alternative maximum green timeset A to D active will automatically switch the corresponding Priority plan 0 to 3 active. Maximum green timesets E to H call up priority sets 0 to 3 again.

All phase maximum green timings and all Bus Priority unit timings are switched when an alternative maximum facility is introduced. Therefore, any maximum green times that do not required to be changed in an alternative plan should be set to the same value as in the previous plan.

Any timer that is already active at the time of switching will remain effective until the next start of that timing period. For example, if a maximum green of 50 seconds has already started and the maximum is switched in the middle of that 50 seconds to a new value of 30 seconds, the 50 seconds will still be timed. The 30 seconds will become effective when that maximum green timer next has a reason to start.

Note: If a maximum green timeset is introduced using command/function code ‘3’ in the timetable, the time switch event for the previously active maximum set is automatically cleared.

33.3.3 Switch a Sign On/Off

Timetable settings may illuminate or extinguish a secret sign.

Note that two time switch functions exist, one to switch the sign on and one to switch the sign off. However, the two functions should not be used with the same sign. Only one function should be used on a sign and which one depends on whether the sign is to be switched on or off should the clock in the controller be incorrect, e.g. after the power has been switched off for too long, see section 33.4

Note: The illuminating and extinguishing of a secret sign would normally be dependent on the leaving amber of the associated phase as well as the timetable setting. If this is required, Special Conditioning must be written to tie the secret sign to the amber leaving of the appropriate phase as well as the timetable setting. “SIGN ON” and “SIGN OFF” in timetable should not be used. Instead a conditioning flag is used in timetable, see 33.3.6.

These time switch functions have been retained to allow easier upgrade of existing configurations. Their use on new configurations is not recommended. Instead, use Special Conditioning to control a Switch Sign and use the timetable function to set a conditioning flag (33.3.6).

33.3.4 Switch a Stage/Phase In/Out of Cycle

Any stage, apart from the Start up and Part-time Shutdown Stages may be deleted and re-introduced by a timetable setting.

If a stage is deleted, it will be omitted from the cycle until it is re-introduced.

If an optional real phase is deleted, the signals will remain at red (or blackout in the case of a green arrow phase) whenever a stage that the phase normally appears in is active. Note that fixed phases should not be deleted.

If a dummy phase is deleted, any effect its appearance has on stage changes or timings will be cancelled.

When a stage is deleted, any demands for that stage or for phases within the stage must also be deleted by the same timetable setting, unless the phases appear in other stages.

In order to delete current demands and prevent further demands, it is recommended that such demands be deleted by using special conditioning to write a “FALSE” state to the entry in the latched or unlatched demand arrays for the appropriate phase/stage.

When a phase is deleted, any demands for that phase must also be dependent on the same timetable setting.

If the above two conditions are not met, outstanding demands for stages or phases may never be satisfied.

The deletion of stages or phases is effective in all modes except Hurry Call and Fixed Time mode, as deletion of phase/stages associated with these later two modes would cause the controller to lock up.

If you wish to delete a phase or a stage and a form of fixed time working is required, “Fixed time to Current Maximums” can be used. This uses the VA mode with permanent demands and extension. Thus if a phase/stage is to be deleted, provided demands for it are also deleted, it can be deleted without problems.

These time switch functions have been retained to allow easier upgrade of existing configurations. Their use on new configurations is not recommended. Instead, use Special Conditioning to modify the operation of the controller and use the timetable function to set a conditioning flag (33.3.6).

33.3.5 Switch To/From Part-Time Mode

Part-time mode may be switched to and from by a timetable setting. See documentation on Part-Time mode for a more detailed explanation.

33.3.6 Switch a Conditioning Flag Active/Inactive

A conditioning flag that is required to indicate a particular time of day may be switched active or inactive by a timetable setting. Special conditioning can then read the Flag and perform the required function(s).

33.3.7 Switched DFM Timings

DFM can be switched between four different timesets as required. The Monitor times for each timeset can be adjusted by the Handset.

33.4 Time Switch Event Default States

Time switch Event	Default State (i.e. when no time switch events are active)
33.3.1 Input active	Input normal operation (following external influence)
33.3.1 Input inactive	Input normal operation (following external influence)
33.3.1 Output active	Output normal operation (following controller influence)
33.3.1 Output inactive	Output normal operation (following controller influence)
33.3.2 Maximum Green	Maximum green timeset A and Priority Set 0 selected.
33.3.3 Sign ON	Sign will be OFF
33.3.3 Sign OFF	Sign will be ON
33.3.4 Delete Phase	Phase not deleted
33.3.4 Delete Stage	Stage not deleted
33.3.5 Part Time	Not Part time (i.e. signals illuminated normally)
33.3.6 Conditioning Flag	Special Conditioning flag will be false
33.3.7 DFM timesets	DFM timeset 0 selected

Table 4 Time Switch Event Default States

33.5 Holiday Clock

33.5.1 Introduction

The standard timetable allows events to be introduced at certain times on certain days of the week. See the description of the 'day code' in section 33.1. These events would normally occur on the same day and at the same time every week.

The Holiday Clock facility allows days during the year to be defined when the normal timetable events should not run.

Example: Consider a controller in which the normal timetable events request CLF plans in order to provide a linked method of control during the rush hours. The Holiday Clock facility can be used to define holidays when the volume of traffic is expected to be lower and so the controller is required to remain isolated and not run the CLF plans.

The Holiday Clock facility provides:

- Special Holiday Periods that allow ranges of dates to be configured during which an alternative set of timetable events run.
- Special Days that allow specific dates to be selected on which different timetable events can be configured to run.

33.5.2 Special Holiday Periods

The Holiday Clock facility allows the period between two dates to be considered as a Special Holiday period. Currently, up to 32 special holiday periods can be configured in advance.

Example: The controller can be configured with a special holiday period that starts on 29-MAR-13 and finishes after 12-APR-13 in order to define the Easter school holiday period as March 29th to April 12th 2013.

Timetable events that use the normal day code numbers (i.e. those in the range 0 to 15) will not run on the days during these special holiday periods. Thus taking the original example from section 33.5.1, the CLF plans would not be introduced and the controller would remain isolated.

However, if different CLF plans were required to start at different times during these holiday periods, new timetable events can be added to action these requirements during the special holiday period. The timetable event should be entered as normal other than adding 100 to the required day code number (see section 33.1). For example, use the day code 109 for every weekday during the holiday period.

If certain timetable events are to run regardless of these special holiday periods, rather than defining two entries, one for outside the holiday period and one for within the holiday, one entry can be defined. In this case, add 200 to the required day code number (see section 33.1). For example, use the day code 209 for every weekday regardless of the holiday periods.

To summarise, day codes in each of the following ranges are actioned as follows:

0 to 15	100 to 115	200 to 215	
Ignored	**Actioned**	**Actioned**	During a Holiday Period
Actioned	Ignored	**Actioned**	Outside all Holiday Periods

Special Holiday Period settings can be reviewed and changed using the Controller - Timetable - Special Holidays web page.

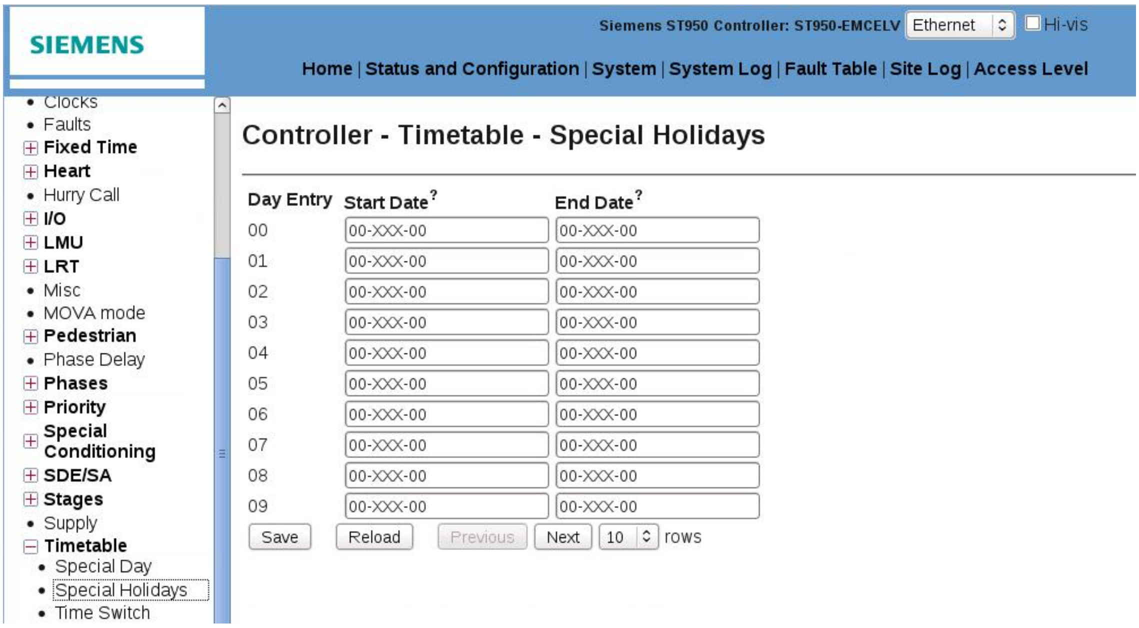


Figure 81 Controller - Timetable - Special Holidays web page

33.5.3 Special Days

The Holiday Clock facility allows specific individual dates to be defined when the normal timetable events should not run, e.g. Bank Holidays. Currently, up to 64 special days can be configured in advance.

For each Special Day, a Date and a Day Code is defined.

Day Codes 15 to 99

If the specified day code is not one of the normal timetable day codes (see section 33.1), only timetable events that use that exact day code number run on that specific date.

For example, specifying day code 20 and the date 25-DEC-XX means that only time switch events with day code 20 would run on December 25th (Christmas Day) every year.

The controller ignores the special holiday periods in this case and thus the above is true even if the configured date falls within a configured special holiday period.

Day Codes 0 to 15

If the specified day code is one of the normal day codes that runs on just one day of the week (see section 33.1), effectively the specified date is turned into the specified day of the week.

For example, specifying day code 1 and the date 26-AUG-13 (which was a Bank Holiday Monday in the UK) means that the controller would actually process the timetable as though it were a Sunday (because day code 1 is normally the configured day code for Sunday, see section 33.1).

Therefore, on Monday August 26th 2013, the controller would not run the normal timetable events for a Monday, but instead would run the normal time switch events for a Sunday. The controller will then go on to examine the Special Holiday Periods.

If this Special Day is outside all the holiday periods, time switch entries with the following day codes will run:

1	Sunday outside a holiday period
7	Every day outside a holiday period
201	Every Sunday
207	Every day

However, if this Special Day is within one of the holiday periods, time switch entries with the following day codes will run:

101	Sunday within a holiday period
107	Every day within a holiday period
201	Every Sunday
207	Every day

Special Day settings can be reviewed and changed using the Controller - Timetable - Special Day web page.

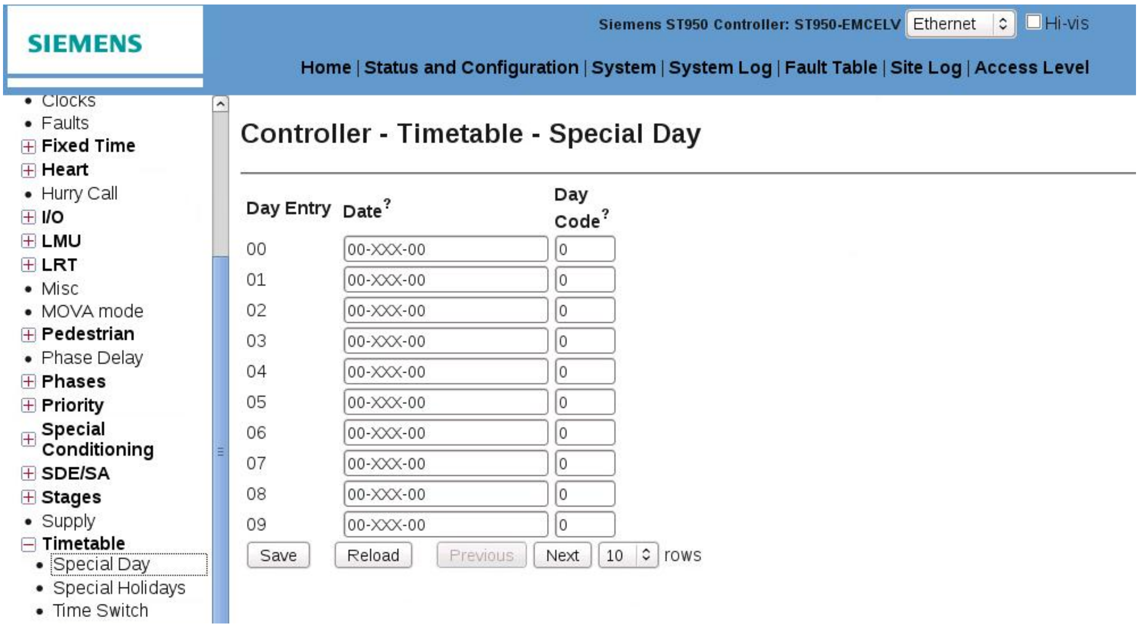


Figure 82 Controller - Timetable - Special Day web page

34 LINKING

Controllers can be linked in various ways:

- **Urban Traffic Control**; each controller is connected to one Instation, which controls the signal sequence - refer to the documentation on UTC mode for more information.
- **Cableless Linking**; using defined plans and a common time source to synchronise controllers without any physical connection between them - refer to the documentation on CLF mode for more information.
- A **Repeat Pulse** from one controller to stimulate a neighbouring controller - refer to section 34.1.
- **OTU Linking**; the OTU at one controller is also linked to a neighbouring controller - refer to section 34.2.
- **Pedestrian Local Linking PV1**; a neighbouring intersection prevents the pedestrian phase gaining ROW - refer to section 34.3.
- **Pedestrian UTC Linking PV**; the UTC Instation prevents the pedestrian phase gaining ROW - refer to the documentation on UTC mode.
- **Cross Inhibit Linking** prevents both ped crossings granting ROW to the pedestrian phases at the same time - refer to section 34.4.

34.1 Repeat Pulses

The controller may be linked to other traffic controllers so that a pulse generated by a condition in one controller may be transmitted to another controller. The function of the pulse when received will depend on the method of control of the intersection.

One use of the facility is to maintain traffic flow through closely associated intersections. When a certain phase gains ROW, a pulse is transmitted to the linked controller to demand a phase along the same route.

Special Conditioning is used to provide an output from the controller under pre-defined conditions, e.g. during Red/amber or amber leaving of a particular phase.

34.2 OTU Linking

Sometimes it is not practical to fit an OTU (Outstation Transmission Unit) or provide a network connection in a second controller cabinet. Instead, two controllers are linked by I/O cables and they 'share' the one OTU. In this case, the OTU in the first controller cabinet also controls and monitors a second controller.

Regardless of the type of OTU installed, one option is to pass all the control and reply bits between the OTU and the first controller, which then (using Special Conditioning) explicitly 'copies' the UTC control and reply bits to controller I/O for connection to the second controller. Alternatively, the OTU may be wired directly to the second controller, without those UTC bits passing through the logic of the first controller:

Where a physically separate 'free-standing' OTU is fitted, the OTU control bit outputs and reply bit inputs can be divided up and physically connected to the relevant controller I/O. For example, one UTC control word (8 control bit outputs) is connected to the first controller and the second word is connected to the second controller.

Where the internal UTMC-OTU Application is used, the OTU application can be configured to direct the required control and reply bits to physical digital I/O, which are then connected to the second controller. The operation and IC4 configuration of the Controller Application in the first controller has no effect on those connections.

Where a semi-integral Gemini (Serial UTC) is used, the Gemini unit can be configured to direct the relevant control and reply bits to its physical digital I/O, which are then connected to the second controller. The first controller will have no effect on those connections.

34.3 Local Linking PV1

PV1 is a digital input to a stand-alone pedestrian stream to prevent the pedestrian phase while traffic from a nearby intersection is heading through the crossing.

PV1 is normally held active to prevent the pedestrian phase and the release of PV1 is only actioned after a configurable delay period.

A pedestrian demand is serviced while PV1 is inactive and the delay has expired. A window period starts when the delay period expires, and vehicle phase extensions are inhibited during that window time.

Link Override Timer (MCE0125) - If the PV1 input is active for longer than the override period, the pedestrian phase is permitted to gain ROW. Whether the override period only starts if a pedestrian demand has been received is configurable. Two options (modes) are available when the override period expires. By default, the PV1 input is ignored when the override period expires; the stream reverts to non-linked operation allowing pedestrian demands to be serviced until PV1 is released and activated again. Alternatively, the delay and window periods are run as though the PV1 input had gone inactive.

Link Fail Times (MCE0145) - If the PV1 input is held active or inactive longer than the configured fail periods the input appears to be stuck. A fault is raised and the pedestrian phase is prevented from gaining ROW. A short release pulse (< 300mS) on PV1 does not start the delay or window timers but does restart the link fail timers; the short pulse confirms that the signal is not 'stuck'.

Local linking is configured through the Controller - Pedestrian - Standalone and Controller - Pedestrian - Linking web pages.

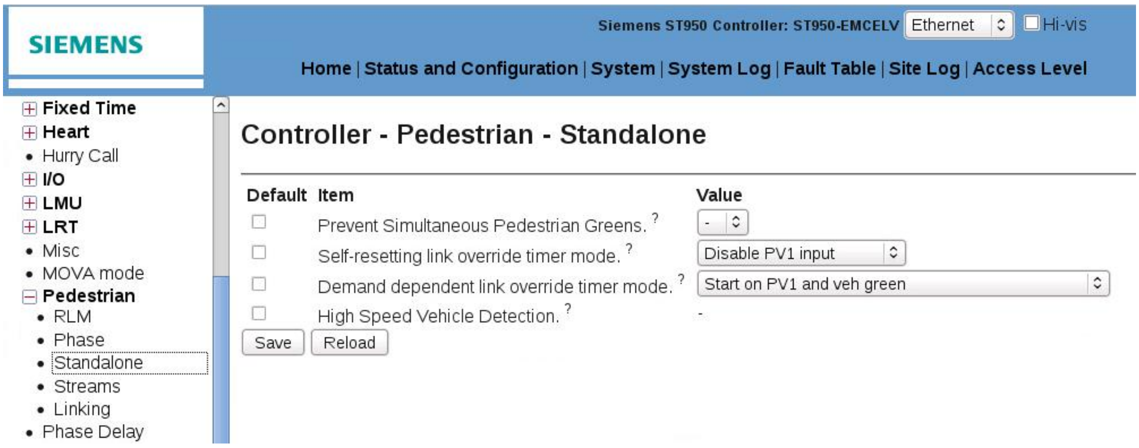


Figure 83 Controller - Pedestrian - Standalone web page

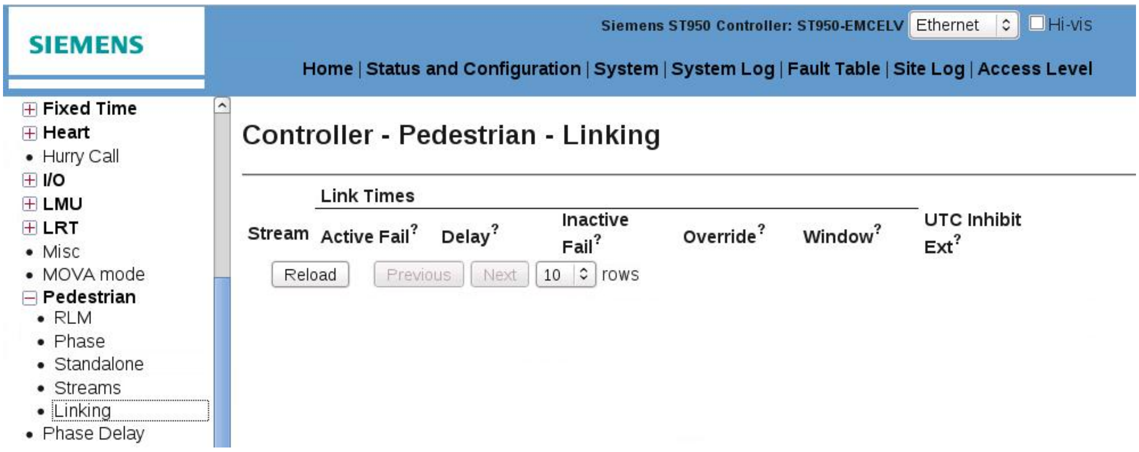


Figure 84 Pedestrian - Linking web page

If web page access is not available then handset commands can be used:

- LKD - Link delay time
- LKW - Link window time
- LKO - Link override time
- LKM - Link mode - resetting mode & override timer start mode
- LKA - Link active fail time
- LKI - Link in-active fail time

Local link dimming can be configured using the UTC dim override input SO and setting DIT=1 which allows the input to force the controller to dim if active.

34.4 Cross Inhibit Linking

Where two pedestrian crossings are close together, e.g. one across each carriageway of a dual carriageway, it is often required that both pedestrian phases do not appear at green together.

'Cross Inhibit Linking' prevents one stream from giving right of way to its pedestrian phase while another stream has given right of way to its pedestrian phase, forcing one to follow the other if both are demanded.

This removes the situation where pedestrians that have just crossed one carriageway also attempt to cross the other carriageway because that pedestrian phase has not yet returned to 'no right of way' (because it also gained right of way around the same time as the first crossing).

By preventing one pedestrian stream from appearing at right of way while the other is at right of way, it allows the pedestrians time to cross one carriageway before the other crossing is allowed to appear at right of way.

The controller provides the facility for a dual stand-alone pedestrian stream controller, which can be enabled on the Controller - Pedestrian - Linking web page or by using the handset command CIL.

Special Conditioning must be used if other combinations are required, e.g. when stream 0 is an intersection stream and streams 1 and 2 are the dual pedestrian crossing near-by, or where more than two stand-alone pedestrian streams need to be controlled.

35 ALTERNATIVE SIGNAL SEQUENCES AND FLASHING SIGNALS

35.1 Alternative Signal Sequences (Non UK Only)

For the UK, the signal sequences are fixed and cannot be changed. For non UK use, there are 8 easily definable lamp sequences, with each phase assigned one of these lamp sequences. Each lamp sequence set defines the signal states (i.e. colours) for at right of way, at no right of way and the Part-time (standby) state. It also defines the power on sequence, the signals off to on sequence, the sequence from normal operation to Part-time and back to normal operation, as well as the sequences between “at right of way” and “at no right of way”. Each sequence can consist of up to 3 steps where the signal states and times can be specified.

Green must always be used for “at right-of-way” for traffic, pedestrian & green arrow phases because of the green conflict facility.

Traffic Phases

Some examples of alternative signal sequences are:

	Example 1	Example 2
at no ROW:	RED	RED
changing to ROW:	RED	RED
at ROW:	GREEN	GREEN
changing to no ROW:	AMBER	GREEN/AMBER

In both examples, the omission of RED/AMBER for “changing to ROW” does not affect the length of the inter-green.

In the second example, the GREEN/AMBER would normally be the same value as AMBER LEAVING, i.e. 3 seconds.

The RED/AMBER and AMBER LEAVING periods in the standard signal sequence are fixed at 2 seconds and 3 seconds respectively and the rest of the lamp sequence is fixed in order to conform to U.K. requirements. These values may be changed in order to meet other specifications if required. For example, it is possible to specify a variable amber leaving time in a similar way to specifying pedestrian blackout times (see the LAT handset command).

Pedestrian Phases

The standard signal sequence for pedestrian phases does not allow for an amber to appear in the “changing to right-of-way” and “changing to no right-of-way” sequences since the amber is utilised to drive the wait indicator on a pedestrian phase.

An example of a pedestrian signal sequence is:

at no ROW:	RED MAN
at ROW:	GREEN MAN

changing to no ROW:	BLACKOUT or FLASHING GREEN MAN

If an amber is required, the amber can be configured in the signal sequence, and if a wait indicator is also required, this has to be programmed as a switched sign phase.

35.2 Alternative Start-Up Sequences

As an alternative to the standard start-up sequence and blackout during Part-time mode, modifying the lamp sequences may easily provide the following.

(a) Start-up Sequence

FLASHING AMBER for 6 seconds
ALL RED for the length of the starting inter-green plus the amber leaving time

With ROW going first to Stage 1 before completing one cycle.

(b) Part-Time Mode

At the changeover to Part-time mode, following the expiry of all phase minimum greens, ROW goes to an all-red stage (normally Stage 0) for a specified time. Flashing amber to all traffic phases and blackout to all pedestrian and green arrow phases then follows this.

Allocating a dummy phase to the stage provides the specified time in the all-red stage. The minimum green value of the dummy phase will provide the time.

At the changeover from Part-time mode the start-up sequence is effective.

35.3 Flashing Signals

The signals on traffic, pedestrian and green arrow phases are normally a continuous display. If required, displays may be programmed to flash instead, for example:

Traffic phases:

at no ROW:	RED
Changing to ROW:	RED/AMBER
at ROW:	GREEN
Changing to no ROW:	FLASHING AMBER

Pedestrian phases:

at no ROW:	RED
at ROW:	FLASHING GREEN

Traffic phases:

	Phases A,B & C	**Phase D**
at no ROW:	RED	RED
changing to ROW:	RED/AMBER	RED/AMBER
at ROW:	GREEN	FLASHING GREEN
changing to no ROW:	AMBER	AMBER

The displays that are programmed to flash will do so every time they appear. They cannot be programmed to be solid and flashing.

The flashing facility may also be applied to the part-time state and the start-up sequence if required, for example:

	Phases A,B & C	Phase D
Part-time state:	FLASHING AMBER	FLASHING RED
Start up sequence:	RED	RED

Followed by ROW going to Stage 1 before commencing a complete cycle.

35.3.1 Variable Flashing Signals

The facility is available to have flashing traffic, pedestrian and LRT signals. The rate of flashing is adjustable with adjustable on/off ratio. The adjustment is in 20mS steps for both on and off periods, with a limit of 5.1 seconds.

Due to the operation of the green monitoring system, the 'off' period should not be configured more than 1.5 times the length of the 'on' period without consulting Siemens Engineering at Poole.

35.4 Non UK Signal Sequences

The following is a list of some of the foreign signal sequences that can easily be configured by altering the lamp sequences.

BAHRAIN: Blackout start-up and flashing amber part-time with standard British traffic and pedestrian sequences (no blackout).
Supply: 240V 50Hz.

CHINA:

Beijing: Normal start-up sequence and blackout part-time mode.
Traffic: red - green - amber - red.
Supply: 220V 50Hz.

Shekou: Normal start-up sequence and blackout part-time mode.
Traffic: as Beijing.
Ped: red - green - flashing green - red.
Supply: 220V 50Hz.

Shen Zhen Province: As Columbia, but 220V 50Hz.

COLUMBIA: Flashing amber start-up and part-time.
Traffic: red - green - amber - red.
Ped: red - green - flashing green - red.
Supply: 110V 60Hz.

DALLAH:	Flashing amber start-up and part-time. Traffic: red - green - amber - red. Ped: red man - green man - blackout - red man (Usually as parallel pedestrians). Supply: 220V 60Hz (Except Damman Port - 277V 60Hz. A special transformer is needed here). Side road flash in part-time may be red instead of amber. Amber leaving may also be requested as five seconds instead of the normal three.
EIRE:	Normal start-up. Traffic: red - green - amber - red. Ped: standard (sometimes with blackout). Supply: 240V 50Hz.
HONG KONG:	Start-up sequence: A 7-10 second blackout followed by all red usually 8 seconds. Then phases in starting stage go immediately to green. Traffic: red - red/amber - green - amber - red. Ped: red - green - flashing green - red. Supply: 200V 50Hz The LRT phase sequence is: Stop - Proceed - Flashing Proceed - Stop. Proceed may be ahead, and/or left turn and/or right turn proceed signals. If two different ahead moves are required, a separate phase is required for each.
SYRIA:	Flashing amber start-up and part-time. Traffic: red - green - amber - red. Ped: standard (with three-second blackout). Supply: 240V 50Hz (Damascus).
SRI LANKA:	As Bahrain, but with flashing amber start-up. 240V 50Hz.
TRINIDAD:	Flashing amber start-up with flashing amber (main road) and flashing red (side road) part-time. Traffic: red - green - amber - red. Ped: standard sequence. Both 240V 50Hz and 110V 60Hz are used in Trinidad and Tobago depending on the actual location.
ZAMBIA:	As Syria with 240V 50Hz.

36 WIG WAG SIGNALS

36.1 Introduction

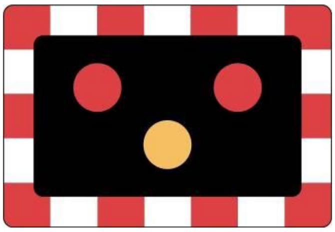


Figure 85 Flashing Red Wig-Wag Signals

The Siemens Wig-Wag system is a complete solution for the provision of priority signals at fire and ambulance stations. The signals may also be used in other locations such as bridge crossings where there is a need to stop ordinary traffic flow but where it may be difficult for drivers to forecast when they will be required to stop

In the UK, the ST950LED and ST950ELV Traffic Controllers are approved to both TR2500A and TR2513A, which allows them to be used at fire and ambulance stations and at bridges, but not at rail crossings.

The controller can provide stand alone Wig-Wag applications and also full intersections where Wig-Wags are required nearby.

Both LV and ELV Wig-Wag Signals utilise the latest generation of low power CLS LED signals. The Siemens Wig-Wag signals are compliant with TSRGD Diagram 3014 and conform to EN12368. Lamp monitoring is undertaken directly by the controller on both LV and ELV signals, eliminating the need to fit lamp monitoring equipment within the Wig-Wag signals, ensuring power usage is kept to a minimum.

IMPORTANT: As Wig-Wag configurations are more complex to create than intersection configurations it is strongly recommended that they should only be created by Intersection Engineering at Siemens, Poole.

36.2 Flexible activation

Typically Wig-Wags are activated by a button within the fire or ambulance station. Where just simple button activation is required this may be implemented with a Puffin Demand unit, using the demand indicator to signal back that the controller has registered the demand.

Where a more sophisticated control system is required a full activation box is available. For more information download the Wig-Wag Brochure from the Siemens Traffic website.

Interfaces to control panels and mimic signals are provided using standard controller digital inputs and outputs and optionally phase drive outputs.

36.3 The Wig-Wag Sequence

For most of the time, the Wig-Wag Signals are extinguished. Only when it is required to stop the normal traffic flow are the signals illuminated, to let an ambulance leave the station quickly and safely for example.

The default Wig-Wag sequence consists of a fixed 5 second amber period, followed by the left / right flashing of the red signals.

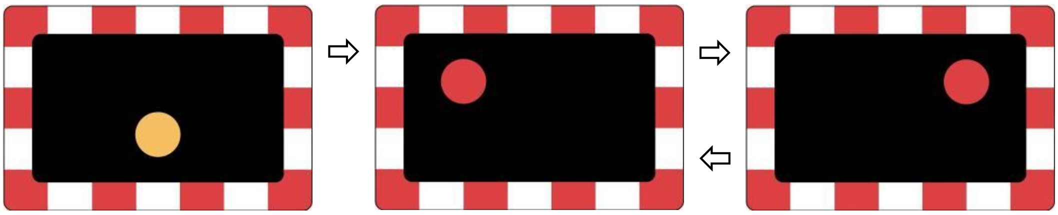


Figure 86 Wig-Wag Signal Sequence

When it is clear for the traffic to proceed again, the flashing red signals are extinguished.

Wig-Wag Signals can also be positioned facing the egress of the fire or ambulance station to allow the drivers of the emergency vehicles to confirm the state of the other Wig-Wag signals. Where regulations (such as those in the UK) stipulate that all vehicles, including emergency service vehicles, must stop at flashing red Wig-Wag signals, Wig-Wag Signals are also available with flashing blue aspects (replacing the usual flashing red aspects) for use in these positions.

In countries where the UK specification TR2513 does not apply, the amber period can be altered or removed, in similar ways to a traffic amber-leaving period.

The default flash period for the reds is 400mS (left) and 400mS (right). Longer flash periods are available if required. However, it must be noted that all the flashing signals displayed by a controller flash at the same rate.

36.4 Phase and Sensor Usage

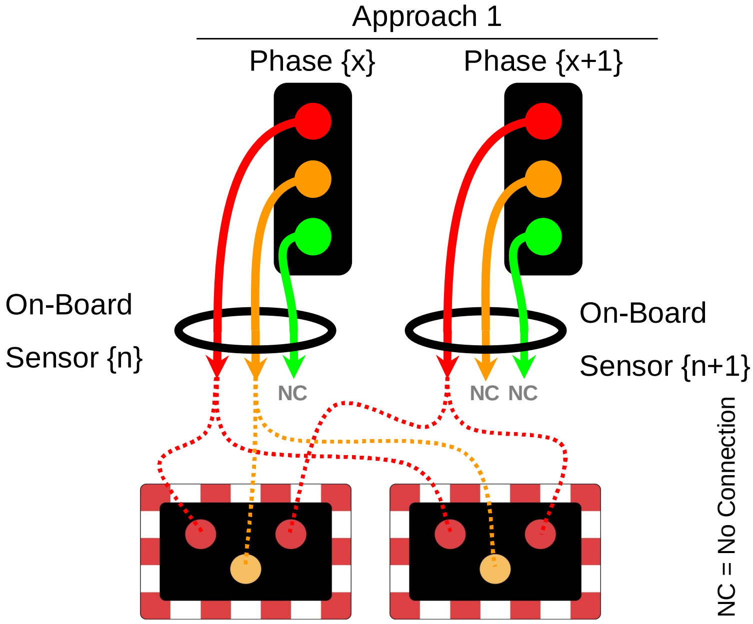


Figure 87 Wig-Wag Phases and Sensors

In order to provide the correct flashing sequence and be able to Red Lamp Monitor the signals correctly, each pair of Wig-Wag Signals on one approach must be driven by two adjacent phases and monitored by two adjacent sensor numbers. A maximum of two red aspects per sensor can be monitored, i.e. two left reds by one sensor and two right reds by the next sensor.

One approach (with two signals) is shown above. More than one approach can be configured as required, up to the phase limit of the Traffic Controller. Each approach requires two phases (and two on-board sensors).

If mimic signals are required to use phase outputs (rather than digital outputs) an approach can be added to drive just those signals. In this case, lamp monitoring would normally be disabled on both sensors of that ‘mimic’ approach.

36.5 Red Lamp Monitoring

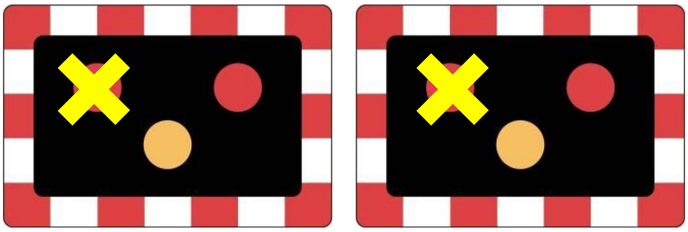
Wig-Wag signals are typically arranged in pairs, one pair of signals for each approach.

It is required by TR2513A that red lamp failures are counted independently on each Wig-Wag approach, and all the Wig-Wag signals are extinguished when any two red lamps fail on an approach.

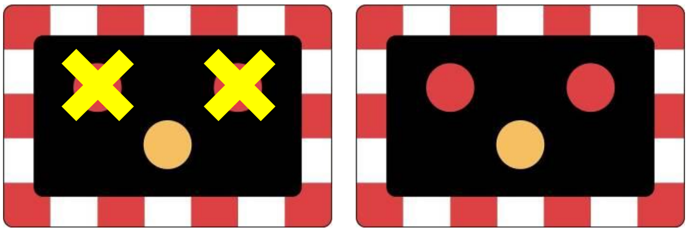
In order to meet the TR2513A requirement that any two red lamp failures on an approach trigger the second red lamp fail actions, installations are limited to a maximum of two Wig-Wag Signals per approach because a maximum of two red aspects can be monitored by each sensor. If more than two Wig-Wag Signals are required on an approach, the pairing of the signals and the operation of the Red Lamp Monitor must be carefully considered – if in doubt, please contact Siemens Poole for further advice.

Having separate phases and sensors for each approach meets the requirement to count faults on each approach independently. All the Wig-Wag signals are extinguished when any two red lamps fail on an approach, i.e. when any of the following occur:

- Two red lamp failures or a feeder failure on either sensor. This is normal operation for the controller’s Red Lamp Monitor.



- One red lamp failure on BOTH sensors of the approach. This case is specific to Wig-Wag Signals.



36.6 Flashing Amber Wig-Wags

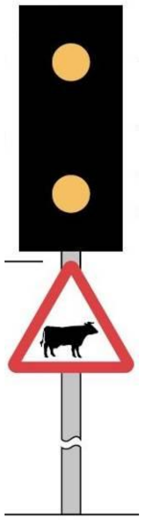


Figure 88 Flashing Amber Wig-Wag Signal

In addition to the flashing red Wig-Wag Signals shown previously, the controller is capable of driving and monitoring flashing amber Wig-Wag Signals, e.g. at cattle crossings.

If lamp monitoring is required, with or without ‘red’ lamp monitoring options, then it is recommended that the sequence used for the flashing red Wig-Wag on two phases is used, but amber coloured aspects are fitted instead of red. The fixed 5 second amber period in the lamp sequence can be deleted from the Lamp Sequence using IC4.

37 Inputs And Outputs

37.1 Inputs (I/P)

Inputs into the controller may include the following:

- Demands and extensions from detectors
- Call/Cancel detectors
- Extensions from SDE/SA assessors
- Extensions from all-red detectors
- UTC control bits
- Priority Vehicle detectors
- Hurry Call requests
- Links from other controllers
- Solar cell input

37.2 Outputs (O/P)

Outputs from the controller may include the following:

- UTC reply bits
- Hurry Call Confirmations
- Links to other controllers

37.3 Logic Conditions

The physical (and logic) states of the inputs and outputs are shown below:

	NON-UTC		UTC	
	INPUTS	OUTPUTS	INPUTS	OUTPUTS
ACTIVE	CLOSED (1)	CLOSED (1)	CLOSED (1)	OPEN (0)
INACTIVE	OPEN (0)	OPEN (0)	OPEN (0)	CLOSED (1)

Table 5 Input and Output States

The physical and logical state of the IO ports can be viewed on the Controller - I/O - Lines (shown in below) or on the Controller - I/O - Ports web page (shown in section 37.4). The active and inactive states for each input or output are configurable by choosing whether or not to invert them.

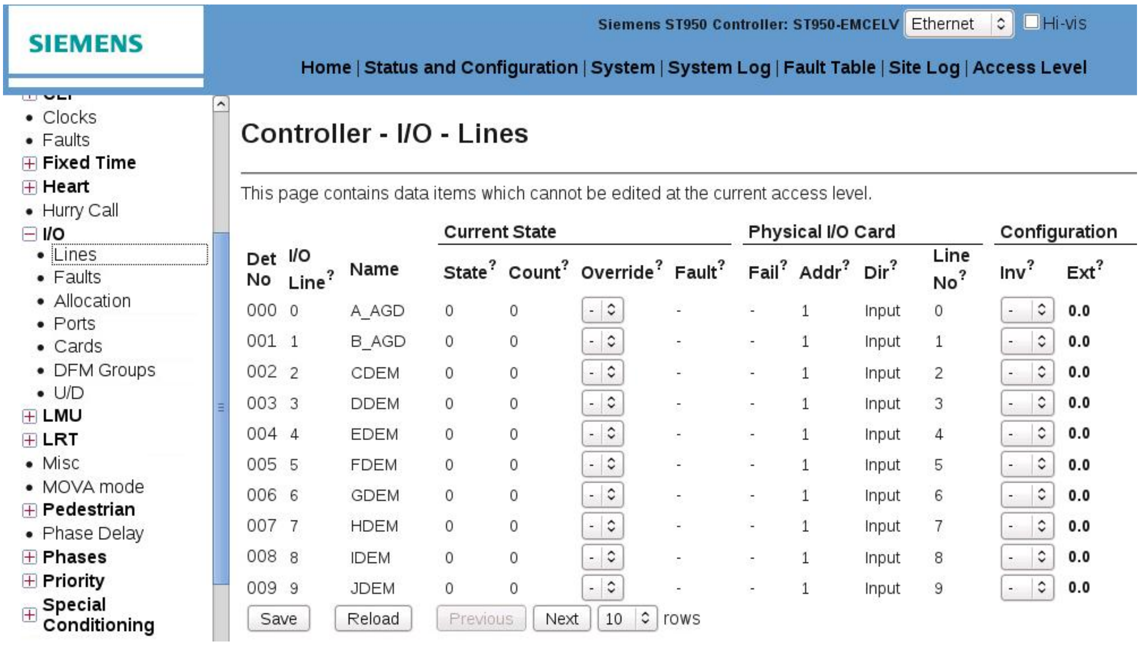


Figure 89 Controller - I/O - Lines web page

37.4 Ports

The ports of the controller provide a means of connecting the hardware of the input and output signals to the controller software.

Each port normally consists of 8 bits (0 to 7) which must be either all inputs or all outputs.

In order to calculate the number of ports that are required, the inputs and outputs are allocated, where practical, into groups of 8. It is better for configuring if all the detectors for one phase are on the same port. UTC inputs must be allocated different ports to detector or other inputs for software reasons.

The physical and logical state of the IO ports can be viewed on the Controller - I/O - Ports web page (shown below).

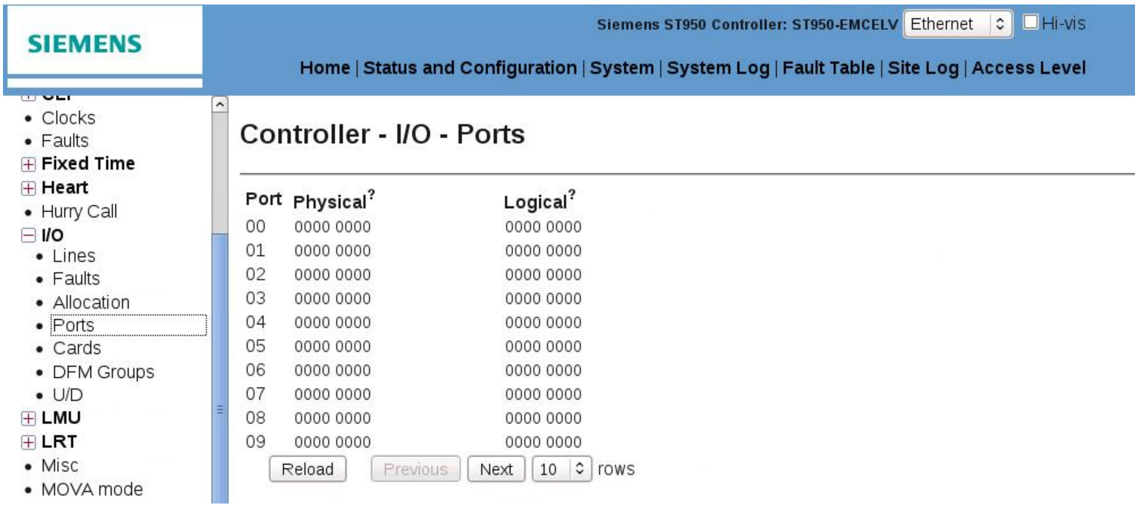


Figure 90 Controller - I/O - Ports web page

Alternatively the IOL and IOP handset commands may be used.

37.5 Port Allocation

The controller can use up to 31 I/O ports, numbered 0 to 30, giving a total of 248 I/O lines numbered 0 to 247.

Each I/O port normally contains 8 input lines (for detectors and push buttons, etc.) or 8 output lines (for UTC reply bits, etc.), although there are only 4 outputs on the 24 Input / 4 Output variant of the Serial I/O Card. The I/O card number is set by a rotary switch on each card.

Always refer to the works specification / IC4 printout for the I/O used by a particular installation.

The types of IO card required by the IC4 configuration can be reviewed on the Controller - I/O - Cards web page.

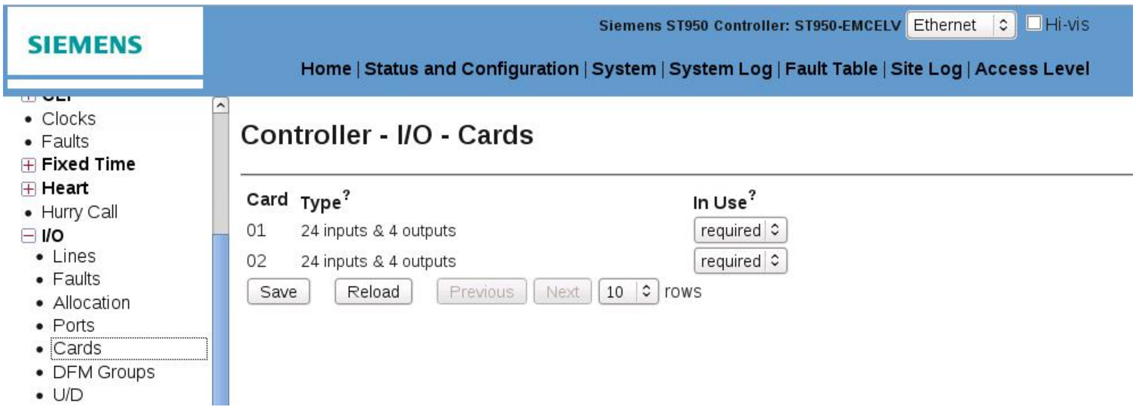


Figure 91 Controller - I/O - Cards web page

37.6 Re-arranging I/O

It is sometimes necessary to re-arrange the I/O allocated in the IC4 configuration; moving the logical function of I/O line to a different physical I/O line position.

The Allocation of IO within the controller can be reviewed and updated using the Controller - I/O - Allocation web pages or the IOA handset command.

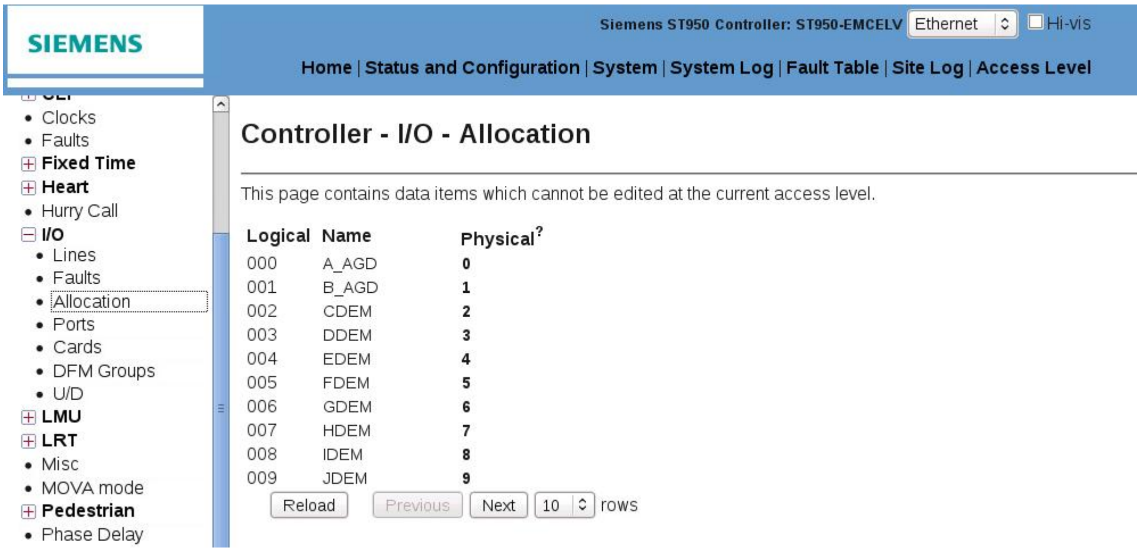


Figure 92 Controller - I/O - Allocation web page

37.7 Detector Fault Monitoring (DFM)

DFM is allocated to specified detector inputs and, if required, pedestrian push-button inputs. This is separate from the specific monitoring applied to pedestrian on-crossing detectors, pedestrian kerbside detectors, and Priority/LRT vehicle detectors.

With the DFM facility, if an input does not change state and remains permanently active or inactive for a specified period, a DFM fault has been confirmed and the following happens:

- The cabinet alarm is illuminated.
- Optionally, the input can be forced active or forced inactive.
- Entries will be made in controller's fault logs.

DFM faults can only be cleared if the controller has seen the input change state since reporting the fault. If the input has remained permanently active or inactive since the fault was reported, the DFM fault cannot be cleared.

Accepting DFM Faults: If the detector fault cannot be immediately repaired, the DFM fault can be 'accepted' by entering the handset command ADF=1. The cabinet alarm will then be extinguished, allowing further faults to be indicated.

Clearing DFM Faults: If the RFL=1 or the RDF=1 handset command is entered, or the DFM Reset push-button on the Manual panel (if configured) is operated, the DFM fault will be cleared assuming the controller has seen the input change state. The cabinet alarm lamp will be extinguished, the input will no longer be forced active or inactive, and the fault log entries will be cleared from the controller's fault log.

The DFM configuration and state can be reviewed and changed using the Controller - I/O - Faults web page.

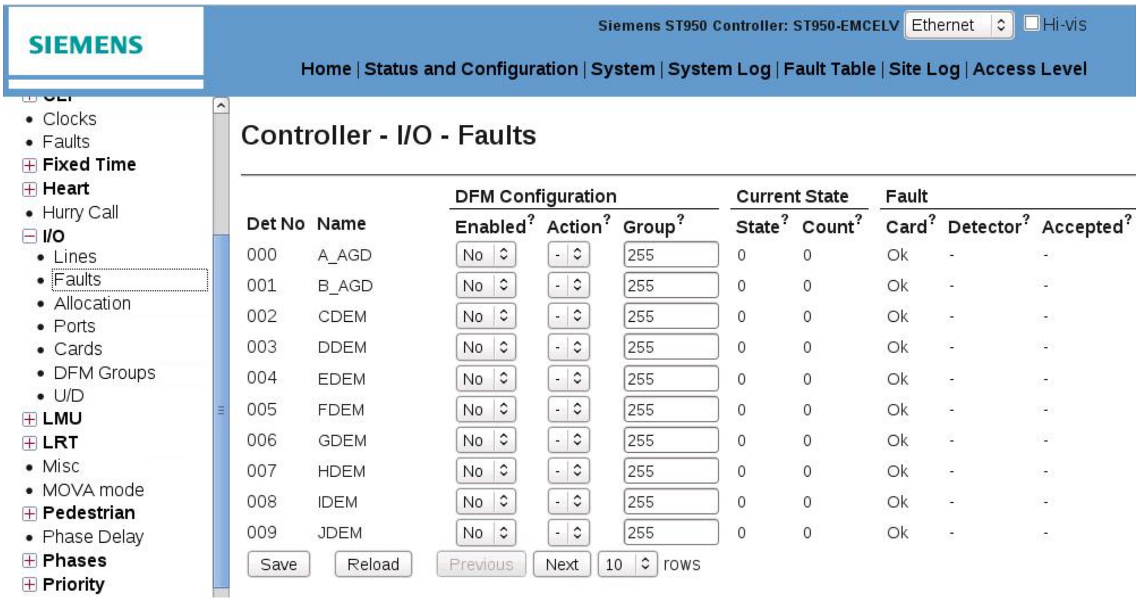


Figure 93 Controller - I/O - Faults web page

Each controller input can be assigned to one of eight DFM groups. Each DFM group can be configured with up to four DFM 'timesets' that are switched by the timetable. Each 'timeset' includes one 'stuck active' (measured in minutes) and 'stuck inactive' (measured in hours) threshold time. For example:

	DFM Timeset 0		**DFM Timeset 1**		**DFM Timeset 2**		**DFM Timeset 3**	
	Active	**Inactive**	**Active**	**Inactive**	**Active**	**Inactive**	**Active**	**Inactive**
DFM Group 0	60	2	30	4	30	4	30	4
DFM Group 1	30	9	30	18	15	9	15	255
etc…								

In this example, the DFM thresholds used during DFM timeset 0 for all the inputs assigned to DFM Group 0 are 60 minutes for the 'stuck active' threshold and 2 hours for the 'stuck inactive' threshold. Thus if any of those inputs remain permanently active for longer than 60 minutes or permanently inactive for longer than 2 hours a DFM fault will be reported.

The range for the 'stuck active' thresholds is 1 to 254 minutes, in 1-minute steps.
The range for the 'stuck inactive' thresholds is 1 to 254 hours, in 1-hour steps.
(A value of 255 disables DFM monitoring of that state during that timeset)

Note that the 'stuck inactive' threshold for DFM group 1 during DFM timeset 3 is set to '255'. This disables detector fault monitoring of the input(s) in their inactive state. Thus the input(s) may remain inactive during the whole of timeset 3 without a DFM fault being logged. For example, it may be required that pedestrian push buttons are not monitored over the weekend when there may not be many pedestrians present.

Note that the timer for each input resets when the input changes state, but it is not reset when the timetable switches between the different DFM timesets. Therefore, if the timer value is greater than the new threshold when a new DFM timeset is introduced by the timetable, a DFM fault is reported straight away.

Therefore, short DFM thresholds should not be introduced at the beginning of a period where demand is expected to increase, but some time later to allow for the fact that timer may already exceed the new threshold.

The DFM Group configuration within the controller can be reviewed and modified using the Controller - I/O - DFM Groups web page.

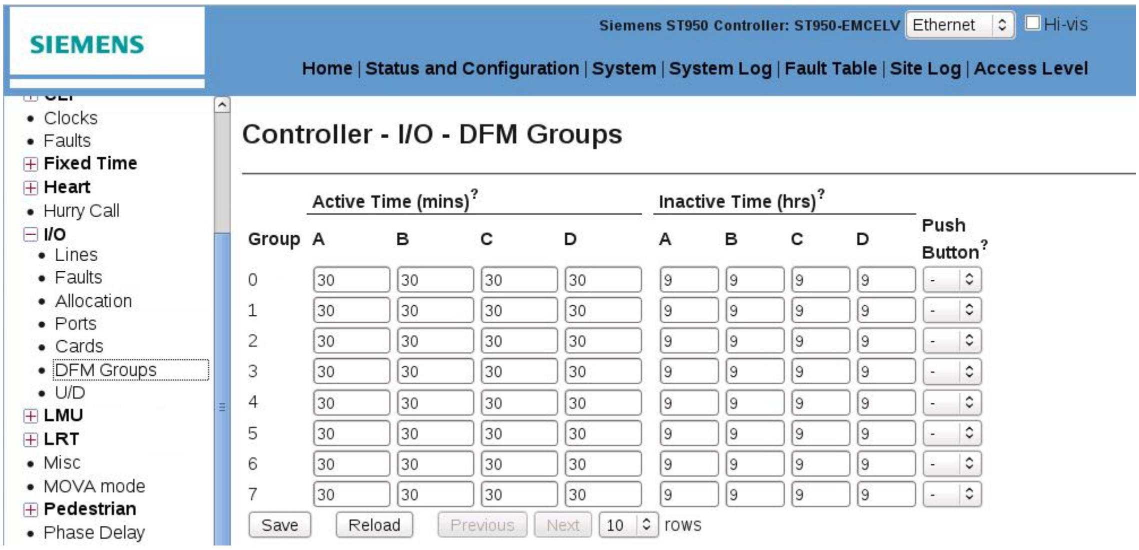


Figure 94 Controller - I/O - DFM Groups

37.8 Uni-Directional (U/D) Facility

If only vehicles travelling in one direction over a detector are required to activate it, whereas vehicles travelling in the opposite direction are not, the controller includes the Uni-Directional (U/D) facility.

The facility uses two inputs that are connected to two inductive loops that partially overlap on the carriageway, such that vehicles travelling in the required direction activate the ‘A’ loop first, then the ‘U’ loop.

If the ‘A’ loop is activated first, the controller processes the ‘A’ input as normal.

However, if the ‘U’ loop is activated first, the ‘A’ input will be forced to remain inactive by the controller (even if the ‘A’ loop input to the controller is actually activated) until both inputs return inactive when the vehicle has passed.

If either loop remains active for longer than a specified time-out period, the ‘A’ input is forced active so that the controller sees a demand, since a vehicle appears to be stationary on one or both loops.

The configuration of the unidirectional loop facility can be reviewed and updated through the Controller - I/O - U/D web page.

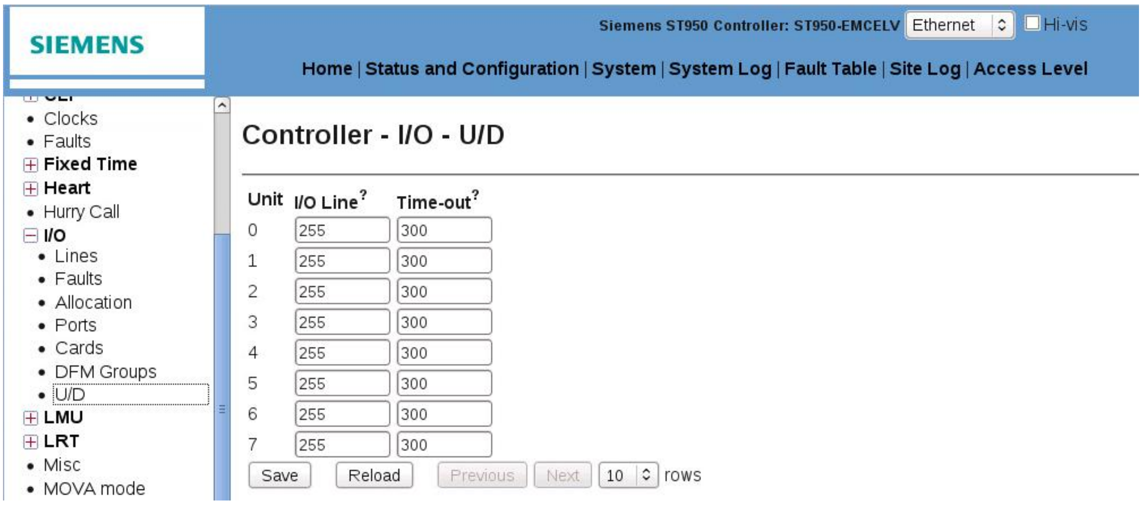


Figure 95 Controller - I/O - U/D web page

Alternatively the handset commands CUD and UDT can be used.

37.9 Signal Dimming

37.9.1 Solar Cell

Signal dimming is provided to dim the signals during darkness hours under control of a photoelectric solar cell mounted on a signal head.

37.9.2 Solar Cell – ST950 and ST950LED (230V Operation)

There are three values of dimming voltage available for the standard ST900:

120V	140V	160V (preferred value)

The size of the dimming transformer required by a controller depends on the average signal lamp power and the dimming voltage required.

The ST950LED has only one dimming tap of 154V and is 500VA (0.5KVA)

Note that dimming is not available on 110V/120V mains supplies.

37.9.3 Solar Cell – ST950ELV

The ST950 ELV Controller must only be used with the STC ELV Solar Cell (part number 506/4/97891/005) in order to maintain the integrity of the Extra Low Voltage system on the street.

There is only one dimming voltage available: 27.5V

The size of the lamp supply transformer required by a controller depends on the average signal lamp power.

37.9.4 Dimming by Time of Day

The dimming facility may be operated by time of day rather than a light operated switch (Solar Cell). To allow this facility to be implemented, the Solar Cell input of the controller must be wired to the solar cell supply to switch the controller to 'DIM' permanently. This state is then ‘overridden’ by special conditioning to switch the controller to the Bright State.

A special conditioning flag can be set from the MTCS timetable to indicate when to switch to bright, allowing the time of dim state change to be altered by changing the timetable.

38 Manual Panel

38.1 Standard Facilities (Intersection Controller)

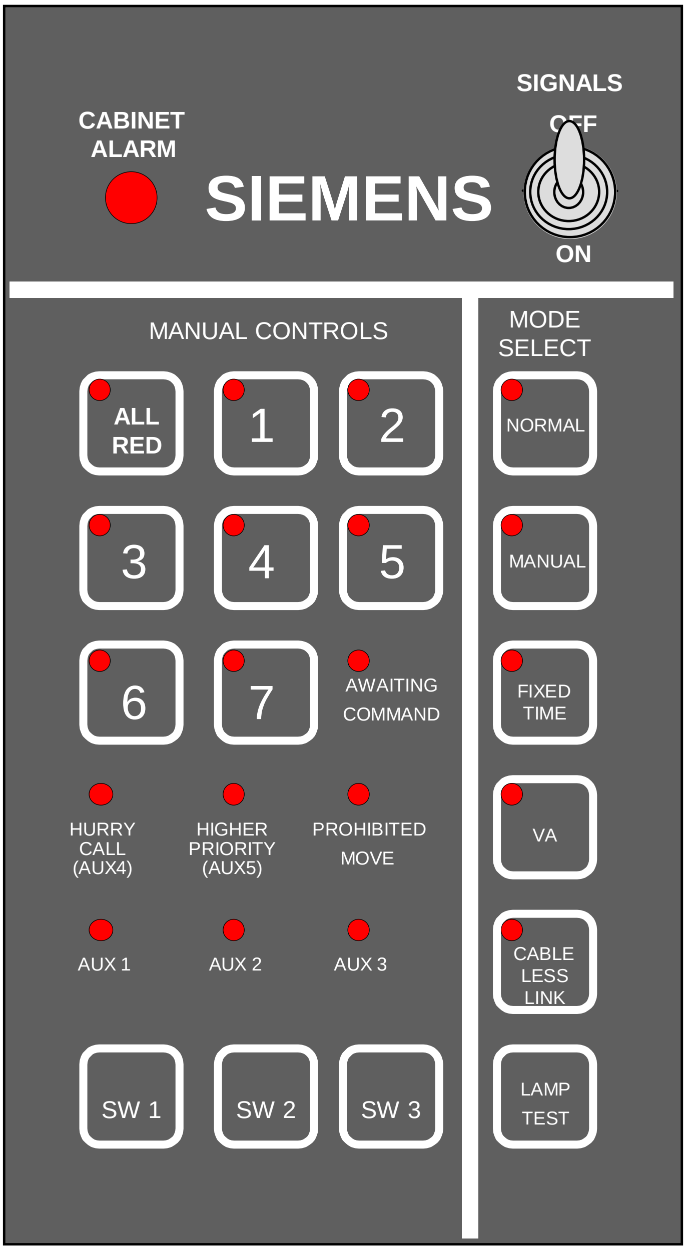


Figure 96 Intersection Manual Panel

In addition to the original Intersection Manual Panel with its English text, an alternative Manual Panel is available with symbols instead of text:

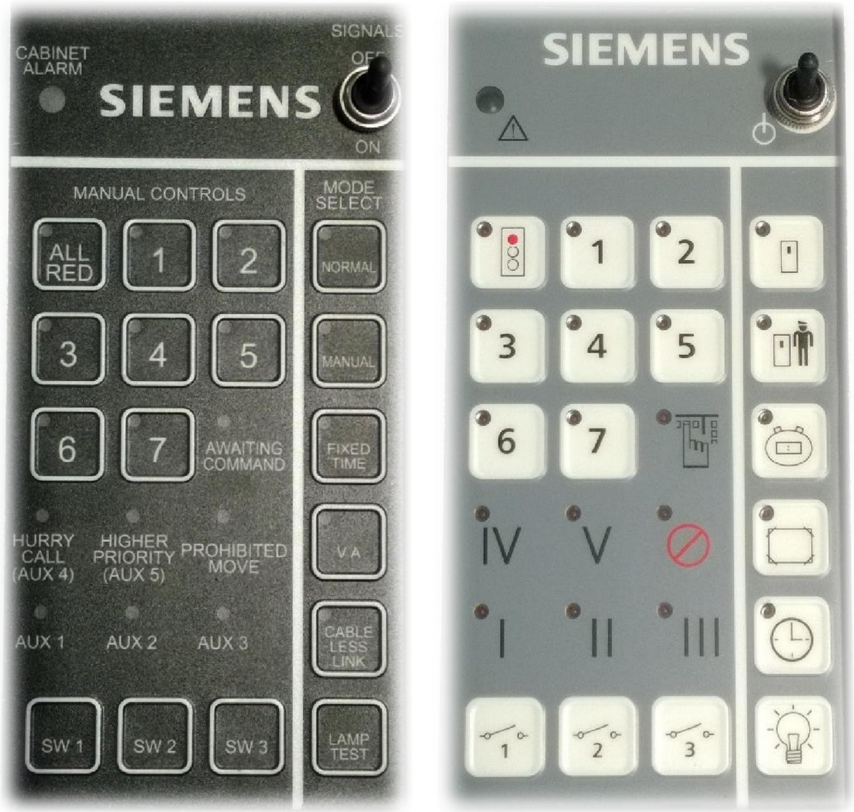


Figure 97 Original and Alternative Manual Panels

38.1.1 Stage Selection Push-Buttons

There are 8 stage selection push buttons (0 to 7) available for use during Manual mode.

Push button 0 is normally allocated to Stage 0, the manual all-red facility, and is therefore designated ALL RED. Push buttons 1 to 7 may have any 7 of the remaining stages allocated to them.

The SW buttons and AUX LEDs can be configured to provide various customer and site specific facilities.

38.1.2 Mode Select Push-Buttons

When the NORMAL mode select push-button is pressed, the highest priority mode with operating conditions active will be the current mode and the NORMAL indicator will be illuminated. If the mode running on all of the streams is VA, CLF or FIXED TIME, that indicator on the manual will also be illuminated indicating that the controller is running ‘normal VA’ for example.

Selection of either MANUAL, VA, CLF or FIXED TIME will illuminate the associated indicator and cause the mode selected to become operational providing no higher priority mode is active. If the mode selected is not running on any of the streams, the indicator will flash. This may because a higher priority mode is running temporarily, e.g.

hurry call or start-up, in which case the mode may become operative and the indicator stop flashing and remain on after a short delay.

For more information on these facilities, refer to the documentation on the modes 'Manual' and 'Selected FT, VA or CLF'.

38.1.3 Signals OFF/ON Switch

When the OFF position is selected the signal lamps will be extinguished immediately regardless of their current state. While the signal lamps are extinguished the controller will continue to function.

When the ON position is selected the signal lamps will be illuminated immediately at whatever point the controller has reached, or go through a start-up sequence, depending upon configuration.

38.1.4 Cabinet Alarm

The cabinet alarm illuminates when a DFM fault is confirmed or flashes when a red lamp fault is confirmed. Special conditioning can also illuminate the cabinet alarm.

38.1.5 SW1, SW2 and SW3 Push-Buttons

The function of these switches can be set up in configuration for such facilities as Dim Override, DFM Reset or Part-time mode, etc. (see below).

SW1, SW2 and SW3 can be used to implement optional manual facilities such as:

Dim Override
DFM Reset
Part-time (Non UK only)
Signals Flash (Non UK only)
Alternative Maximum
Override Audio Signal
Diversion

38.1.6 Lamp Test Push-Button

The LAMP TEST push-button applies a signal that illuminates all indicators on the Manual panel and illuminates the CABINET ALARM lamp for test purposes.

38.1.7 Stage Indicators

The Stage Indicators are primarily for use during Manual mode. They generally indicate the number of the current stage selected.

These indicators are only illuminated when manual mode is in operation or when the cabinet door is opened (assuming a door switch is fitted). While the controller is moving to the stage, the indicator will flash once a second, and when the stage is reached, the indicator will stop flashing and remain on.

Note: If the combination of stages at ROW does not match the configured combination of stages for any of the stage buttons, none of the stage indicators illuminate.

38.1.8 Awaiting Command Indicator

When Manual mode is operative, the AWAITING COMMAND indicator illuminates when a stage change is permitted, i.e. the minimum green periods for the phases in the current stage have expired.

38.1.9 Prohibited Move Indicator

When Manual mode is operative the PROHIBITED MOVE indicator illuminates if the selected stage is prevented, deleted by the master time clock or if the move is prohibited. The indicator will extinguish when a valid move is selected.

38.1.10 Hurry Call Active Indicator (AUX4)

This is illuminated immediately a valid Hurry Call is received and remains illuminated until the end of the hold period even if Hurry Call mode is not the current mode due to a higher priority mode being active. Alternatively, the indicator could be used for any purpose.

38.1.11 Higher Priority (UTC) Active Indicator (AUX5)

This is illuminated whenever the current operating mode is higher priority than manual mode (this could be due to UTC bus priority etc.). Alternatively, the indicator could be used for any purpose.

38.1.12 Spare Indicators

There are three indicators (AUX1, AUX2, AUX3) whose function can be set up in configuration, e.g. to indicate when an input to a Priority Unit is active, UTC active, Remote Reconnect, Dim override, Alternative Maximum, Audio override, Barrier Up, Continuous Demands and/or Extensions, Green Wave etc.

If more than three indicators are required, the HURRY CALL active or HIGHER PRIORITY active indicators may be used if they are not required for their normal use. Another use is to indicate the state of the switches SW1, SW2 and SW3, e.g. to show if Dim Override is active or not.

38.2 Stand-alone Pedestrian Controller Manual Panel

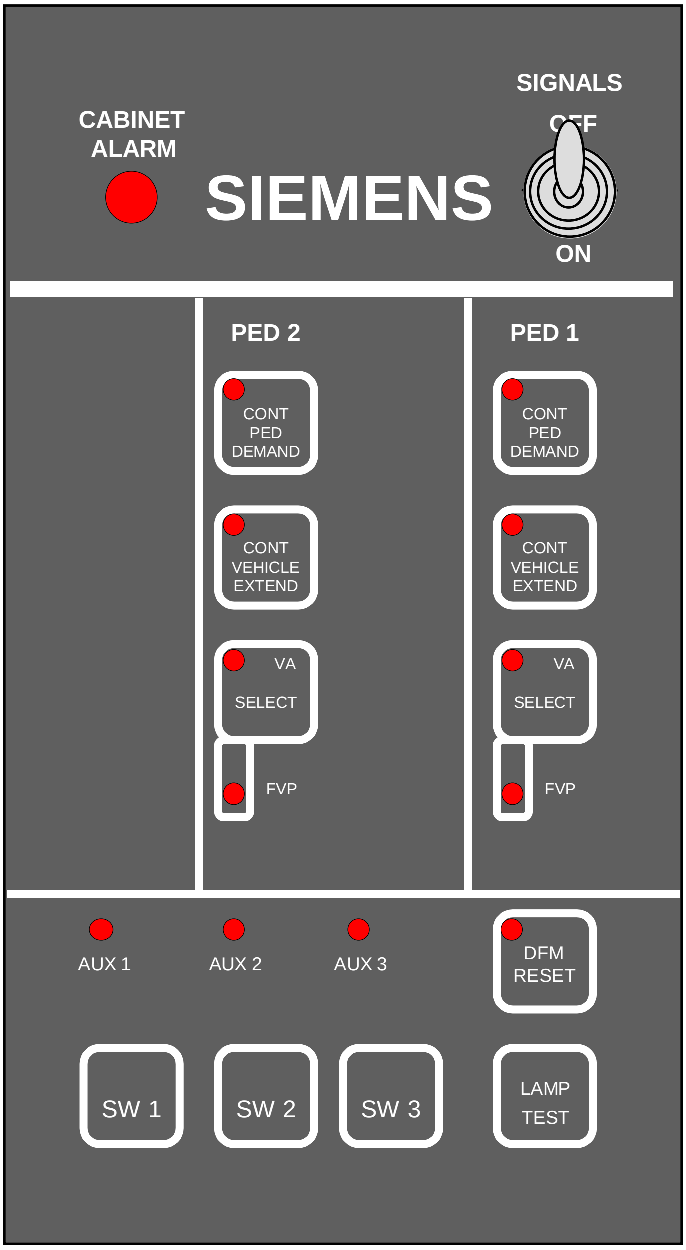


Figure 98 Stand-alone Pedestrian Controller Manual Panel

38.2.1 Continuous Pedestrian Demand

These buttons can be used to insert continuous pedestrian demands on the first (PED1) or the second (PED2) stand-alone pedestrian stream. Pressing the button toggles the state of the associated indicator. While the indicator is illuminated, an artificial demand for the pedestrian phase is inserted.

For near-sided pedestrian crossings (i.e. those showing red during the clearance period), an artificial on-crossing detect is inserted as required by TR2500 to extend the clearance period to its maximum.

38.2.2 Continuous Vehicle Extend

These buttons can be used to insert continues vehicle extensions on the first (PED1) or the second (PED2) stand-alone pedestrian stream. Pressing the button toggles the state of the associated indicator. While the indicator is illuminated, the vehicle phase is artificially extended up to its maximum green period.

38.2.3 Select VA or FVP

These buttons can be used to switch the two stand-alone pedestrian streams (PED1 and PED2) between Vehicle Actuated mode and Fixed Vehicle Period mode.

Pressing the button toggles the states of the associated indicators. Note that indicators just show the requested mode, they do not necessarily show the actual mode that is running. The handset command PEV can be used to disable VA mode, enable VA mode (allowing these buttons to select the mode) or force VA mode (ignoring the state requested by these buttons).

38.2.4 Other Buttons and Indicators

The function of the ‘DFM Reset’ button is described in the IO section. The remaining buttons and indicators provide the same function as on the Intersection Manual Panel.

38.3 Basic Manual Panel

If the Manual Panel is not required, a basic Manual Panel that only contains a SIGNALS OFF/ON switch can replace it.

39 SPECIAL CONDITIONING

39.1 Introduction

There are often special requirements for the operation of a controller, which are not covered by its normal methods of working. This is normally due to the peculiarities of a particular intersection. For example it may be a requirement that demands for a particular phase are inhibited during the first six seconds of appearance of another phase, or a demand for a particular phase is inserted when there is a demand on another phase and an extension on another, etc. Special Conditioning can cater for this type of facility.

The operation required by Special Conditioning is specified at configuration and the data is located in the configuration. This data forms a special software language that is interpreted by the controller. The types of functions that can be performed are described below.

For more information, see the IC4 Configurator Handbook and Help.

39.2 Special Conditioning Operators

A large selection of controller variables can be read from Special Conditioning, and a smaller selection of variables can be written to which will then modify the operation of the controller.

A number of logical operations can be performed on variables that have been read. These include the logical operations of 'NOT', 'AND', 'OR' and 'EXCLUSIVE OR'. The values of certain variables can be tested to see if they are 'EQUAL' to a specified value or 'GREATER' than a specified value.

There are Special Conditioning timers that can be run and tested from within Special Conditioning, started with time periods that can be altered using the handset.

39.3 Special Conditioning Examples

The following list is included to indicate the type and range of facilities that can be provided by Special Conditioning:

- Stages appearing more than once per cycle if many stages
- Inter-greens extended by curtailed extensions
- LRT prevent moves
- Ped audible switched off/quiet by time of day
- Dimming by time of day
- Linking to remote pedestrian controllers or other controllers
- Fault recognition of pedestrian controllers
- Limit Green timer
- Hurry call watchdog
- CLF plans affecting VA operation
- Instigation of Flash Amber Mode due to Fault
- Holding a stage with a Special Conditioning timer

39.4 Reading Controller Timers

It is possible to read whether certain controller timers are active, held or expired, and also what the count value is. Following is a list of timers that have the above facility:

Minimum Green	Call/Cancel
Green Extension	Priority Extension
Maximum Green	Priority Maximum
Phase Delay	Priority Inhibit
Lamp Sequence, such as R/A, ped clearance	Compensation
Inter-green	Fixed Time
Hurry Delay	Window Times
Hurry Hold	Hold Inter-green Maximum
Hurry Prevent	Hold Inter-green Extension
Conditioning	

Note the timers cannot be loaded with a value in conditioning and the actual count value cannot be read. Only logical expressions can be performed, e.g. timer is active, count equal to ‘x’ or count greater than ‘x’.

Example

If a side road phase is extending towards its maximum and a demand is inserted for the main road, providing the side road max timer has exceeded 20 seconds, the extensions may be prevented, to allow the main road phase to gain ROW immediately.

<table>
<tr><td colspan="3">Phase B at green and demand present for phase A?
YES NO</td></tr>
<tr><td colspan="2">Phase B max timer > 20?
YES NO</td><td rowspan="2">Do nothing</td></tr>
<tr><td>Prevent phase B extensions</td><td>Allow phase B extensions</td></tr>
<tr><td colspan="3">END</td></tr>
</table>

MAIN ROAD = PHASE A
SIDE ROAD = PHASE B

39.5 Special Conditioning Libraries

Within the controller configuring system (The IC4 Configurator), files containing special conditioning code can be stored and used as a library. These allow commonly used items of special conditioning to be recalled for use at any time. For further details see the Configurator Handbook.

39.6 Monitoring and Updating

Special conditioning timers and facilities can be monitored and updated using the Controller - Special Conditioning web pages.

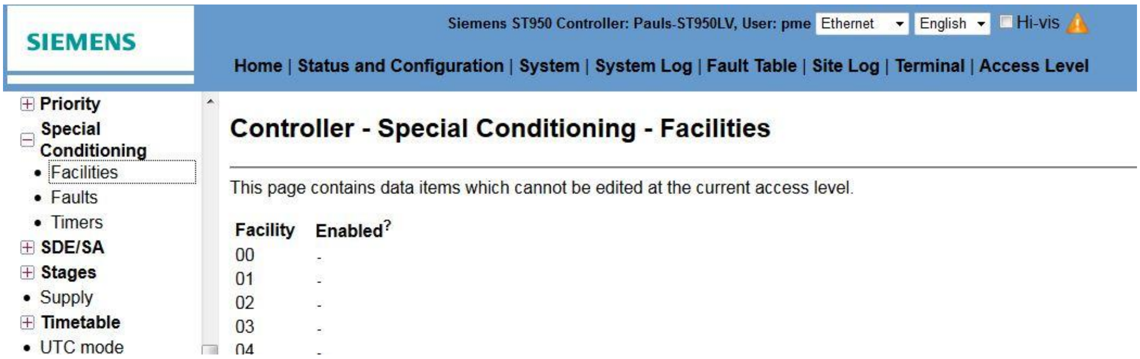


Figure 99 Controller - Special Conditioning - Facilities web page

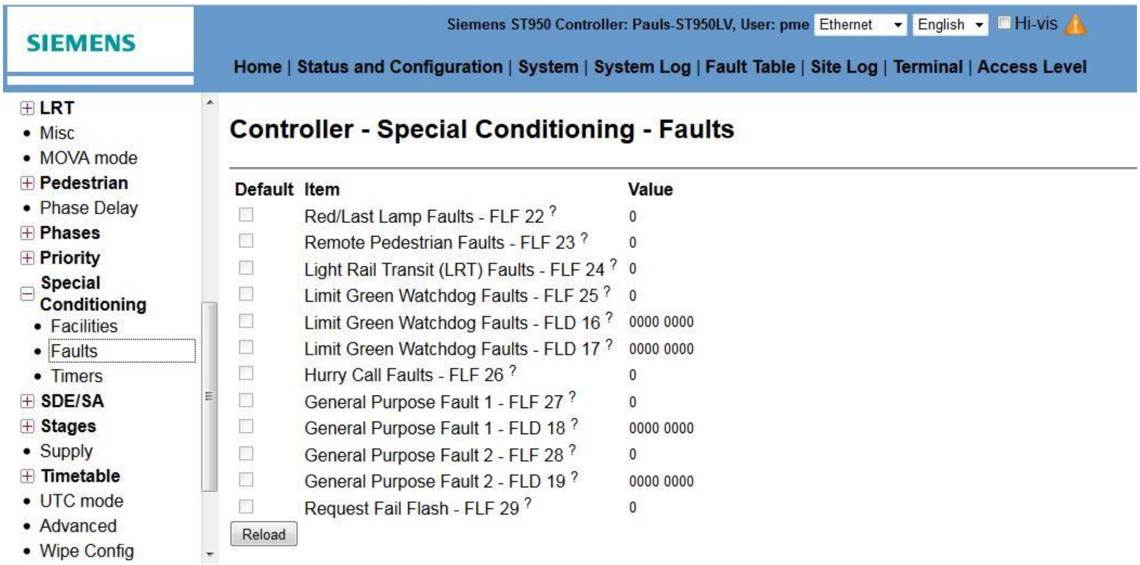


Figure 100 Controller - Special Conditioning - Faults web page

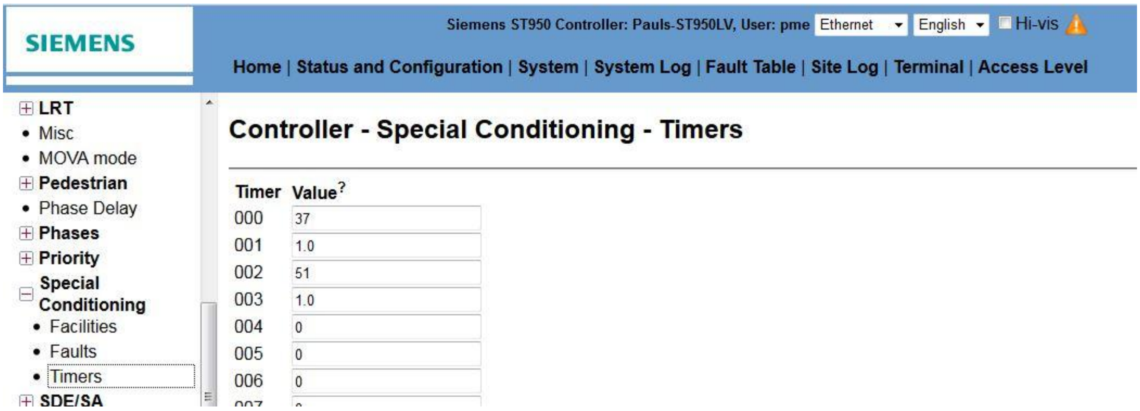


Figure 101 Controller - Special Conditioning - Timers web page

40 HARDWARE CHECKS

40.1 Primary and Signal Monitor CPU

The heart of the controller is the CPU card.

This CPU card contains the Primary CPU that determines the required state of the traffic signals as well as monitoring the signals. It also has a Signal Monitor CPU that monitors the signals and the Primary CPU:

In the LV controller, the Signal Monitor is the CPU known as the ‘PHP' CPU because it directly controls and monitors the parallel phase bus to the LV Lamp Switch Cards.

In the ELV controller, the Signal Monitor is the CPU known as the 'SEC' CPU (Secondary Enhanced Capability). This device monitors the communications between the Primary CPU and the LSLS lamp switch cards.

The Primary CPU and the SEC CPU monitor the state of each other. On an LV controller, the Primary and PHP CPU also monitor each other.

All three CPU can independently shutdown the controller if a problem is detected, which either extinguishes all the signals or invokes the hardware fail flash facility depending on the controller set-up.

In addition, there is a hardware watchdog that monitors the state of the Primary CPU and will also shutdown the controller if a problem is detected.

40.2 Monitoring the Signals

The correspondence check (also known as an equivalence check) is available on all three colours, not just greens. A correspondence error on a monitored green will always cause the controller to shut down. For Non-UK Controllers, correspondence errors on reds and ambers can be configured to report the failure but allow the controller to continue normally, shown by the options (a) to (d) in the table.

Switched signs are treated separately. Their monitoring option is set regardless of which colour output they are assigned to; i.e. a switched sign assigned to a spare green output can be monitored differently from all the other ‘normal' green outputs.

The following table summarises the hardware checks performed by the firmware, identifying which processor (Primary or Signal Monitor) performs the check and what the action will be when the fault is confirmed.

Condition	Primary CPU Fault Action	Signal Monitor Fault Action
Red Correspondence Failure Compares "required" states against actual states or the dual voltage monitors disagree. Measured by voltage on drive. Functions with no external load. Monitoring can be disabled.	a) Controller Shutdown	a) Controller Shutdown
	b) Stream direct to part-time state	b) Controller Shutdown
	c) Stream direct to part-time state	c) Check Disabled
	d) Fault report only	d) Check Disabled
Amber Correspondence Failure Compares "required" states against actual states or the dual voltage monitors disagree. Measured by voltage on drive. Functions with no external load. Monitoring can be disabled.	a) Controller Shutdown	a) Controller Shutdown
	b) Stream direct to part-time state	b) Controller Shutdown
	c) Stream direct to part-time state	c) Check Disabled
	d) Fault report only	d) Check Disabled
Green Correspondence Failure Compares "required" states against actual states or the dual voltage monitors disagree. Measured by voltage on drive. Functions with no external load. Monitoring cannot be disabled.	a) Controller Shutdown	a) Controller Shutdown
	b) Stream direct to part-time state	b) Controller Shutdown
Green / Green Conflict If caused by an extra green being forced ON in error, then this fault is confirmed as a Green Correspondence failure; see above. If caused by a software, configuration or run-time fault in main processor in which it requests that two conflicting aspects are illuminated, then: 1) The main processor firmware includes a check to detect the fault before the request is actually transmitted and results in Controller Shutdown before the aspects are actually illuminated. 2) If the fault is not detected by the main processor firmware, then the Signal Monitor will confirm the conflict fault in the actual states of the signals. Measured by voltage on drive - functions with no external load. Monitoring cannot be disabled.	Controller Shutdown	Controller Shutdown
Green / Amber Conflict or **Green / Red+Amber Conflicts** Which ambers to consider is configurable, and the whole check can be disabled if required. If caused by an extra green or amber being forced ON in error, then this fault is confirmed as a Green or Amber Correspondence failure; see earlier in the table. If caused by a software, configuration or run-time fault in main processor in which it requests that two conflicting aspects are illuminated, then the fault is confirmed as for Green / Green Conflicts above.	Controller Shutdown	Controller Shutdown
Diagnostic Checks: Monitor Validation Monitoring cannot be disabled. Monitoring performed by the Primary CPU only.	Controller Shutdown	(N/A)

Condition	Primary CPU Fault Action	Signal Monitor Fault Action
Diagnostic Checks: Aspect Monitoring Miscellaneous internal checks of the controller logic, includes bus tests etc. Monitoring cannot be disabled. These checks are performed by various CPU, including those on the LSLS cards.	Controller Shutdown	Controller Shutdown
Hardware Watchdog Hardware watchdog on Main Processor. Cannot be disabled by configuration. Hardware watchdogs may be provided for other processors, but these are not required for safe operation of the controller.	Controller Shutdown	(N/A)
Software Watchdogs Lack of valid communications between processors. Monitoring cannot be disabled.	Controller Shutdown	Controller Shutdown
Low Lamp Supply Test (Mains) Dim and Bright Voltage thresholds (0 to 255V), hysteresis and Durations are configurable by handset command or 8DF	a) All aspects extinguished	(N/A)
	b) All streams direct to part-time state (Still reverts to all-off if supply very low)	(N/A)
Lamp Supply out of Range (ELV) If the lamp supply is detected outside of bands configurable by '8DF' file, all signals are extinguished to prevent damaged and to ensure signals are on and bright enough.	All aspects extinguished	(N/A)
Mains Missing / No ZXO Sync' Synchronisation to the AC supply has failed, possibly due to a mains break or excessive noise. Power failure events are logged and FLF 6 NZXO if the problem persists.	All signals extinguished	(N/A)
Lamp Supply Relay Failure Stuck closed check. Stuck open will be detected by the 'low lamp supply test' above. Check cannot be disabled and failure always results in controller shutdown. Note: Test to be done at start-up and at a configurable time each day.	Controller Shutdown	(N/A)
Firmware Checksum Fail Check on power-up and in the background during normal operations. Monitoring cannot be disabled.	Controller Shutdown	Controller Shutdown
Configuration Data Checksum Fail Check on power-up and in the background during normal operations. Monitoring cannot be disabled.	Controller Shutdown	Controller Shutdown

Table 6 Hardware Checks and Fault Actions

40.3 Correspondence Monitoring – Greens

Option a) Fail to Part-Time State is not selected. Both processors will independently detect a green correspondence failure. If the actual states of the greens do not match the requested states and the fault will be confirmed if the situation persists. When the fault is confirmed, the processor will shut down the whole controller.

Option b) Fail to Part-Time State is selected (Non-UK Only). Correspondence monitoring of greens is performed independently by both processors. The Main Processor moves the stream to its part-time state. If the fault persists, or a green fault occurs while already in the part-time state, the Main Processor and Signal Monitor can shutdown the controller.

Options c) and d) cannot be selected (because this would disable checking).

40.4 Correspondence Monitoring – Reds / Ambers

Option a) Correspondence monitoring is enabled and Fail to Part-Time State is not selected. Correspondence monitoring of that colour is performed independently by both processors and either processor can shut down the controller when a fault is confirmed.

Options b) and c) are available if Fail to Part-Time State is selected (Non-UK Only).

Option b) Correspondence monitoring is enabled and 'Ignore during Fail to Part-Time' not selected. Correspondence monitoring of that colour is performed independently by both processors. The Main Processor moves the stream to its part-time state. If the fault persists, or this fault occurs while already in this state, the Main Processor and Signal Monitor can shut down the controller.

Option c) Correspondence monitoring is enabled and 'Ignore during Fail to Part-Time' is selected. Correspondence monitoring of that colour is disabled in the Signal Monitor and monitoring is only performed by the Main Processor. The Main Processor moves the stream to its part-time state. If this fault occurs while already in this state, the Main Processor will just record the fault.

Option d) Correspondence monitoring is disabled (Non-UK Only). Correspondence monitoring of that colour is disabled in the Signal Monitor. Monitoring is still enabled in the Main Processor, but no action (other than recording of the fault) is performed when a fault is detected.

40.5 Monitor Validation

The Main Processor periodically (approximately once every second) checks that the Lamp Switch Card Processors are correctly reading aspect output states by activating a control signal for one mains cycle which causes pre-defined states to be produced by the monitors. It then checks that this modification is correctly passed back to it.

If a particular test is not successful, several further attempts are made. If the failure persists, the Main Processor will shut down the controller.

This test is undertaken without the knowledge of the Signal Monitor so if the signal remains active (say due to a fault) the Signal Monitor will detect correspondence (and possibly conflict faults) and shut down the controller.

For the LV controller, when the Monitor Validation signal is active, the hardware on each Lamp Switch card inverts a number of the actual lamp states.

For the ELV controller, when the Monitor Validation signal is active, the primary voltage readings (V1) of all outputs are forced so that it appears that all the outputs are ON. The indication from the secondary monitor (V2) for each output will continue to function normally.

40.6 Lamp Supply Checks

If the lamp supply drops below two limits, one for dim and one for bright, the controller will log a fault and extinguish the signals.

The LV controller will attempt to flash them if so configured (see the Fail to Part-Time State option) and the supply is not too low. Normally, and for all UK controllers, the signals are extinguished when the lamp supply drops below the configurable thresholds set by the handset commands LDT and LBT.

The ELV controller will only extinguish and not attempt to flash the signals since LED Signals provide a constant light output over their complete operating range and may operate erratically outside of these bands. In addition, there are also two upper limits, one for dim and one for bright. If the lamp supply is detected above these limits, the controller will log a fault and extinguish the signals.

When the lamp supply recovers the fault will be automatically cleared and the controller will follow its ‘Signals Off to Signals On’ lamp sequence.

The ‘switch off’ and ‘switch on’ confirm times are handset configurable using the handset commands LSF and LSN.

41 HARDWARE FAIL FLASHING FACILITY (NON UK ONLY)

Hardware Fail Flashing (HFF) is an integral part of the controller configured using various hardware switches and/or links.

If any processor or the hardware watchdog shuts down the controller, with the Hardware Fail Flash enabled, some traffic signals will flash while the others are extinguished - usually HFF is set up to extinguish all the signals and flash the amber aspects to the vehicles.

Compare Hardware Fail Flashing with the Software Fail Flash (fail to part-time) facility, which switches individual streams to their flashing state when faults are confirmed still under software control (so links or hardware changes are required). Note that both fail to part-time and Hardware Fail Flash can be enabled on a controller.

HFF can also be initiated by Special Conditioning, however normal operation can only be re-instated by operator intervention (e.g. fault reset through web page or RFL=1 and power off/on). Note that as an alternative the part-time state can be configured to flash the signals and this can be initiated and removed by Special Conditioning without operator intervention.

41.1 IC4 Configuration

The IC4 Configuration also needs to be made aware of whether Hardware Fail Flashing is required, although configuration data does not enable or disable the facility.

Once the hardware is set up for HFF, the facility can be enabled and disabled by a switch on the CPU Card.

The flash rate used by HFF is set by the IC4 Configuration and is the same as that used for normal operation. The HFF flash period is stored in FLASH memory on the CPU Card and updated by the IC4 Configuration. Until the first IC4 Configuration is loaded, the HFF flash rate used by a CPU Card defaults to 400ms On / 400ms Off.

41.2 LV Controller

If the controller is shutdown with HFF enabled, the following sequence occurs:

- The Green Lamp Supply relay is released - all Green signals are turned off;
- Both SSR & Red/Amber Lamp Supply relays are forced on;
- The Dim/Bright Relay released to force signals to their ‘Bright’ state;
- All the Red, Amber and Green phase output latches on the Lamp Switch cards are ‘Reset’;
- ‘Flash Oscillator’ output enabled onto the Phase Bus.
- Red and Amber signals ‘Flash’ as selected on the Lamp Switch cards.

Please note that undesirable signal states are possible in Failure Mode because supplies are still present, and in these cases, the controller cannot take any further actions because the system is already in Failure Mode.

For example, with the Lamp Supply available to all the Red and Amber drives, it is possible that a fault within the Lamp Switch Card could cause any Red or Amber signal to illuminate. Also, with flashing signals present on-street, a short-circuit between cables can cause additional signals to flash.

41.3 ELV Controller

For Hardware Fail Flash controllers, a HPU link is moved allowing the controller hardware lamp supply to remain to LSLS Card 1 while switched off to the other LSLS Cards.

The configuration set up by IC4 must include the Hardware Fail Flash option. This re-arranges the allocation of phase outputs, so that all outputs that are required to flash are allocated to the first LSLS card. All the other outputs are allocated to other cards. This means that an ELV controller with Hardware Fail Flash must be fitted with at least two LSLS cards.

If the controller is shutdown with HFF enabled, the following sequence occurs:

- Lamp Supply Relays are released, switching off the lamp supply to all but the first LSLS Card.
- The Dim/Bright Relay released to force signals to their ‘Bright’ state;
- All the Red, Amber and Green phase output latches on the LSLS cards are ‘Reset’;
- ‘Flash Oscillator’ output enabled onto the Phase Bus.
- All the Red and Amber signals connected to the first LSLS card flash.

Please note that undesirable signal states are possible in Failure Mode because supplies are still present, and in these cases, the controller cannot take any further actions because the system is already in Failure Mode.

For example, with the Lamp Supply available to one LSLS Card providing the flashing LSLS Outputs, it is possible that a fault within that card could cause any of those Red or Amber flashing signals to illuminate (and not flash). Also, with flashing signals present on-street, a short-circuit between cables could cause additional signals to flash, although usually the output would stop flashing in such cases. (Outputs on LSLS Cards that are switched off are indirectly connected to Earth, so a flashing LSLS output will normally be switched off by its over-current protection if it is connected back to a different LSLS output on an LSLS Card that is powered down.)

42 'Fail to Part-Time' / Software Fail Flash

42.1 Introduction

This configuration option is available primarily for non-UK controllers. It allows the controller to immediately switch a stream directly into its part-time state when a fault is confirmed on that stream, which could be configured as blackout or flashing vehicle ambers for example.

This facility can be enabled even if part-time mode is not required, i.e. even if the controller is not required to enter part-time by time of day.

It is also known as 'Software Fail Flash' because the stream enters the fail flashing state when the fault is confirmed, but the software remains in control and continues to operate others streams normally. With 'Hardware Fail Flash', all streams must enter the fail flashing state when a fault is confirmed.

42.2 Fault Actions

Correspondence faults will cause the stream(s) on which the faults exist to immediately enter their part-time state, while other streams continue to cycle normally. Once in this state, further faults on reds and ambers can be configured to be ignored, but faults with greens will always cause the whole controller to shut down, removing the lamp supply. If hardware fail flash is configured, all streams will enter their hardware flash state.

Red Lamp Failures and Last Lamp Failures can also be configured to cause streams to enter their part-time flashing state (section 44).

43 EXTERNAL MOVA (MICROPROCESSOR OPTIMISED VEHICLE ACTUATION) UNIT

43.1 Introduction

MOVA monitors the movement of vehicles through an intersection and then adjusts the operation of the controller to optimise its flow.

An external MOVA unit may be connected where MOVA is implemented by the separate unit rather than using the MOVA application built into the controller (see section 22). It may be desirable to do this when upgrading controllers if no change to the MOVA is required.

If using a Siemens Gemini2 MOVA unit, also see the Gemini2 Handbook, part number 667/HB/38001/000, or 667/HB/52250/000 for Gemini 3 / Stratos Outstation.

An external MOVA unit uses the controller's UTC interface, which allows it to influence the operation of the controller. This can use the controller's physical inputs and outputs; however a Siemens controller and Siemens MOVA unit use a serial link, known as 'Serial MOVA' and a 'Semi-Integral MOVA unit', see below.

43.2 Instructions for Connecting External MOVA to Traffic Controllers

1. Stage Green confirms and, where required, phase green confirms will be open circuit during green. They will be short circuit at other times except as detailed in item 3.
2. Controller ready bit will be short circuit during normal operation, except as detailed in item 3, and open circuit when manual control (or any other higher priority mode) is operational.
3. Stage green confirm 1 and 2 and controller ready bit will all be open circuit during the following conditions:
    - Manual Control
    - Selected Fixed Time if available
    - Selected VA time if available
    - Signals off (switched off manually or due to a Fault)
4. Force bits closed contact provides the force signal.
5. An output is usually required for each pedestrian phase, which should be closed when the wait indicator is illuminated. These are passed to the MOVA unit as the detector inputs for those phases (MOVA 'Links').

43.3 Semi-Integral MOVA / Serial MOVA

The Siemens Gemini2 MOVA unit can be connected via a serial link to an traffic controller to provide the 'Semi-Integral MOVA'.

The serial link uses the existing physical handset link between the OMU and the controller. This serial link has been enhanced to provide a high-speed data link between the Siemens controller and the Siemens Gemini2 unit, which allows the OMU to monitor the controller's inputs and lamps without the need for any other cables. See the description of the enhanced serial link in the Gemini2 handbook,

With a combined Siemens Gemini2 and MOVA unit, the control and reply bits between the ST900 and MOVA are also passed through this link so no digital I/O cables are required. Also, all the MOVA detectors are only connected to the controller and passed to MOVA through this serial link.

The layout of the control and reply words should be configured as normal, with F1 starting at control bit 0 and G1 starting at reply bit 0. However the 'TO' (take-over) and 'CRB' (controller reply bit) bits should be excluded since they are automatically passed between the controller firmware and the MOVA firmware as unique bits and thus do not appear in the normal control and reply words.

44 LAMP MONITORING

44.1 Lamp Monitoring Facility

The Lamp Monitor provides a means to check that the signals (the lamps) are all working and no failures have occurred.

The controller includes the lamp monitoring facility, which can be enabled by the configuration, and the standard controller hardware includes all the sensors necessary to monitor all the lamps driven by the controller as standard.

The general lamp monitoring characteristics can be reviewed and updated using the Controller - LMU - General web page.

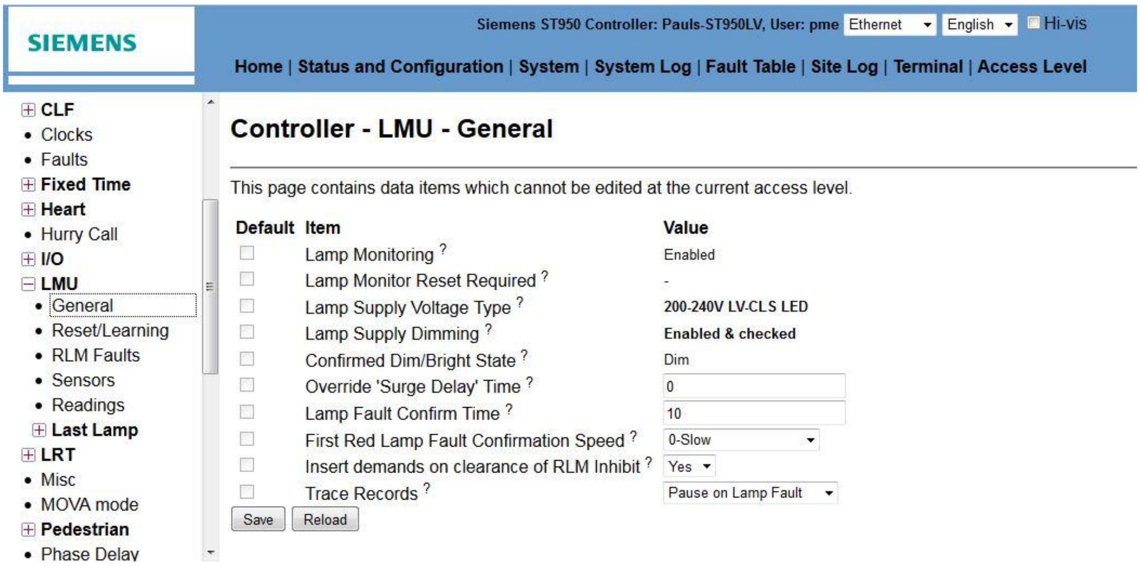


Figure 102 Controller - LMU - General web page

The current lamp monitoring status can be viewed using the Controller - LMU – Readings web pages (previously called the Sensor / Aspect web page).

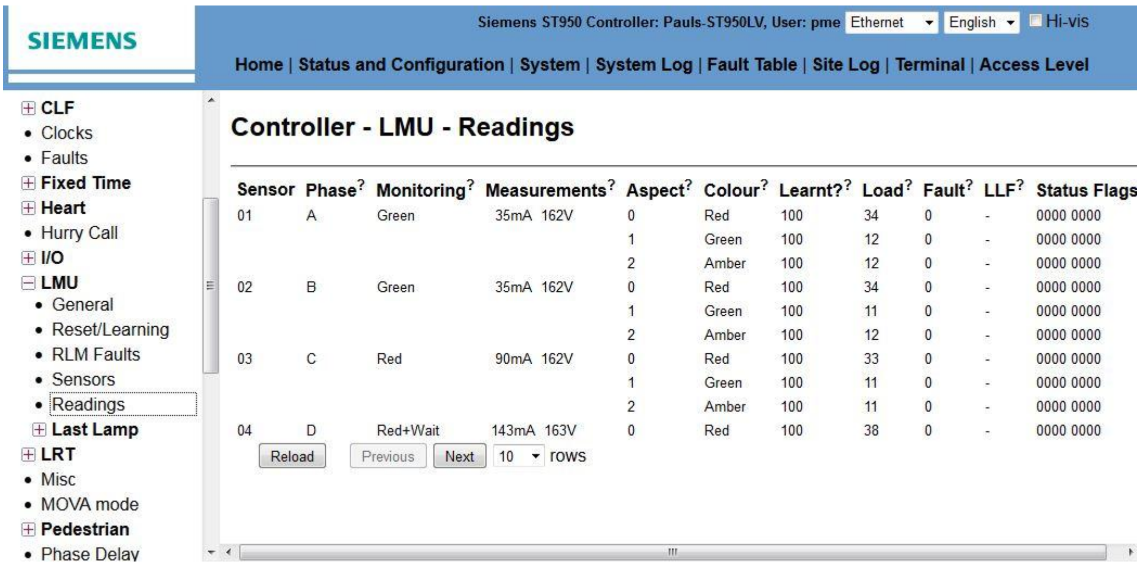


Figure 103 Controller - LMU - Readings web page

44.1.1 Lamp Monitor Fault Reports

Dim / Bright Changes

The lamp monitor monitors the lamp supply and thus confirms each dim/bright changeover.

Two faults can be confirmed by the lamp monitor, one for 'no changes' and the other for 'too many changes' confirmed in 24 hours. While either fault is logged, the signals are forced to the bright state. These fault reports can be cleared at any time by performing a reset fault log operation.

LMU Reset

This can be performed using the Controller - LMU - Reset/Learning web page.

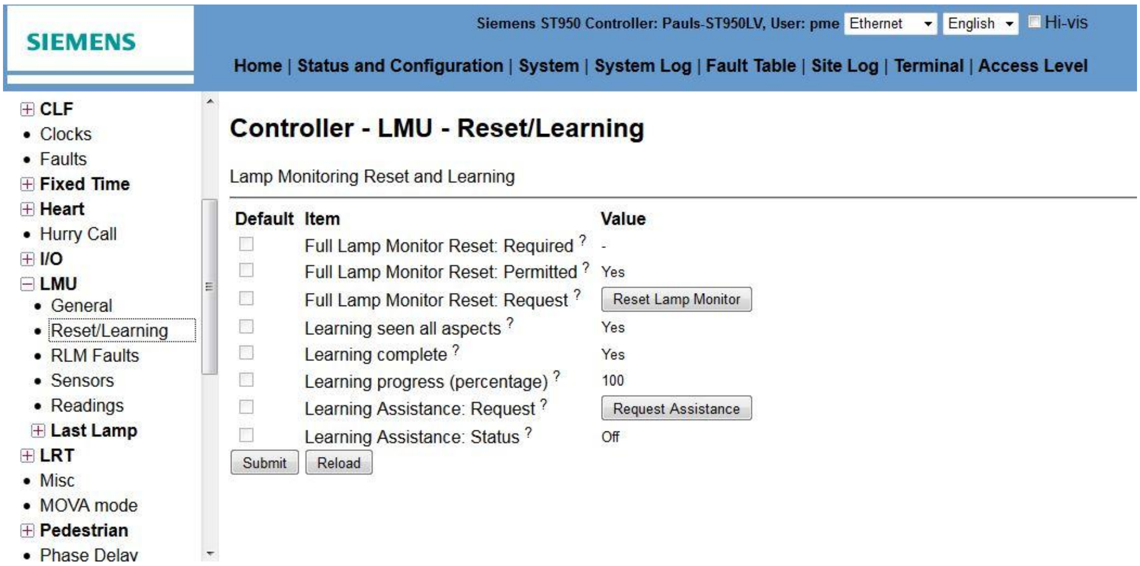


Figure 104 Controller - LMU Reset web page

Whenever the lamp monitor is reset (and thus asked to clear any outstanding lamp faults and relearn all the lamp loads), an event is entered into the system log.

Lamp Faults

There is one FLF fault flag associated with lamp failures, which will be set when there is any confirmed lamp fault. The system log identifies the phase and colour of the lamp fault. The Controller - LMU - Readings web page also identifies the faults.

As soon as all lamp replacements are confirmed, this fault will be cleared and the system error LED on the processor card will be extinguished (assuming no other faults are active) without needing a fault log reset.

If the associated RLM fault is configured as non-latching, the RLM fault will also be cleared automatically when the lamp replacement is confirmed without needing a fault log reset.

44.1.2 Lamp Monitor Operation

For each sensor, a configurable threshold (in watts at the nominal lamp supply) can be defined, or is implied by the selection of the Load Type (detailed in section 44.1.4).

When a change in the current is detected, if the size of the change is larger than this threshold, the lamp monitor will start to confirm the lamp fault or replacement. The time period over which the lamp monitor confirms a lamp fault is defaulted to 10 seconds but can be altered using the Figure 102 Controller - LMU - General web page or KLC handset command. Note that vehicle red lamps monitored by the red lamp monitor, see section 44.2, use shorter fixed confirm times to meet the UK requirements of that facility.

If the change is smaller than this threshold and no lamp fault or replacement is being confirmed, the change is simply tracked and used to adjust the ‘learnt load’.

When a lamp fault has been confirmed, the lamp monitor will log the current drop in watts (at the nominal lamp supply). For example, if a 50W lamp fails, a drop of approximately 50W is logged, even if the lamp fault was confirmed while the signals were dimmed.

This allows the lamp monitor to monitor many different types of lamps. It simplifies the monitoring of 40W waits with 50/60W reds since the threshold can be set low enough to detect a 40W wait lamp failing without causing a 60W pedestrian red lamp failure to be counted as two lamps.

Given that the fault log records the load drop, any unexpected rise in load will be tracked but not logged as a fault. If an increase is confirmed, an event is recorded in the system log but no fault is recorded in the fault table. This allows the replacements of lamps to be learnt without generating a fault if the lamp monitor did not confirm the lamp failure in the first place because, for example, the lamp had already failed when the lamp monitor was reset and asked to relearn. If no lamps were working when the lamp monitor was reset, e.g. due to a feeder failure or powering the controller in a depot with no signals attached, a lamp monitor reset must be issued after all the lamps are reconnected to allow the controller to learn the dim/bright profile of the lamps.

Other faults can also cause an unexpected rise in current, e.g. a short-circuit between the red and amber drives so that when the controller drives one colour, the lamps of both colours illuminate, or by a faulty drive that the controller is unable to switch off. However, as voltage monitors are provided on all three colours of each phase on all controller types and the ELV Controllers also include over-current detection, these faults will be confirmed (within 300ms) and can optionally extinguish all the signals by removing the lamp supply.

44.1.3 Lamp Monitor Sensor Types

Each controller phase is usually monitored by one lamp monitor sensor. Each sensor must be assigned a lamp monitor 'sensor type', although these do not need to be changed from their default settings unless the lamp sequences for the phases are altered. The sensor types currently available on the controllers are shown below.

Monitored Colours				Description / Example of use
Red	Green	Amber	-	Standard vehicle phase for example
Red	Green	Amber	F/Amber	Also monitors flashing amber part-time state for example
Red	Green	Amber	F/Red	Also monitors flashing red part-time state
Red	F/Green	Amber	-	Flashing green used for at ROW
Red	F/Green	Amber	F/Red	Plus flashing red part-time for example
Red	Green	F/Amber	-	Flashing amber instead of steady amber
Red	Green & F/Amber	-	-	Pedestrian phase with flashing amber ball which appears during green.
Red	Green	Red & Wait	-	Standard Pedestrian with wait
Red	Green	Red & Wait	F/Red	Plus flashing red part-time state
Red	F/Green	Red & Wait	-	Flashing green used for at ROW
Red	Green	-	-	Amber / wait drive not used or monitored separately
-	Green	-	-	Standard Green-Arrow
-	Green	Amber	-	Green-arrow with amber leaving aspect
-	Wait	-	-	Separately monitored wait / demand indicators
-	On	-	-	Regulatory Sign
-	On	-	-	Switched bulb or tube (any colour)
-	F/Green	-	-	Flashing green

Table 7 Lamp Monitor Sensor Types

Notes:

- 'F/Colour' = Flashing Colour, e.g. 'F/Amber' = Flashing Amber
- Each sensor type does not have to include every combination that may appear on the phase. For example, a standard UK vehicle phase is not monitored during the red/amber period because both the red and the amber appear separately at other points in the cycle.
- Each combination monitored by a sensor type must appear otherwise learning will never be indicated as complete. For example, if the traffic amber is not used, change the lamp monitor sensor type to the 'Red, Green' type.

44.1.4 Lamp Monitor Load Types

Where LED Signals* are used, the controller must also be configured with the correct load type for each lamp monitor sensor. This is configured using the IC4 Configurator and can be changed using the Figure 105 Controller - LMU - Sensors web page or KLT handset command.

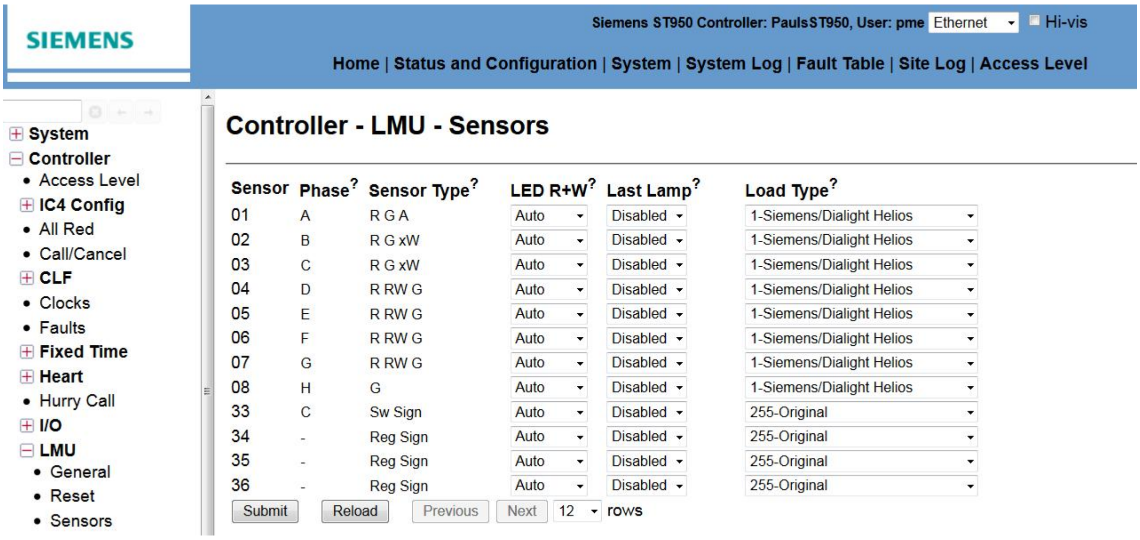


Figure 105 Controller - LMU - Sensors web page

The load type informs the controller as to the type of signal connected; all signals monitored by the sensor must be of this type.

Specifying the load type configures various parameters within the lamp monitor. This includes information such as the nominal current consumed by each signal, which governs the ‘threshold’ to be used (as referred to in section 44.1.2). It also includes the expected change in the current given a change in the supply voltage, because this differs between different types of LED Signal and is very different from the profile of incandescent lamps.

On an ELV Controller, all signals are LED types and thus require the load type to be configured.

A standard LV Controller cannot monitor LED Signals (except those that mimic the load of an incandescent lamp*). However, by upgrading to “LED Lamp Switch” Cards, an LV Controller can monitor Helios CLS LED Signals (NLM; with No LMF Module). Refer to the handbook 667/HB/32921/007 for details. This type of controller is sometimes referred to as an “ST950LED Controller”.

Refer to the 667/SU/46000/000 compatibility handbook for a list of the types of LED Signals supported by the controller.

* Some LED Signals (e.g. Helios CLS Signal with an LMF module or Helios LED Signal) mimic the load of an incandescent lamp and thus can be monitored as lamps rather than LED signals.

44.2 Red Lamp Monitor

44.2.1 Introduction

To meet UK requirements, the Red Lamp Monitor function is required at part-time signals, at junctions that are fitted with pedestrian audible or tactile devices and stand-alone pedestrian signals.

The vehicle red lamps are monitored and when lamp failures are detected, the operation of the controller is modified to ensure that unsafe signal conditions do not occur.

When a first red lamp fails on a vehicle phase, the inter-greens between that phase and any conflicting pedestrian phases can be increased.

When a second red lamp fails on a vehicle phase (or when no red lamps are illuminated due to a feeder failure), the conflicting pedestrian phases can be configured to remain at red and not appear at green (referred to as 'inhibited'). For part-time or stand-alone signals, it is a UK requirement that all the signals are extinguished if two vehicle red lamps fail on a phase.

For Non-UK Controllers, Red Lamp Monitoring can be enabled or disabled as required, and configured to inhibit, extinguish or flash phases when a second red lamp failure is confirmed. Alternatively, **Last Lamp Failed Monitoring** can be enabled instead – see section 44.4, starting on page 261.

44.2.2 First Red Lamp Failures

RLM Delays between Conflicting Phases

For each phase to phase transition, a user alterable time can be defined. These times define how long a phase should be delayed from appearing when certain phases terminate with one red lamp missing. These configured times can be altered using the handset command RLT.

If a time is defined between two conflicting phases, the time can be thought of as an inter-green extension, i.e. how much longer should the phase gaining right of way be delayed when the phase leaving right of way has missing red lamps. The usual inter-green rule applies: if two phases leaving right of way have inter-green times defined to one phase that is gaining right of way, the phase will appear when both inter-green times have expired.

In the following diagram, phases A, B and C are losing right of way and the conflicting phase D is about to appear.

Example 1 shows the normal operation: when all the inter-green times have expired, phase D appears.

Example 2 shows what happens if phase A has one or more red lamps missing. At the point where phase D would appear, the RLM facility calculates that an additional 3-second delay is required. Even if phases B and C also had missing red lamps, the calculation would still result in a 3-second delay.

Example 3 shows what happens if phase A has no missing red lamps, but phase C has one or more missing. At the point at which phase D would normally appear, the RLM facility calculates that of the 5 second delay required by phase C, only 2 seconds is left to run. Therefore, phase D is delayed by 2 seconds. Even if phase B had missing red lamps, the RLM facility would calculate that only 1 second of its delay is left to run, which is less than the delay required by phase C.

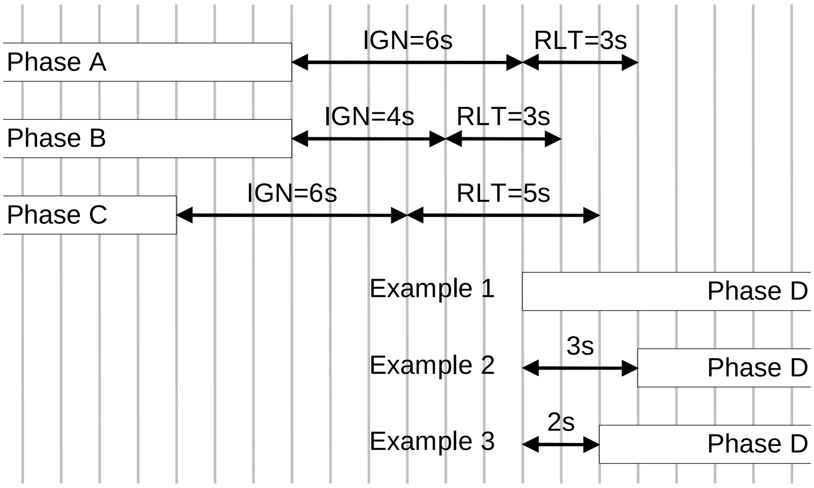


Figure 106 First Red Lamp Failure Delays

Inter-greens:	**A**	**B**	**C**	**D**
A		-	-	6
B	-		-	4
C	-	-		6
D	-	-	-	

RLM times:		**A**	**B**	**C**	**D**
Required delays	**A**		-	-	3
when this phase	**B**	-		-	3
terminates with	**C**	-	-		5
missing reds	**D**	-	-	-	

Table 8 First Red Lamp Failure Delays (Example 1)

RLM Delays between Non-Conflicting Phases

For most junctions, delays are only required between conflicting phases. However, it is sometimes required to delay a number of phases simultaneously so that they always appear together.

To get two phases to appear at green at the same time on a certain stage to stage movement, the phase that would otherwise appear first is delayed using phase delays. Following a single red lamp failure where one of these phases is delayed, it is sometimes required that the other must also be delayed, even if it does not conflict with the phase which has missing red lamps.

Therefore, a red lamp monitor delay time can be specified between two phases that do not conflict. In this case, this time is used directly to delay the phase that is appearing, since there is no inter-green between two such phases.

In the following diagram, phases A and B are losing right of way and conflict with phase D that is gaining right of way. Phase C is also losing right of way and conflicts with phase E. The requirement is that phases D and E appear at green at the same time on this stage to stage movement.

Example 1 shows the normal operation where a 10-second phase delay delays the appearance of phase E.

Example 2 shows what happens when phase A has one missing red lamp. It delays the appearance of phase D by 5 seconds. If a red lamp monitor time from A to E of 5 seconds is also specified, even though phases A and E do not conflict, phases D and E still appear at green at the same time.

Example 3 shows what happens when phase B has missing red lamps and not phase A. Phase D would be delayed since the inter-green time plus RLM delay from B to D is 11 seconds. Given that there is already a 10-second phase delay on E, a red lamp monitor time from B to E of 1 second would also give 11 seconds.

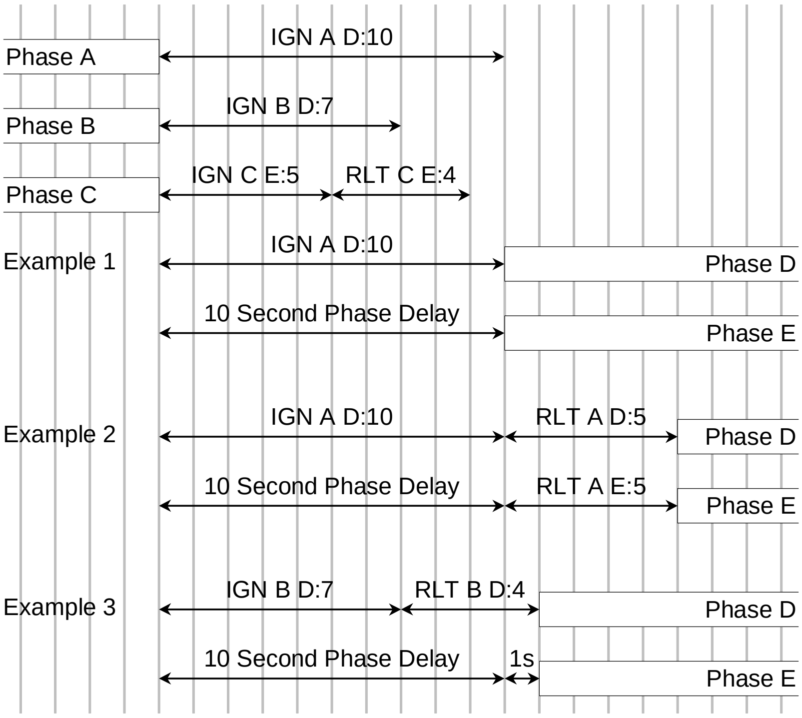


Figure 107 First Red Lamp Failure Delays

RLM times for this example are:

Required delays when this phase terminates with missing reds

	A	B	C	D	E
A		-	-	5	5
B	-		-	4	1
C	-	-		-	4
D	-	-	-		-
E	-	-	-	-	

Table 9 First Red Lamp Failure Delays (Example 2)

RLM Delays and Intermediate Stages

When a stage to stage move is made via an intermediate stage, the RLM delays are applied on the two stage moves independently. However, this can mean that the terminating vehicle phases do not terminate on the same stage move in which the conflicting pedestrian phases appear.

If the intermediate stage is an all-red stage that only appears for a short period, an RLM delay between the vehicle phase and a dummy phase in the intermediate stage should be configured. This delays the appearance of the intermediate stage and thus the appearance of the phases in following stage.

44.2.3 Second Red Lamp Failures

Response to a Second Red Lamp Failure

To determine which phases are to be switched off or just inhibited by a second red lamp fault, two items are required. One defines for each stream whether such faults on that stream switch off or just inhibit phases. The second item defines which phases are to be affected on a phase to phase basis.

If phases are inhibited, they are prevented from gaining right of way and thus remain at red. In the UK this is used to prevent pedestrian phases with audible or tactile indications from gaining right of way if two or more red lamps have failed on a conflicting vehicle phase. Other than this, the stream continues to operate normally.

If phases are switched off, all their aspects are switched off such that the phase is blacked-out. In the UK this is used to extinguish all the phases in a part-time or stand-alone pedestrian stream when two or more red lamps fail on one of the vehicle phases.

The following table illustrates how the actions for second red lamp failures can be configured:

Phases With a 2nd Red Lamp Fault Confirmed	Phases Inhibited or Blacked-Out									
	A	B	C	X	Y	Z	A2	B2	F2
A	1	1	1						
B	1	1	1						
C	1	1	1						
X						1		1	
Y						1			
Z									
A2						1			
B2									
F2									

Table 10 Second Red Lamp Failure (Example 1)

Phases A, B and C belong to a part-time stream and therefore any failures on these phases cause all three phases to be blacked-out so that the whole stream is extinguished.

Phases X to B2 belong to a stream where pedestrian RLM is required. In this case, red lamp failures on the vehicle phases (X, Y, A2) inhibit the appearance of the conflicting pedestrian phases (Z, B2).

For Non-UK Controllers, rather than extinguishing the stream, 'second red lamp failures' can be configured to cause the stream to immediately enter its part-time state, which can be configured as vehicle flashing ambers for example.

If this is required, the 'fail to part-time state' facility should be enabled and the above table should be left blank. The controller then sends the stream immediately to its part-time state (e.g. vehicle flashing ambers) regardless of minimum green times, inter-green times, stage restrictions or the configured switch off stage.

Note that this facility can be used even if the stream(s) are not required to switch off a certain times of day, i.e. even if the part-time facility itself is not required for any other reason.

Consideration for Multiple Part-Time Streams

When one stream is extinguished due to a second red lamp fault, it may be required that other streams are also extinguished so that some streams are not left running while one is extinguished.

In this case, the controller can be configured to extinguish all of the phases on the other streams as well as the all of the phases in the same stream as the phase with the red lamp fault. If in previous example, phases X to B2 had also been a part-time stream, failures on any vehicle phases can easily be configured to blackout all the phases of both streams, i.e.

Phases Inhibited or Blacked-Out (columns); **Phases With a 2nd Red Lamp Fault Confirmed** (rows)

	A	B	C	X	Y	Z	A2	B2	F2
A	1	1	1	1	1	1	1	1	
B	1	1	1	1	1	1	1	1	
C	1	1	1	1	1	1	1	1	
X	1	1	1	1	1	1	1	1	
Y	1	1	1	1	1	1	1	1	
Z									
A2	1	1	1	1	1	1	1	1	
B2									
F2									

Table 11 Second Red Lamp Failure (Example 2)

If the ‘fail to part-time’ facility is used rather than the above table, special conditioning can be used to force the other stream(s) to also immediately enter their ‘fail to part-time’ state when a second red lamp fault is present on any stream.

Where there is a mix of stand-alone pedestrian streams and intersection streams on the controller, it is still possible to configure the actions across those multiple streams.

For example, when a second red lamp fault is confirmed on the intersection stream it can inhibit pedestrian phases within that intersection stream and also extinguish the stand-alone pedestrian stream (shown circled in green).

Phases Inhibited or Blacked-Out

Phases With a 2nd Red Lamp Fault Confirmed	A	B	X	Y	Z	A2	B2	F2
A	1	1	1	1	1	1	1	
B								
X	1	1			1		1	
Y	1	1			1			
Z								
A2	1	1			1			
B2								
F2								

Wrong! These intersection phases are inhibited when RLM faults are confirmed on the associated ped stream (A&B).

Right! The ped stream (A&B) is extinguished when RLM faults are confirmed on the associated intersection streams

Table 12 Second Red Lamp Failure (Example 3)

In the above example, second red lamp failures on the vehicle phases of the intersection stream (X, Y, A2) are configured to inhibit the pedestrian phases in that stream (Z and B2) and also extinguish the stand-alone stream (A and B).

Note: If it is required that red lamp faults on the stand-alone pedestrian stream extinguish all the signals of the controller, but some streams normally only inhibit their pedestrian phases, then special conditioning can be used to switch off the signals when the fault is confirmed. Do not select all the phases in the intersection stream (as shown above circled in red) because this instructs the controller to inhibit all the phases of the intersection stream.

Other RLM Configuration Data

The following ‘switches’ affect the whole controller:

- 1st red lamp failures can be cleared automatically or require RFL=1,
- 2nd red lamp failures can be cleared automatically or require RFL=1,
- 2nd red lamp failures cancel the delays introduced by the 1st red lamp failures.

44.3 Stand-Alone Pedestrian Streams

Two or more vehicle approaches on the same stand-alone pedestrian vehicle phase can be red lamp monitored using one on-board sensor. However, this has the disadvantage that if two red lamps fail on the phase, the controller would have to extinguish the signals because it would not be able to determine whether the failed lamps are actually on two different approaches.

If the two or more vehicle approaches are required to be separately red lamp monitored on a controller, the following options are available to the configuring engineer:

44.3.1 Using External Sensors (LV Only / Not ELV)

The on-board / internal sensor can be disabled and two (or more) off-board / external sensors can be used to monitor the vehicle phase.

This option can be used on Intersection streams as well as stand-alone pedestrian streams. However, check it is possible to monitor the type of signals fitted using external sensors; e.g. check the LV-CLS documentation (667/HB/32921/007).

For example, consider the case where a stand-alone pedestrian stream is required in addition to a five-phase intersection where the intersection stream uses phases ‘A’ to ‘E’, and the stand-alone pedestrian stream uses phases ‘F’ and ‘G’.

If the two approaches of the stand-alone stream are required to be red lamp monitored separately, the on-board sensor 6 can be disabled and two off-board sensors 35 and 36 could both be configured to monitor phase ‘F’ for red lamp monitoring and normal lamp monitoring. Note that sensors 33 and 34 can still be used to monitor any regulatory signs on the intersection.

Figure 108 RLM Approaches (External Sensors)

44.3.2 Using Additional Phases (LV or ELV)

An alternative is to configure phases F and G as the two vehicle approaches and phase H as the pedestrian. This would allow the on-board sensors 6 and 7 to monitor the two approaches for red lamp monitoring and normal lamp monitoring and not use any off-board sensors:

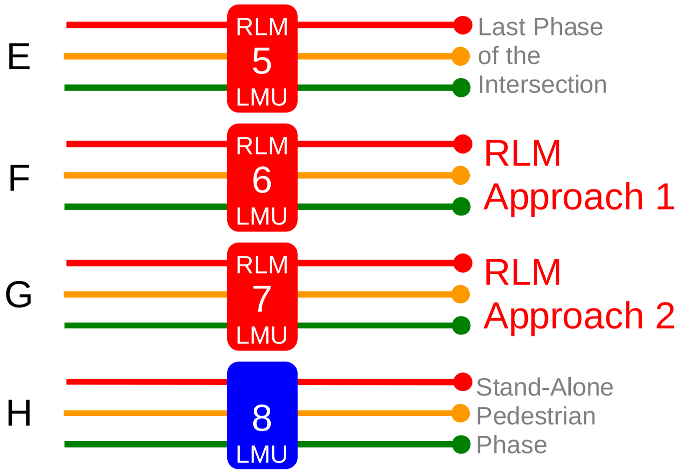


Figure 109 RLM Approaches (Additional Phases)

In this case, the timings for the vehicle stage would be set by phase F and thus it would become the ‘master’ phase while phase G would become the ‘slave’ phase.

The minimum and maximum green times for phase G would be set to zero so that it does not extend the vehicle stage, but would still terminate at the same time as phase F at the end of the vehicle stage. The Controller - Pedestrian - Streams web page and stand-alone pedestrian stream inter-green commands PAR and PIT are stream-based so the same timings would be applied to both vehicle phases. The puffin and toucan pedestrian to vehicle inter-green is controlled by the pedestrian phase’s clearance period which would automatically delay the appearance of all conflicting vehicle phases (as it does on an intersection). The IGN inter-green times for the phases on the stand-alone pedestrian stream are not used.

As inter-greens times for each phase-to-phase transition can be changed on an intersection stream, this option is not recommended for intersection phases – it would be all too easy to change a timing for Phase F but not for Phase G with the result that the two signals on the two approaches show different signal states.

44.3.3 Using Different LSLS Outputs (ELV only)

With an ELV Controller, each phase aspect can be assigned to more than one LSLS Output and each LSLS Output can be monitored by a different Lamp Monitor Sensor. Therefore, two LSLS Outputs can be configured for each aspect of a phase and then, on the IC4 Lamp Monitor Screens, a different sensor can be assigned to the second LSLS Output of each RAG aspect of that phase.

In the example below, two LSLS Outputs have been configured for each RAG aspect of Phase F so the phase uses six LSLS Outputs rather than three. By default IC4 will still configure each of those LSLS Outputs to be monitored by Lamp Monitor Sensor 6. However, the Lamp Monitor Sensor for the second LSLS Output of each RAG aspect can be manually changed from Sensor 6, to any spare sensor. In this example, Sensor 33 has been used.

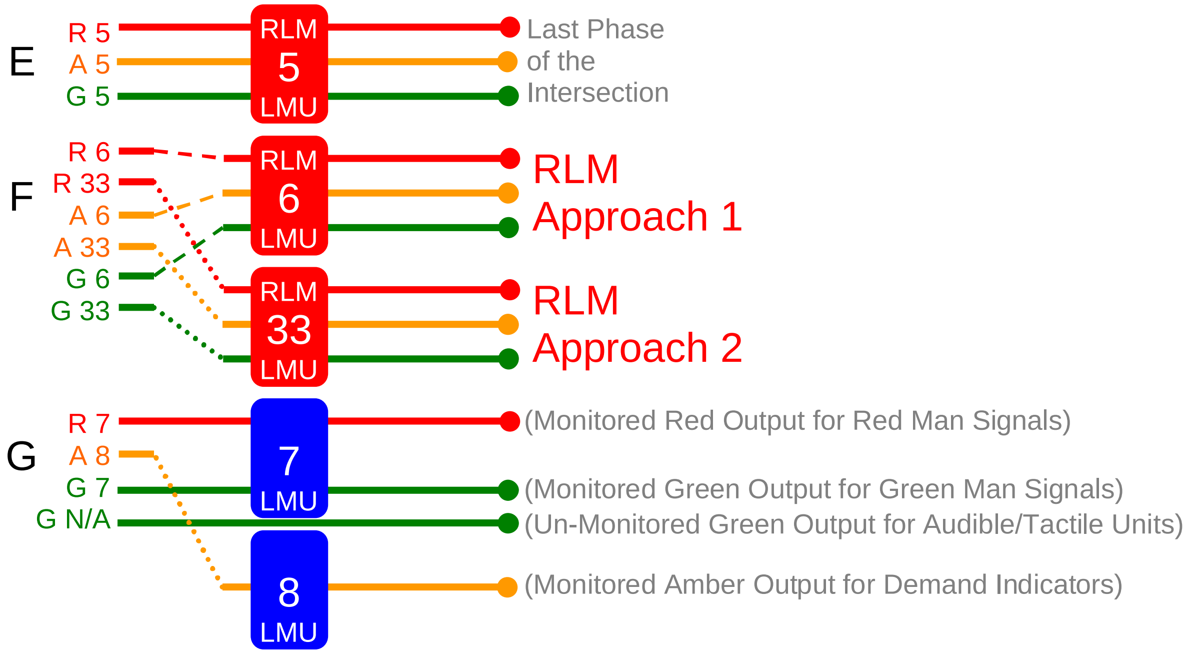


Figure 110 RLM Approaches (Different LSLS Outputs)

Thus, Sensor 6 will count the red lamp failures on Approach 1, while Sensor 33 will independently count the red lamp failures on Approach 2. This has two significant advantages over the other options:

- External sensors are not required since this mapping is handled internally by the firmware.
- All the timings associated with the two vehicle approaches will always be the same since they are being controlled by the same phase. Therefore, this option can be used on Intersection streams as well as stand-alone pedestrian streams.

Note that the example above also shows that a second LSLS Output has been configured for Phase G Green for Audible or Tactile Units. On the IC4 Lamp Monitor Screen the Sensor for this second LSLS Output has been set to “N/A” to disable Lamp Monitoring on that Output. Therefore, the current consumed by these Units will not affect the Lamp Monitoring of the Pedestrian Green Signals (connected to the first LSLS Output), even though both LSLS Outputs are being driven by Phase G Green. It also shows that the pedestrian amber output has been assigned to a different sensor (Sensor 8) so that the low power Demand Indicators can be monitored at the same time as the higher power Red Man signals.

44.4 Last Lamp Failed Monitoring

44.4.1 Introduction

With Last Lamp Failed Monitoring, faults are only reported when the current monitored by a sensor falls below a configurable threshold. This threshold is typically set so the fault is triggered when the last lamp fails, hence its name.

This differs from Red Lamp Monitoring in that no actions are taken before this point, e.g. Red Lamp Monitoring would react when two out the three signals failed.

Last Lamp Failed Monitoring also differs from Red Lamp Monitoring in that it can be configured to monitor outputs of any colour, not just reds.

44.4.2 Faults Actions

When the current is confirmed below the threshold, a standard lamp fault report is generated. For example, a 30W lamp fault reported and the learnt load is reduced to zero if the load learnt was 30W before the last lamp fault was confirmed.

The System Log, Fault Table, LMU Readings and Last Lamp Status web pages and LLE/LLF handset commands identify the fault as a last lamp fault.

Typically further Fault Actions are required and there are two choices:

- Software Fail Flashing – If the Fail to Part-Time facility is enabled (section 42), the associated stream enters its configured part-time state, usually flashing ambers.
- Hardware Fail Flashing or 'All Off' – If the Fail to Part-Time facility is not enabled, the controller is shutdown.

In both cases, the Second Red / Last Lamp Fault FLF22 is also reported to indicate that actions have been taken, with the fault data identifying the phase(s).

This fault can only be cleared manually either locally or remotely* using the normal fault log reset features. The lamp fault report will be cleared when the Lamp Monitor learns the replaced lamp load (unless the 'Last Lamp Faults Only' option is enabled – section 44.4.7).

In addition, Special Conditioning can read the state of the last lamp faults and trigger actions.

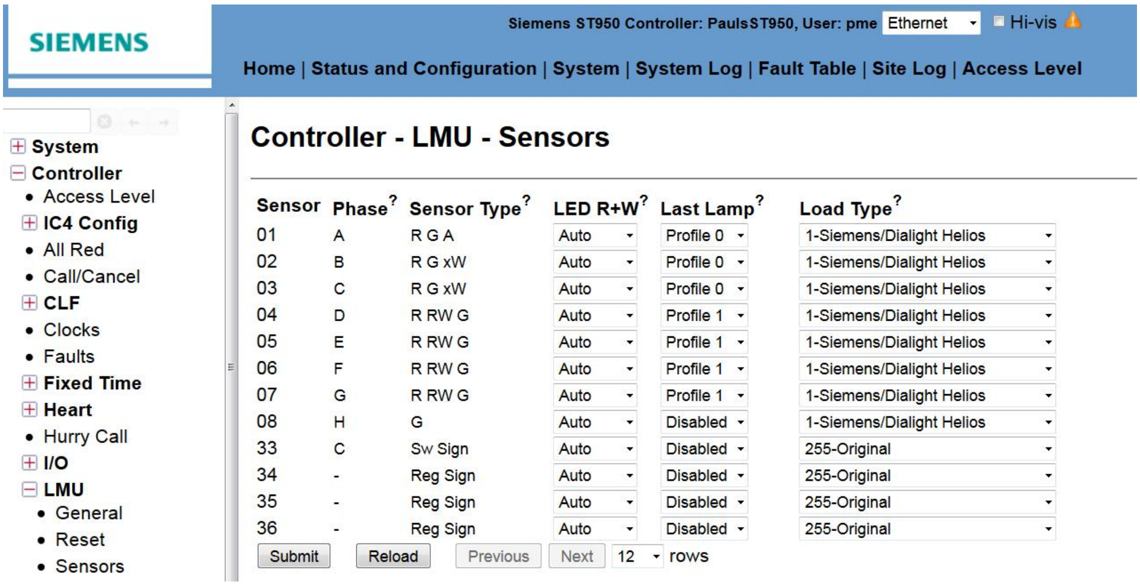
44.4.3 Configuration

The Last Lamp Failed Monitoring facility must be enabled using the IC4 Configurator. However, once enabled, all the settings can be modified using web pages and handset commands.

Note: Last Lamp Monitoring and Red Lamp Monitoring are mutually exclusive; both facilities cannot be enabled in the same configuration.

* If the controller is shutdown, the fault reset requires the Remote Reboot feature (section 7).

Each lamp monitor sensor can be assigned to one a several Last Lamp 'profiles' numbered 0 to 7.

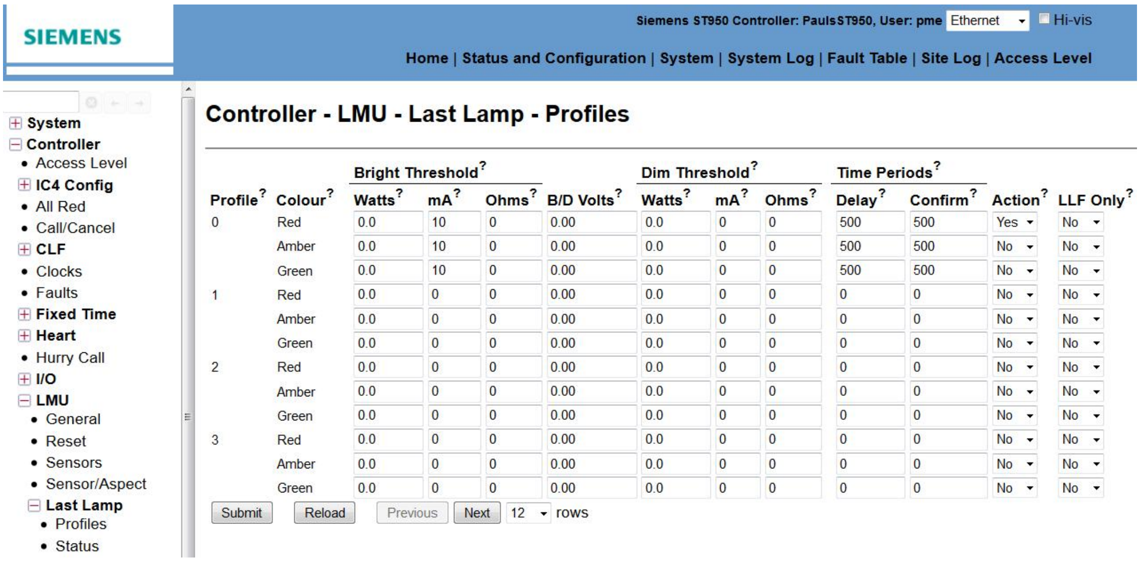


Sensor	Phase?	Sensor Type?	LED R+W?	Last Lamp?	Load Type?
01	A	R G A	Auto	Profile 0	1-Siemens/Dialight Helios
02	B	R G xW	Auto	Profile 0	1-Siemens/Dialight Helios
03	C	R G xW	Auto	Profile 0	1-Siemens/Dialight Helios
04	D	R RW G	Auto	Profile 1	1-Siemens/Dialight Helios
05	E	R RW G	Auto	Profile 1	1-Siemens/Dialight Helios
06	F	R RW G	Auto	Profile 1	1-Siemens/Dialight Helios
07	G	R RW G	Auto	Profile 1	1-Siemens/Dialight Helios
08	H	G	Auto	Disabled	1-Siemens/Dialight Helios
33	C	Sw Sign	Auto	Disabled	255-Original
34	-	Reg Sign	Auto	Disabled	255-Original
35	-	Reg Sign	Auto	Disabled	255-Original
36	-	Reg Sign	Auto	Disabled	255-Original

Submit Reload Previous Next 12 rows

Figure 111 Controller - LMU - Sensors web page

Each 'Profile' defines how a sensor should monitor the signals, including the current threshold to be used, the confirm time and the fault actions.



		Bright Threshold?				Dim Threshold?			Time Periods?			
Profile?	Colour?	Watts?	mA?	Ohms?	B/D Volts?	Watts?	mA?	Ohms?	Delay?	Confirm?	Action?	LLF Only?
0	Red	0.0	10	0	0.00	0.0	0	0	500	500	Yes	No
	Amber	0.0	10	0	0.00	0.0	0	0	500	500	No	No
	Green	0.0	10	0	0.00	0.0	0	0	500	500	No	No
1	Red	0.0	0	0	0.00	0.0	0	0	0	0	No	No
	Amber	0.0	0	0	0.00	0.0	0	0	0	0	No	No
	Green	0.0	0	0	0.00	0.0	0	0	0	0	No	No
2	Red	0.0	0	0	0.00	0.0	0	0	0	0	No	No
	Amber	0.0	0	0	0.00	0.0	0	0	0	0	No	No
	Green	0.0	0	0	0.00	0.0	0	0	0	0	No	No
3	Red	0.0	0	0	0.00	0.0	0	0	0	0	No	No
	Amber	0.0	0	0	0.00	0.0	0	0	0	0	No	No
	Green	0.0	0	0	0.00	0.0	0	0	0	0	No	No

Submit Reload Previous Next 12 rows

Figure 112 Controller - LMU - Last Lamp - Profiles web page

Each Profile has separate settings for each Colour:

- For most signals, this simply equates to the Red, Amber and Green phase outputs.
- For Switched Signs, the colour of the phase output used by the sign determines which colour profile settings are used.
- For Wait indicators, the colour profile settings for Amber are used.
- For Regulatory Signs, the colour profile settings for Green are used.

If only Last **Red** Monitoring is required, only the ‘Red’ row should be completed. If monitoring of all colours is required, all three rows need to be completed, independently defining the settings for each colour.

44.4.4 Threshold

The threshold is critical for the correct operation of Last Lamp Failed.

The simplest threshold is a static current threshold, applied regardless of the supply voltage. For this, simply enter the required current threshold in to the Bright milliamps parameter and set the other threshold parameters to zero, as shown in Figure 112 previously. In that example, should the current fall below 10mA, regardless of the supply voltage, a fault will be confirmed.

However, in some cases this fixed low threshold will not suffice, particularly if the power supplies within the LED signals continue to consume a small amount of current when the LED drivers fail. Also, if incandescent lamps are powered via a step-down transformer, the transformer will continue to consume current when the lamp fails.

Also note that despite its name, the threshold can be set to trigger before the last lamp fails, for example a 15W threshold with 10W LED Signals will trigger when there are no longer two signals remaining, i.e. when only one signal remains or no signals remain.

The following graphs show the typical current consumption (solid blue lines) for a real 10W LED Signal (left) and a 50W lamp (right) and thresholds set at 50% of those nominal loads (dotted green lines).

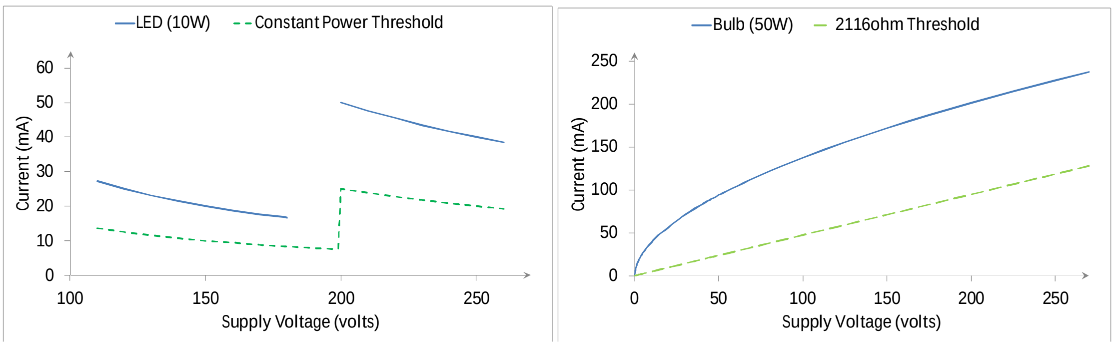


Figure 113 – 50% Last Lamp Thresholds

For each Colour of each Profile a Bright threshold, a Dim threshold and Bright / Dim Voltage can be defined. While the lamp supply is above the Bright / Dim Voltage the Bright threshold is used and below it the Dim threshold is used.

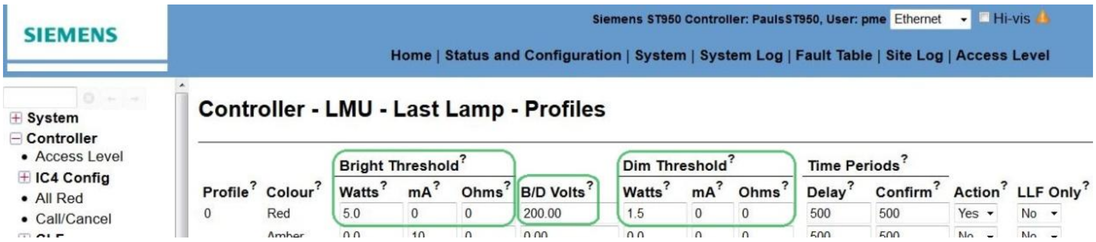


Figure 114 Threshold Settings

Example: If the signals are required to be Bright above 200V and Dim below 180V, the Bright / Dim Voltage should be set to 200V so the higher Bright Threshold is only used when all signals should be Bright.

Where the signals are never dimmed or the Bright Threshold is to be used throughout, the Bright / Dim Voltage can be set to zero so the Dim Threshold is never used.

As can be seen in Figure 114 above, each threshold is defined by three optional parameters: a Constant Power parameter (Watts), a Constant Current parameter (mA) and a Resistive Load parameter (Ohms).

- **Constant Power (Watts)** – Defines a constant power threshold in watts. The maximum value permitted is 5999.9 Watts. To be used with constant power LED signals – signals with a power consumption that varies little with changes in the supply voltage, so the current consumption decreases as the supply voltages increases.
- **Constant Current (mA)** – Defines a fixed current threshold in milliamps. The maximum value permitted is 65535mA. To be used with constant current or current limited LED signals – signals where the measured current reading varies little with changes in the supply voltage.
- **Resistive Loads (Ohms)** – Defines a threshold equivalent to a resistive load. The value entered is in Ohms, with a maximum value of 65535. To be used with incandescent lamps or any signal with a current consumption that increases as the supply voltage increases. With a Resistive Load threshold, the current threshold used increases as the supply voltages increases. As a guide, 2116 Ohms defines a linear threshold that rises to 109mA and 25W at 230V as shown in Figure 113.

If all three parameters for a threshold are zero, monitoring is disabled for that Profile, Colour and Bright/Dim state. A non-zero value needs to be entered in just one of these three parameters to define a threshold.

So for LED Signals, just enter either a number of watts <u>**or**</u> milliamps to define the threshold, or for Incandescent Lamps just enter a resistance value in ohms.

Tip! To convert between a resistive load ***R*** (ohms) and a power value ***W*** (watts) at a nominal voltage ***V*** (volts), use the following simple equations:

$$R = \frac{V^2}{W} \qquad W = \frac{V^2}{R}$$

e.g. to convert 25W @ 230V to ohms

$$R = \frac{V^2}{W} = \frac{230^2}{25} = 2116\ ohms$$

e.g. to convert 2116 ohms to watts (at 230V)

$$W = \frac{V^2}{R} = \frac{230^2}{2116} = 25W\ @\ 230V$$

44.4.5 Complex Thresholds

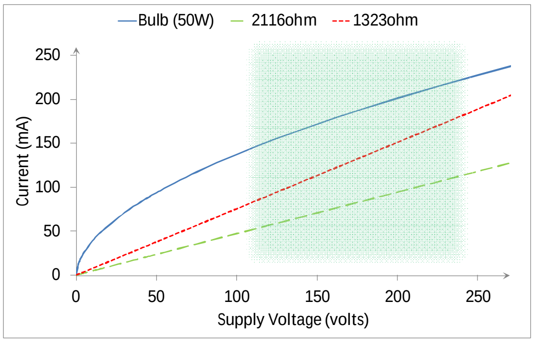
In most cases, a simple resistive threshold for lamps, or a constant power or constant current threshold for LED Signals will suffice and so only one of the three Threshold fields needs to be defined.

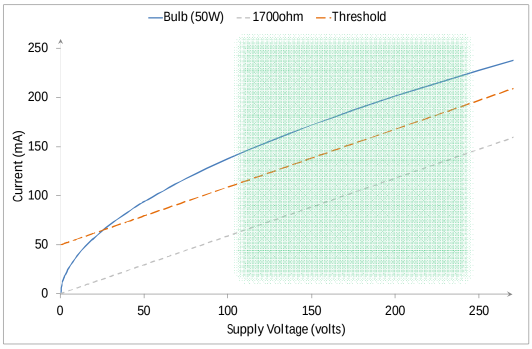
However, if it is required that the threshold be placed higher and closer to the expected current, a more complex threshold may be required in order to better match the current profile of the signals. Simply increasing the threshold value may not be sufficient.

If two or three parameters are non-zero, the thresholds calculated from each parameter are summed and only when the current falls below this combined threshold is a fault logged.

For example, this allows a threshold to be configured that is based partly on a constant power element and partly on a resistive power element, matching the typical components in some LED signals.

In another example, the graph below-left shows what happens when the resistive threshold is raised from 2116 ohms to 1323 ohms. These resistive thresholds are equivalent to 25W and 40W at 230V.





By entered values in two parameters, this threshold can be customised to better match the slope of the signals. As shown above-right, by adding an element of constant current (50mA) to a resistive line (1700ohm) produces a threshold that very closely follows the current of a 50W lamp load at the normal working voltages above 100V.

Note: Last Lamp Failed Monitoring is indirectly suspended below 100V because the Low Lamp Supply facility typically extinguishes the signals.

44.4.6 Time Periods

The Profile defines two time periods for each Colour – a Delay time and a Confirmation time.

The **Delay Time** is the time to wait after the aspect illuminates before monitoring is to commence. This is to allow time for the current readings to settle after the aspect is switched on.

The value is in millisecond units. The maximum value permitted is 65535ms, equivalent to 65s, although such high values are unlikely to be required. For example, values of 3000 or above will prevent monitoring of a three-second amber leaving signal.

If this value is higher than the flash-on period, then monitoring will ignore flashing aspects. If flashing aspects are to be monitored, the Delay Time must be set shorter than the flash-on period.

The **Confirmation Time** is the time between the current falling below the threshold and the fault actions (e.g. signals off).

The value is in millisecond units. The maximum value permitted is 65535ms, equivalent to 65s. A value of zero disables monitoring.

Although permitted, a confirmation time below 300ms is not recommended because too few samples will be used to detect the fault.

If the controller output is switched off during the confirmation period, the confirmation period resumes when the output is next switched on, once the Delay Time has elapsed again. Thus Last Lamp Faults can be confirmed over a number of amber-leaving periods or a number of flashing periods for example.

NOTE: If the last lamp fails shortly after the aspect switches on, the Confirmation Time starts at the end of the Delay Time. Similarly, for flashing signals, the Delay Time is applied at the start of every flash ON period, so only the time remaining in the ON period is used for confirmation.

44.4.7 Last Lamp Faults Only

By default, Last Lamp Monitoring does not prevent the standard Lamp Monitor reporting individual lamp faults.

The two facilities work alongside each other, both independently monitoring the current. Lamp Monitoring detects step changes of the current in order to report individual lamp failures and clearances. Last Lamp Monitoring detects when the current falls below the threshold in order to report a last lamp fault.

Where standard Lamp Monitoring is not required or not possible, there is an option to disable the reporting of individual lamp failures and clearances. In this case, lamp faults are only reported when Last Lamp Failed Monitoring confirms the current below the threshold. Other changes in the current are ignored. In addition, when the Last Lamp Fault is manually cleared, the Lamp Fault is also cleared immediately.

44.4.8 Other Considerations

Reserve State (section 5) – Last Lamp Monitoring continues while the signals are in their Reserve State because the monitoring for last lamp failures is performed by the Primary CPU. If a last lamp fails during the Reserve State, it will be confirmed and the appropriate actions taken even while the Application CPU is loading a new configuration or new firmware. Only the reporting of the fault in to the logs is delayed until the Application CPU returns.

Sensor Checking – During the mechanical Lamp Supply Relay Tests on the LV Controller, all the sensors configured to perform Last Lamp Monitoring are checked to ensure their readings are not 'stuck' – if any sensor continues to indicate that a current is present (even though the lamp supply has been temporarily removed by the Relay Test), the test is repeated. If the problem persists a 'test fault' is reported against the sensor and the configured Last Lamp Fault Actions are triggered as though a Last Lamp Fault had been confirmed.

Red plus Amber periods – If a sensor is configured to monitor both the Red and Amber outputs of a phase, Last Lamp Monitoring is suspended while both outputs are switched on. Last Lamp monitoring only monitors one colour output at a time, using the profile settings for that single colour. For the short Red + Amber 'to ROW' period, this temporary suspension of monitoring is not usually considered a problem because all the conflicting phases are no longer at ROW. Monitoring of the Red will resume when the Red re-appears after the Green ROW period.

Pedestrian Red and Wait (LV Controller) – Last Lamp Monitoring is suspended while two or more monitored outputs are on. For on-board sensors on the LV Lamp Switch Card, this disables monitoring of the Pedestrian Red while the Amber/Wait is on. If this is not acceptable, the remove the loads from the Amber/Wait output and change the Sensor Type to 'R, G' (i.e. a type that ignores the Amber/Wait output). If Wait Indicators are required, consider driving these from Switched Sign outputs.

Pedestrian Red and Wait (ELV Controller) – By default, the Amber / Wait output of a Pedestrian Phase is monitored by a different sensor to the Red and Green outputs. Thus no sensor is configured to monitor both Red and Wait, so each sensor only 'sees' one colour output illuminate at a time.

Sensor Type (KPT) – This general lamp monitor sensor setting defines which colours of the phase are monitored by the sensor and is also used by Last Lamp Monitoring. For example it controls whether the Amber / Wait is to be monitored or whether the sensor monitoring a Switched Sign output.

Load Type (KLT) – This general lamp monitor sensor setting is used by Last Lamp Monitoring to select between LED and 'Original' current scaling on LV-CLS Controllers, but other than that the specific LED Load Type selected has no impact on Last Lamp Monitoring (except for the ELV LSLS Measurement Type below).

LSLS Measurement Type – The Load Type selects which current calculation is used by the LSLS Card on the multiple samples taken over the mains cycle. The CLS* Load Types 1, 4 and 11 select an RMS calculation for those near-sinusoidal signal profiles. The other Load Types select just the highest sample for current-limited LED signals to give a pseudo RMS result, effectively $\sqrt{I_{PEAK}}$.

Multiple Channels for a Phase – Mechanisms are available to split the monitoring of a single phase colour in to a number of outputs monitored by individual sensors, e.g. to independently monitor the red signals of two separate approaches controlled by the same phase.

- On ELV Controllers, a Phase Colour drive can be mapped to more than one LSLS output, each monitored by a different Sensor.
- On LV Controllers, a small number of 'External Sensors' are available that can perform Last Lamp Monitoring of incandescent signals.
- On LV-CLS Controllers, these External Sensors cannot Lamp Monitor LED Signals, but can perform Last Lamp Monitoring. Enable the Last Lamp Faults Only option (44.4.7), select an LED Load Type (KLT) and wrap the feeder cable around the Sensor to increase the gain by a factor of four (to match the current scaling of the Sensors on the LED Lamp Switch Card).

Fluorescent Tubes – Last Lamp monitoring of fluorescent tubes is **not** supported. If fluorescent tubes are fitted, normal lamp monitoring should be used, not Last Lamp. If the Sensor Type is set to 'Switched Tube', monitoring is disabled. If the Sensor Type is set to 'Regulatory Signs' sensors, there is no adjustment for a current phase-shift so the signals fitted must be incandescent lamps or LED signals, not fluorescent tubes.

* Central Light Source

45 RIPPLE CHANGE FACILITY

The 'ripple change' facility optimises stage changes at large busy intersections that have phases that overlap into two or more stages.

45.1 What is a Ripple Change?

The ripple change facility is best explained by an example.

Consider the following junction:

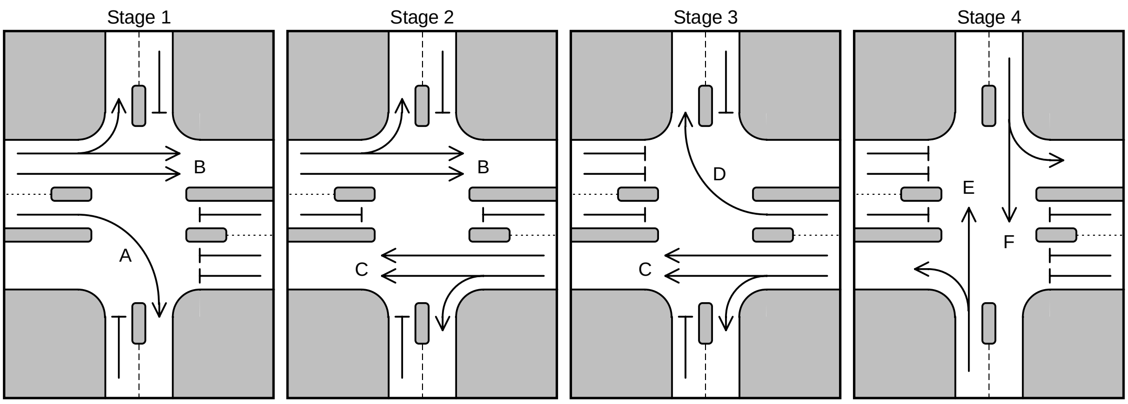


Figure 115 Ripple Change Example

A traffic controller running in VA mode should move as follows when the extensions cease (either due to a 'gap change' or a 'max change') on certain phases.

It should move from stage 1 to stage 2 when the extensions on phase A cease.

It should move from stage 2 to stage 3 when the extensions on phase B cease.

Alternatively, it should move straight from stage 1 to stage 3 if the extensions on phase B cease before (or at the same time as) the extensions on phase A cease.

In effect, the controller should leave stage 1 and move to either stage 2 or stage 3 depending whether a gap appears on phase A or phase B first.

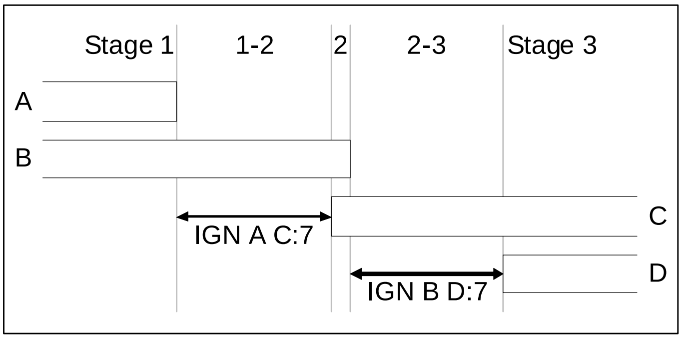
45.2 Normal Controller Operation

Normally the controller can only decide to make a stage change while steady in a stage and cannot make another stage change while one is already in progress on the same stream. This restricts the operation of the junction as follows:

When a gap appears on phase B while phase A is still busy the controller remains in stage 1. When a gap then appears on phase A, the controller will make the move from stage 1 to stage 3. In other words, if a gap appears on phase B before one appears on phase A, the controller would move directly to stage 3.

When a gap appears on phase A while phase B is still busy, the controller would begin the move from stage 1 to stage 2. In other words, if a gap appears on phase A before one appears on phase B, the controller would move to stage 2.

However, if a gap appears on phase B a few seconds after a gap appears on phase A, the controller cannot make another stage move until it has reached stage 2. But stage 2 is not reached until phase C appears which, in this case, is seven seconds after phase A terminates due to the inter-green between the phases.



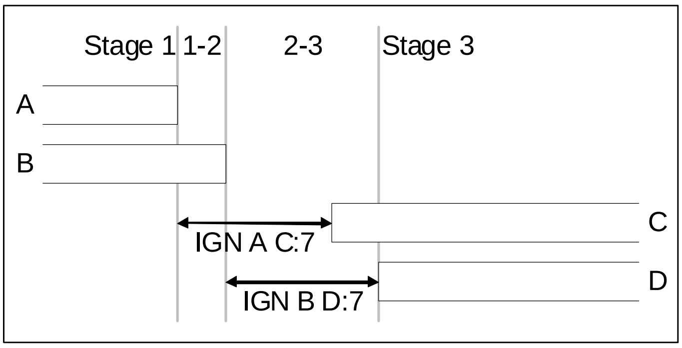
Therefore the controller is forced to leave phase B at green until stage 2 is reached, which effectively delays the appearance of phase D by up to those seven seconds.

45.3 Ripple Change Facility

The ripple change facility allows the controller to ‘change its mind’, terminate additional phases and start moving to a new stage, provided that the phases that are about to appear at green are still present in the new stage.

In the above example, this would allow the controller to make the decision to move to stage 3 while it is still making the move from stage 1 to stage 2, since phase C is present in both stage 2 and stage 3.

In the example to the right, the controller starts a normal stage change from 1 to 2, terminating phase A allowing it to bring on phase C seven seconds later.



However, during the move from stage 1 to stage 2, and before phase C actually appears, the controller can decide to move to stage 3 instead. At this point, it terminates phase B, which allows it to bring on phase D seven seconds later.

Compare this with diagram above and it shows that phase D and stage 3 have been given right of way much earlier.

In effect, when a gap appears on phase A the controller will terminate phase A and begin the process of bringing on phase C. Meanwhile, if a gap appears on phase B the controller will terminate phase B and begin the process of bringing on phase D.

The net result is that the controller can more quickly service the required phases and thus reduce delays at the junction. Numerically, if a gap on phase B occurred one second after phase A, phase D and stage 3 would appear six seconds earlier with a ripple change.

A ripple change will not violate the minimum green time on any phase, nor will it violate any inter-greens between two phases. However, by its very nature, this facility will allow the staggered termination and appearance of phases in order to optimise the flow of traffic through the junction. If the staggered effects are not desirable, the facility should not be enabled.

45.4 Ripple Change Parallel Stage Streaming Facilities

If the ripple change facility is enabled, it automatically affects all the configured streams, but runs independently on each stream – a ripple change on one stream does not affect any other streams.

If it is required that one stream should not ripple change (even though it could) while another stream should be allowed to ripple change, there are various ways to prevent the stream ripple changing. For example, in each stage involved in the possible ripple change, a different fixed dummy phase could be configured.

45.5 Interaction with Other Facilities

This section summarises how the ripple change facility interacts with other facilities on the controller.

To aid clarity, the descriptions below assume that the controller starts to make a normal stage change from stage 1 to stage 2 and during that stage change, the controller ripple changes to stage 3. However, it should be noted that the controller could ripple change across any stages and not necessarily consecutive stages.

45.5.1 Modes

If enabled on a controller, the ripple change will be available in all modes, however it will only really have any impact in VA, bus priority and emergency vehicle modes. The other modes tend to demand particular stages and thus do not normally allow the controller flexibility to change the stage movement part way through since the demand is not cleared until the stage gains right of way.

45.5.2 Demand Dependant Phases

All phases which are gaining right of way by the move from stage 1 to stage 2 which are fixed in stage 2 or are demand dependant and demanded, including those running gaining phase delays, will also have to appear in stage 3 for the ripple change to be considered.

Normally a ripple change from “1 to 2” to “2 to 3” will not be allowed if a phase appears in stage 2 but not in stages 1 and 3. However, the ripple change will be allowed if there is no demand for the phase and it is configured as demand dependant since the phase will simply not appear.

It is therefore possible for the controller to ripple change from “1 to 2” to “2 to 3” if a phase appears in stage 1 and 3 but not 2 (due to a conflict with a demand dependant phase in stage 2 for example). However, the ripple change will be delayed until the phase has actually reached no right of way at the end of stage 1, i.e. until it has completed any losing phase delays and amber leaving periods. This ensures that the phase is ready to re-appear before the ripple change occurs.

Once the phase has reached no right of way, i.e. red, the ripple change may bring the phase back to green after only a very short period, unless a gaining phase delay for the move from 2 to 3 is configured which then would guarantee a minimum red period.

Even without the ripple change facility, it is common to configure such a gaining phase delay on the move from stage 2 to stage 3 if the only inter-green to the phase in stage 3 is from a demand dependant phase in stage 2. The phase delay then delays the appearance of the phase so that it appears with the rest of the phases in stage 3 rather than as soon as the move to stage 3 starts. If the demand dependant phase does actually appear in stage 2, the inter-green from that phase to the phase in stage 3 would delay its appearance as normal.

45.5.3 Phase Delays

Phase delays specified for phases which terminate or gain right of way by the move from stage 1 to stage 2 will be unaffected by the ripple change to stage 3 and will continue to time off.

Phase delays configured on any phases terminated at the end of stage 2 or given right of way by stage 3 will commence at the start of the move from stage 2 to stage 3.

Phase delays for the move from stage 1 to stage 3 will not be introduced on the ripple change from “1 to 2” to “2 to 3” since those times would only be applicable if they were started when stage 1 terminated. The combination of phase delays for the move 1 to 2 and for the move 2 to 3 must take care of any combined requirements for the move from 1 to 3.

At the start of the first stage change in which a phase can gain right of way in a series of ripple changes, the phase delay is started on that phase if one has been configured on that stage movement. After the delay and any inter-greens have expired, the phase is ready to appear. If the phase is demand-dependant, the appearance will be delayed until a demand is actually registered. Phase delays on subsequent movements for this phase will be ignored until a full stage is reached and the ripple change is finished. However, if the controller ripple changes to a stage in which the phase can no longer appear, the process is repeated if the controller then ripple changes to another stage in which the phase can appear again.

45.5.4 Stage Restrictions and All-Red Extensions

The controller will action any stage restrictions (ignores, prevents and alternatives) specified for the move from stage 2 to stage 3 as normal during a ripple change. For example, if the move from stage 2 to stage 3 is configured as an ignore move, the controller will attempt to find another stage to ripple to rather than stage 3.

However, if there is a stage restriction specified for the move from stage 1 to stage 3, the ripple change will be prevented and the controller will wait until stage 2 is reached before moving to stage 3. This is because the ripple change from stage 1 to stage 2 to stage 3 may occur shortly after the move from stage 1 to stage 2 started, and the street will in effect see the move from stage 1 directly to stage 3. Since that move was restricted in the configuration, the controller will not therefore allow the ripple change.

If an all-red extension unit is configured on the moves from stage 1 to stage 2, or from stage 2 to stage 3 or from stage 1 to stage 3, the ripple change will be prevented. The controller will perform the two stage changes in turn, taking any all-red extensions into account on each move independently.

The controller will always check for any stage restrictions or all-red extension units configured from any stage visited during the ripple change to the suggested stage. For example, if the controller also attempts to ripple change to stage 4 after ripple changing from “1 to 2” to “2 to 3”, it will check all the stage moves between these stages. Therefore, the controller will also check for a stage restriction or all-red unit configured for the move “1 to 4” and prevent the move to stage 4 until stage 3 appears if one is found.

Note that the ripple change from “1 to 2” to “2 to 3” would have already checked the moves “1 to 2”, “2 to 3” and “1 to 3”. And the original decision to ripple change from “2 to 3” to “3 to 4” would have checked the moves “2 to 3”, “3 to 4” and “2 to 4”.

45.5.5 SDE/SA Facility

The SDE/SA facility will continue to function alongside ripple change, with any clearance requests from the new stage change introducing the required delays to the inter-greens and gaining phase delays. This is true as long as the ‘gaining phase delays affected’ is configured as required, rather than being left as the default of ‘all ones’.

45.5.6 RLM Delays

The RLM facility will continue to function correctly alongside ripple change, as long as RLM delays are only configured between conflicting phases. The appearance of phases will be delayed even if the vehicle phase actually terminated on a previous stage change (unless the inter-green and RLM delay time has already expired). RLM delays between non-conflicting phases will be introduced regardless of how long ago the phase terminated.

45.5.7 Green Arrows

Left-turn green filter arrows may require an intermediate stage if the controller is required to ripple from the left-turn only stage to the full green stage, see section 35.6.

45.5.8 UTC

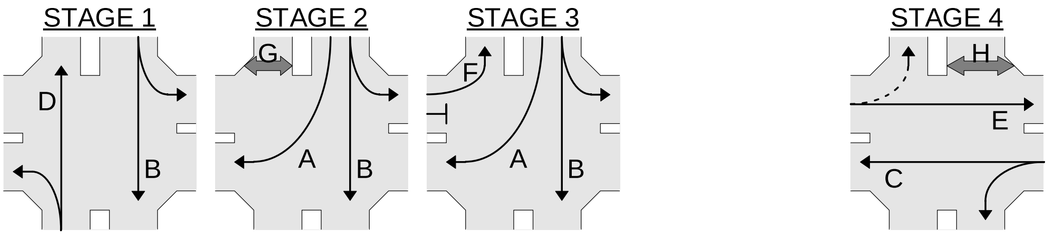
If the controller can ripple from “1 to 2” to “2 to 3”, the controller can appear to be in an interstage (from stage 1 to stage 3) for longer than normal. Therefore the minimum and maximum limits used by the UTC Instation to check the interstage times must be set-up to allow for the direct move from stage 1 to stage 3 as well as the ripple change via stage 2. The maximum limit for the move from 1 to 3 needs to allow for the summation of the interstage time from 1 to 2 plus the interstage time from 2 to 3.

If the controller can make a number of ripple changes in succession before residing in a stage and replying a stage confirm bit, the UTC Instation may report a fault since the controller has been ‘stuck’ in an interstage for a long period of time. In this case, either the Instation checking should be switched off if the controller is running in isolation or phase confirms should be used instead of stage confirms. Alternatively, dummy phases must be configured to force the controller to reside in some of the stages for a minimum period before moving on.

45.6 Green Filter Arrows

Left-turn green filter arrows pose a particular problem for a ripple change. The problem arises because, by default, the left-turn green filter arrow phase does not appear in the ‘main road stage’, i.e. the stage which contains the associated three aspect traffic signal, even though the traffic controlled by that signal moves in both stages.

Consider the following example:



Stage 1 allows the traffic from the north and south to flow while stage 2 allows the heavier traffic from the north to also turn right unopposed by the other traffic.

When the pedestrian phase G has finished its minimum green period in stage 2, it can be terminated and the left-turn green filter arrow F can be given right of way. If there were no demand for the pedestrian phase G, special conditioning would prevent stage 2 and the controller would move to stage 3 instead.

When the flows on phases A and B finish, the east and west traffic is allowed to flow and the left-turn green filter arrow is switched off when its associated three aspect traffic signal phase E appears at green.

If the traffic on phases A and B finishes before the pedestrian phase G has run its minimum green time, the controller would move directly from stage 2 to stage 4 when phase G’s minimum green time expires and the green filter arrow would not appear.

Ripple changing helps this junction as it allows the controller to start to move to stage 3 when phase G finishes, but if a gap appears on phases A and B, the controller can decide to move to stage 4 instead.

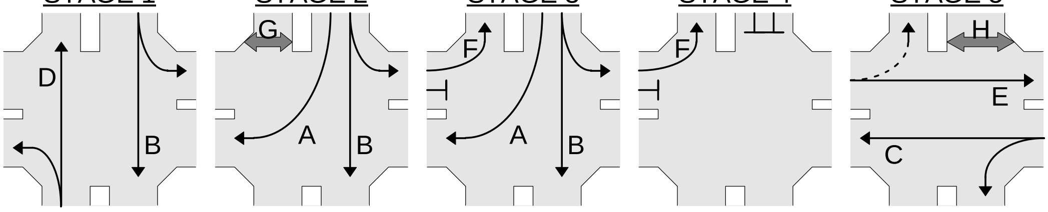
However, since phase F does not actually appear in stage 4, the controller would refuse to ripple change to stage 4. Instead, it would wait until phase F appears before it would consider moving to stage 4 and terminating phases A and B.

Put another way, once the controller has decided to go to stage 3, phases A and B cannot be terminated until phase F appears, therefore delaying the appearance of phases C and E.

Note that the minimum green time for such a filter arrow is normally set to zero so that it does hold the controller in stage 3. The phase automatically remains at green for several seconds since it is not extinguished when stage 3 terminates, but when its associated phase gains right of way. Also note that phase F should be configured as fixed in stage 3 to ensure that at least one fixed phase gains right of way on that move. Therefore the controller will always wait for phase F to appear even if the demand for it and stage 3 was removed.

One way round the problem is to allow the left-turn green filter arrow phase F to appear with phase E in stage 4, i.e. so it does not terminate when phase E appears at green. However, this may mean that this green arrow at this particular junction does not operate the same as other green arrows at other junctions and thus may confuse the drivers.

The alternative is to add an intermediate stage to which the controller can ripple change during the move from stage 2 to stage 3, so allowing it to terminate phases A and B before phase F has actually appeared. Once phase F has appeared, the controller can move to stage 5, bringing on phases C and E when any inter-green times from A and B have expired.



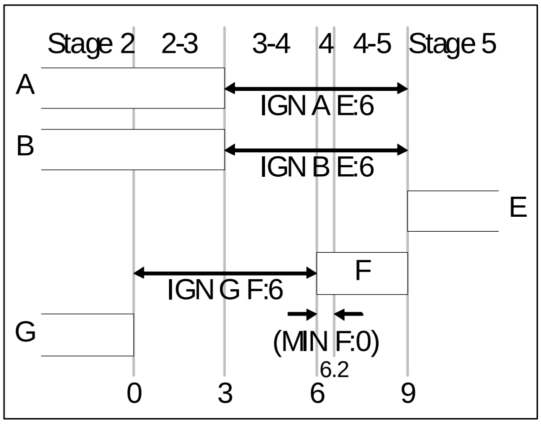
The following special conditioning generates the unlatched demands for the left-turn green-arrow filter (phase F) and the intermediate stage (stage 4):

```
;in VA mode prevent stage 2 unless there is a demand for the ped
(MODE0 EQL <2>).NOT(LCPHG+UCPHG) = PRVST2

;when in stage 2 with A or B extending, demand stage 3 to switch off the
;ped and bring on the filter if there is a demand for main road phase E
STAGE2.(EXTAA+EXTAB).(LCPHE+UCPHE) = +UCST3

;if the controller is in or on the way to stage 3 and there is a demand
;for the main road (phase E) then demand the green arrow phase so it
;appears in stage 3 and also demand stage 4 to allow the controller to
;ripple change.
(NXTSTG0 EQL <3>).(LCPHE+UCPHE) := +UCPHF
                                *= +UCST4
```

The example below shows what happens if a gap appears on phases A and B three seconds after phase G terminates and the controller started to move from stage 2 to stage 3.



- Time 0:Phase G's minimum expires while A or B is still busy and so the move to stage 3 is started.
- Time 3:A gap appears on A and B so the controller can terminate phases A and B and ripple change to stage 4 instead.
- Time 6:When the inter-green from phase G expires, phase F appears and the controller is in stage 4.
- Time 6.2: 200ms later phase F is no longer running its minimum green time and so the controller can move to stage 5. However, since phase F is configured as a filter green-arrow, it remains at green until its associated phase (E) appears at green,
- Time 9:Phase E appears when the inter-greens from phases A and B terminate.

Since phase F is configured as a left-turn green filter arrow, it remains at green until its associated phase, i.e. phase E, appears at green even though its minimum green time is set to zero and stage 4 finished several seconds earlier.

This move has allowed the controller to:

- Terminate the pedestrian phase G when its minimum green time expires, allowing the left-turn green filter arrow on as soon as possible.

While still allowing the controller to:

- Terminate phases A and B when a gap appears to allow the main green of phase E (as well as phases C and H) to appear as soon as possible.

46 SELF TEST

46.1 Introduction

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

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

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

A 20 character by 4 line handset connected displays information about the checks it is performing, such as the firmware issue and the lamp supply voltage, both dim and bright, and details any faults found.

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

Self-Test performs the checks detailed on the following pages and reports error messages if faults have been detected. The error messages, with their possible causes and any recommended course of action, are included in the appropriate Installation, Commissioning and Maintenance handbook for the specific controller, e.g. 667/HE/45950/000 for the ST950ELV controller.

46.2 Structure of Self Test

Self Test comprises several parts:

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

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

3. Test of non traffic signal aspects of the system. Run when self test initiated by powering up the controller with the level 3 access button pressed and tests can also be run at other times using the Tester web page. The tests run are configurable as described in section 46.6.

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

46.3 Manual Panel

While the Self-Test is running, the Manual Panel can be checked. Pressing each button on the panel should illuminate the button’s associated LED while the button is pressed, except that the ‘Lamp Test’ button illuminates all the LEDs on the Manual Panel.

To test the Signals ON/Off Switch and the Cabinet Alarm Indicator, switching the switch to the signals ‘ON’ position illuminates the cabinet alarm. Switching it to the ‘off’ position extinguishes the cabinet alarm. The Signals On/Off Switch does not affect the Self-Test in any other way. In fact, the Signals On/Off Switch and Manual Panel do not need to be fitted to perform the Self-Test.

46.4 ELV Self Test

46.4.1 ELV Self-Test Part 1

Part 1 of the ELV Controller Self-Test facility performs tests with the lamp supply turned off as described in section 46.2. The following shows example information output by Self Test during Part 1, and summarises the tests it performs:

```
Controller SelfTest
===================
Q: Pause Display
After 4 Lines? [YN]
PRI:46020 1,4
SEC CPU......Active
LSLS Cards...---321
3 LSLS Cards
VLS 1:32941 7,4
HW:667/1/11111/000
   ISS 99
   DOM 2012/08/11
VLS 2:32941 7,4
HW:667/1/11111/000
   ISS 99
   DOM 2012/08/11
VLS 3:32941 7,2
No Inventory Data
VLS 4:-
VLS 5:-
VLS 6:-
PHP CPU......None
Ok, ELV Controller
Waiting for EFC...
EFC started...
EFC in control...
(See section 46.6)
...
ZXO From.....SEC
Mains Freq...50.0Hz
SEC CPU......Active
P/Bus Init...Ok
L/Supply Off=0V
V/Mons Off...Passed
...
All Cards Working?
```

Step 1 Complete, Start Step 2:

At this point, the Self-Test has successfully checked-out the logic side of all the LSLS cards that it has found. It then displays a scrolling pattern on the amber LEDs on these

LSLS cards to prove that it can address all the cards correctly and to show that the first part of the Self-Test is complete.

46.4.2 ELV Self-Test Part 2

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

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

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

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

Part Two of the ELV Controller Self-Test facility performs tests with the lamp supply turned on as described in section 46.2. The following shows example information output by Self Test during Part 2, and summarises the tests it performs:

```
All Cards Working?

**** IMPORTANT ****
All LED Signals to
be covered before
continuing...

Starting Pass 0001
V/Mons Off...Passed
Lamp Supply..51V
M/V Test.....Passed
Dim L/Supply=28V
HPU Relays switch
off LSLS cards:
A:All LSLS Off
B:All LSLS Off
Controller Set-Up:
'Fail To Black-Out'
LSLS Outputs:1-10
Relay A-PRI..Ok
LSLS Outputs:11-20
Relay B-SEC..Ok
LSLS Outputs:21-32
LSLS Outputs:Passed
SEC Working
===================
Pass 0001 Complete.
===================
Run Time = 00:xx:xx
...
```

Regardless of whether the switch on the CPU card is set to ‘fail to black-out’ or ‘fail to flashing’, if the Controller set-up allows the ‘fail to flashing’ option then the controller flashes all of the outputs on LSLS#1 for five seconds to confirm that set-up.

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

After a few seconds, Self-Test repeats Part 2, allowing the controller to be soak-tested.

46.5 LV Self Test

46.5.1 Self-Test Part 1

Part One of the LV Controller Self-Test facility performs tests with the lamp supply turned off as described in section 46.2. The following shows example information output by Self Test during Part One, and summarises the tests it performs:

```
Controller SelfTest
===================
Q: Pause Display
After 4 Lines? [YN]
PRI:46020 1,4
SEC CPU......Active
LSLS Cards...------
No LSLS Cards Found
PHP CPU......Active
SIC:PB815 ISS 4
L/S Cards....--21
2 Eight Phase Cards
Ok, LV Controller
Waiting for EFC...
EFC started...
EFC in control...
(See section 46.6)
...
ZXO From.....PHP
Mains Freq...49.9Hz
ADC Tests....Passed
2.5V Reading: 4% HI
L/Supply Off=0V
V/Mons Off...Passed
P/Bus Init...Passed
M/V Test.....Passed
...
All Cards Working?
```

Step 1 Complete, Start Step 2:

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

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

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

This pattern remains until the operator presses the level 3 button to confirm that the pattern is scrolling correctly on all the cards fitted. After the level 3 button is pressed, Self-Test switches ON the lamp supply and continues its tests.

46.5.2 LV Self-Test Part 2

Caution	It is essential that the correct number of Lamp Switch cards have been detected at this point as following this, the Self-Test starts applying mains to the signals.

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

After the level 3 button is pressed, Self-Test switches on the lamp supply.

Towards the end of this second sequence of tests, it tests all the TRIACs by switching each one on in turn for a very short period.

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

WARNING	If in doubt, all non-HI signal heads, i.e. 240V lamp LED signals, should be covered before proceeding any further with the Self-Test.

Part Two of the LV Controller Self-Test facility performs tests with the lamp supply turned on as described in section 46.2. The following shows a typical information output by Self Test during Part Two, and summarises the tests it performs:

```
All Cards Working?

**** IMPORTANT ****
All LED Signals to
be covered before
continuing...

Starting Pass 0001
V/Mons Off...Passed
Lamp Supply..240V
SSR Off Test=3V
Dim L/Supply=163V
Triac Tests..Reds
Relay A-PRI..0V
Triac Tests..Ambers
Relay B-SEC..0V
Triac Tests..Greens
Relay B-PHP..0V
Triac Tests..Passed
Checking Lamp
Supply Arrangement:
RelayB:All Sigs Off
RelayA:All Sigs Off
Controller Set-Up:
'Fail To Black-Out'
===================
Pass 0001 Complete.
===================
Run Time = 00:xx:xx
...
```

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

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

After a few seconds, Self-Test repeats Part 2, allowing the controller to be soak-tested.

46.6 Self Test Part 3

The testing performed during this phase of the Controller Self-Test is configurable and may include any combination of the tests described in the following table.

Test ID	Test Name	Test Description
MassStorage	Heart	Checks for a Heart and whether it can be accessed
RemovableDrive	USB Drive	Checks for a USB drive and whether it can be accessed
LicenceReader	Licence Reader	Checks the on board licence card reader
LicenceCard	Licence Card	Checks the licence card in the on board reader
USBCardReader	USB Card Reader	Checks for an external USB card reader
USBLicenceCard	USB Reader Licence	Checks the licence card in an external USB card reader
LicenceInventory	Licence Inventory	Reads and logs the installed licences
SmartCardInventory	SmartCard Inventory	Reads and logs the Smartcard Inventory
eth0Ping	Ethernet eth0 Ping	Pings devices on Ethernet eth0 link
NetworkInventory	Network Inventory	Reads and logs the network inventory
PcPing	PC Ping	Test network connection to PC connected to the USB handset port.
modemTxRx	Modem TX/RX	Performs TX/RX loopback test on the modem port (requires external connection of TX & RX)
modemDtrCts	Modem DTR/CTS	Performs DTR/CTS loopback test on the modem port (requires external connection of DTR & CTC)
modemRtsDsr	Modem RTS/DSR	Performs RTS/DSR loopback test on the modem port (requires external connection of RTS & DSR)
modemDtrRi	Modem DTR/RI	Performs DTR/RI loopback test on the modem port (requires external connection of DTR & RI)
aux3TxRx	Aux3 TX/RX	Performs TX/RX loopback test on the aux3 port (requires external connection of TX & RX)
aux3DtrCts	Aux3 DTR/CTS	Performs DTR/CTS loopback test on the aux3 port (requires external connection of DTR & CTS)
aux3RtsDsr	Aux3 RTS/DSR	Performs RTS/DSR loopback test on the aux3 port (requires external connection of RTS & DSR)

Test ID	Test Name	Test Description
SystemVersion	System Version	Checks that the system version data can be accessed
modemPowerOn	Modem Power On	Turns on the modem power
modemPowerOff	Modem Power Off	Turns off the modem power
modemPowerOnOff	Modem Power On / Off	Turns the modem power on then off
GSPITester	GSPI	Reads and logs the GSPI Inventory
cabinetAlarmOn	Cabinet Alarm On	Turns on the cabinet alarm output. Note: this test does not operate if the controller is in self test mode.
cabinetAlarmOff	Cabinet Alarm Off	Turns off the cabinet alarm output. Note: this test does not operate if the controller is in self test mode.
cabinetAlarmOnOff	Cabinet Alarm On / Off	Turns the cabinet alarm output on then off. Note: this test does not operate if the controller is in self test mode.
doorOpen	Door Open	Checks that the door is reported as open. Note: this test does not operate if the controller is in self test mode.
doorClosed	Door Closed	Checks that the door is reported as closed. Note: this test does not operate if the controller is in self test mode.
doorLoopBack	Cabinet Alarm / Door Loop Back	Controls the door state using the cabinet alarm signal. Requires Cabinet Alarm LED Drive - output to be connected to Door Switch input. Note: this test does not operate if the controller is in self test mode. (requires external connection of cabinet alarm & door input)
rflActive	Reset Fault Log Active	Checks that the state of the Reset Fault Log button is reported as active.
rflInactive	Reset Fault Log Inactive	Checks that the state of the Reset Fault Log button is reported as inactive.
rflLoopBack	Cabinet Alarm / Reset Fault Log Loop Back	Controls the Reset Fault Log button state using the cabinet alarm signal. Requires Cabinet Alarm LED Drive - output to be connected to Reset Fault Log button input. Note: this test does not operate if the controller is in self test mode. (requires external connection of cabinet alarm & reset fault log input)

Test ID	Test Name	Test Description
Primary	Primary	Logs the Primary's Inventory and tests the link.
Secondary	SEC	Logs the Secondary's Inventory and tests the link.
FF	Fail Flash	Logs the FF Inventory and tests the link.

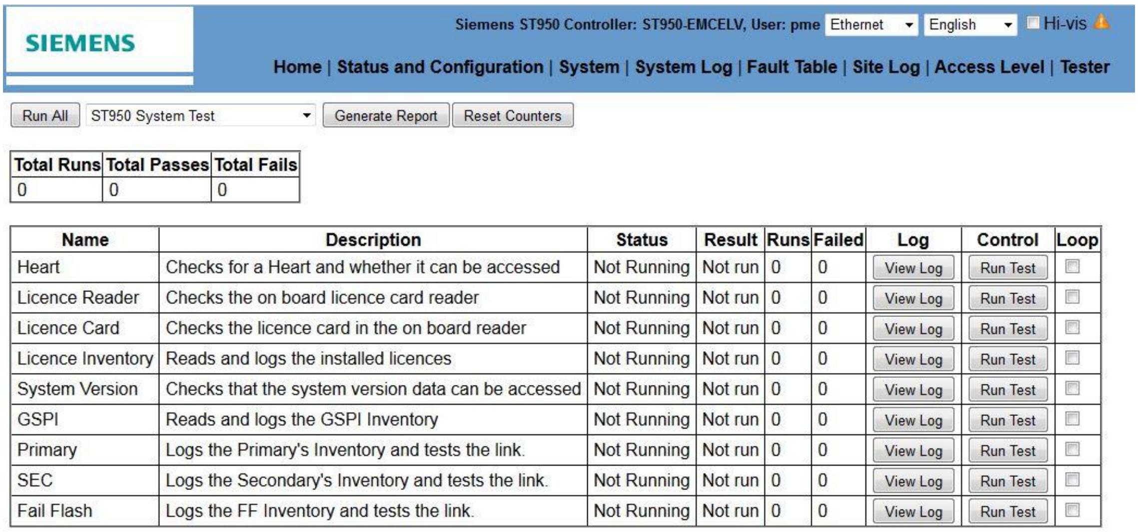
Table 13 - Self Test Part 3 Tests

46.6.1 Test Scenarios

The tests run in this phase depend on the scenario selected by the user, or the default scenario if the user makes no selection. The following scenarios are defined by the controller.

ST950 System Test

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



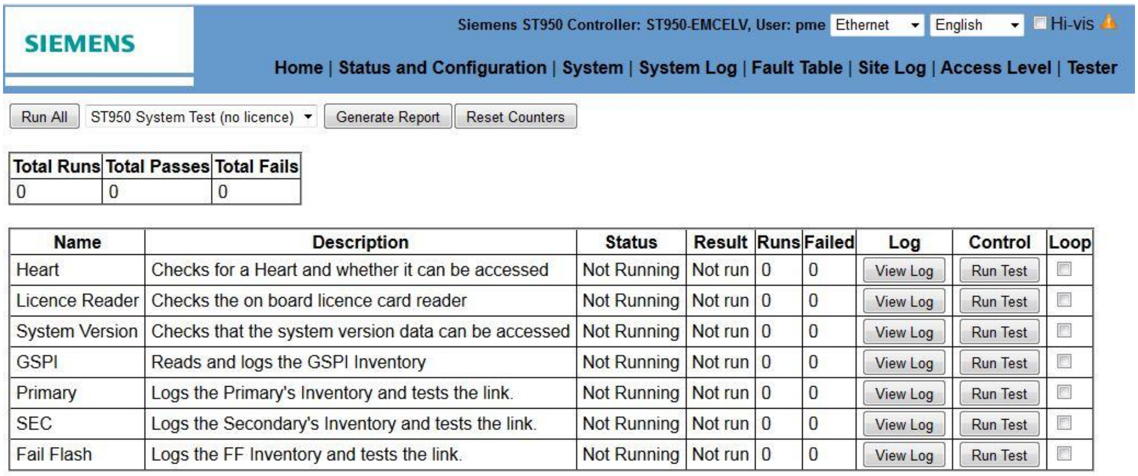
Total Runs	Total Passes	Total Fails
0	0	0

Name	Description	Status	Result	Runs	Failed	Log	Control	Loop
Heart	Checks for a Heart and whether it can be accessed	Not Running	Not run	0	0	View Log	Run Test	
Licence Reader	Checks the on board licence card reader	Not Running	Not run	0	0	View Log	Run Test	
Licence Card	Checks the licence card in the on board reader	Not Running	Not run	0	0	View Log	Run Test	
Licence Inventory	Reads and logs the installed licences	Not Running	Not run	0	0	View Log	Run Test	
System Version	Checks that the system version data can be accessed	Not Running	Not run	0	0	View Log	Run Test	
GSPI	Reads and logs the GSPI Inventory	Not Running	Not run	0	0	View Log	Run Test	
Primary	Logs the Primary's Inventory and tests the link.	Not Running	Not run	0	0	View Log	Run Test	
SEC	Logs the Secondary's Inventory and tests the link.	Not Running	Not run	0	0	View Log	Run Test	
Fail Flash	Logs the FF Inventory and tests the link.	Not Running	Not run	0	0	View Log	Run Test	

Figure 116 - ST950 System Test Scenario

ST950 System Test (no licence)

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



Total Runs	Total Passes	Total Fails
0	0	0

Name	Description	Status	Result	Runs	Failed	Log	Control	Loop
Heart	Checks for a Heart and whether it can be accessed	Not Running	Not run	0	0	View Log	Run Test	
Licence Reader	Checks the on board licence card reader	Not Running	Not run	0	0	View Log	Run Test	
System Version	Checks that the system version data can be accessed	Not Running	Not run	0	0	View Log	Run Test	
GSPI	Reads and logs the GSPI Inventory	Not Running	Not run	0	0	View Log	Run Test	
Primary	Logs the Primary's Inventory and tests the link.	Not Running	Not run	0	0	View Log	Run Test	
SEC	Logs the Secondary's Inventory and tests the link.	Not Running	Not run	0	0	View Log	Run Test	
Fail Flash	Logs the FF Inventory and tests the link.	Not Running	Not run	0	0	View Log	Run Test	

Figure 117 - ST950 System Test (no licence) Scenario

ST950 PCB Test

This scenario incorporates tests to more fully test the external interfaces of the ST950 CPU board. Special test connections such as loopbacks are required in order to support these tests. Without these external connections some test will fail.

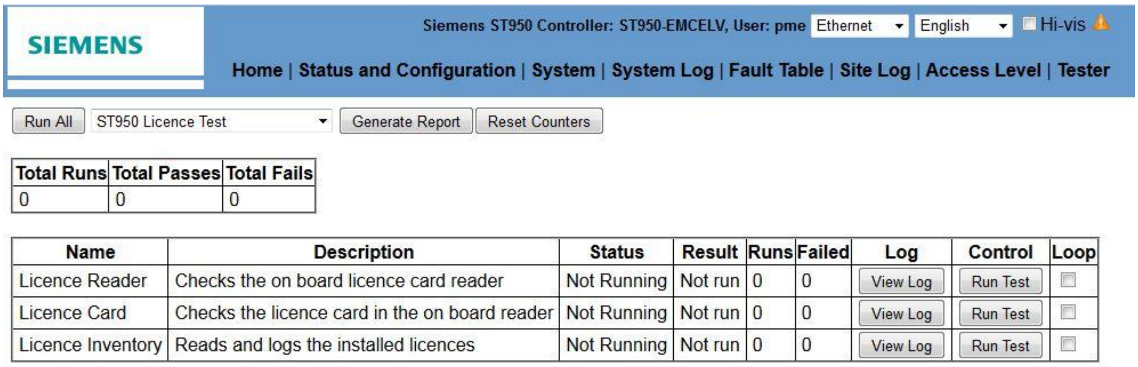
Total Runs	Total Passes	Total Fails
0	0	0

Name	Description	Status	Result	Runs	Failed	Log	Control	Loop
Heart	Checks for a Heart and whether it can be accessed	Not Running	Not run	0	0	View Log	Run Test	
USB Drive	Checks for a USB drive and whether it can be accessed	Not Running	Not run	0	0	View Log	Run Test	
Licence Reader	Checks the on board licence card reader	Not Running	Not run	0	0	View Log	Run Test	
Licence Card	Checks the licence card in the on board reader	Not Running	Not run	0	0	View Log	Run Test	
USB Card Reader	Checks for an external USB card reader	Not Running	Not run	0	0	View Log	Run Test	
USB Reader Licence	Checks the licence card in an external USB card reader	Not Running	Not run	0	0	View Log	Run Test	
Licence Inventory	Reads and logs the installed licences	Not Running	Not run	0	0	View Log	Run Test	
Ethernet eth0 Ping	Pings devices on Ethernet eth0 link	Not Running	Not run	0	0	View Log	Run Test	
Network Inventory	Reads and logs the network inventory.	Not Running	Not run	0	0	View Log	Run Test	
PC Ping	Test network connection to PC connected to the USB handset port.	Not Running	Not run	0	0	View Log	Run Test	
Modem TX/RX	Performs TX/RX loopback test on the modem port	Not Running	Not run	0	0	View Log	Run Test	
Modem DTR/CTS	Performs DTR/CTS loopback test on the modem port	Not Running	Not run	0	0	View Log	Run Test	
Modem RTS/DSR	Performs RTS/DSR loopback test on the modem port	Not Running	Not run	0	0	View Log	Run Test	
Modem DTR/RI	Performs DTR/RI loopback test on the modem port	Not Running	Not run	0	0	View Log	Run Test	
Aux3 TX/RX	Performs TX/RX loopback test on the aux3 port	Not Running	Not run	0	0	View Log	Run Test	
Aux3 DTR/CTS	Performs DTR/CTS loopback test on the aux3 port	Not Running	Not run	0	0	View Log	Run Test	
Aux3 RTS/DSR	Performs RTS/DSR loopback test on the aux3 port	Not Running	Not run	0	0	View Log	Run Test	
System Version	Checks that the system version data can be accessed	Not Running	Not run	0	0	View Log	Run Test	
Modem Power On / Off	Turns the modem power on then off	Not Running	Not run	0	0	View Log	Run Test	
GSPI	Reads and logs the GSPI Inventory	Not Running	Not run	0	0	View Log	Run Test	
Cabinet Alarm / Door Loop Back	Controls the door state using the cabinet alarm signal. Requires Cabinet Alarm LED Drive - output to be connected to Door Switch input. Note: this test does not operate if the controller is in self test mode.	Not Running	Not run	0	0	View Log	Run Test	
Cabinet Alarm / Reset Fault Log Loop Back	Controls the Reset Fault Log button state using the cabinet alarm signal. Requires Cabinet Alarm LED Drive - output to be connected to Reset Fault Log button input. Note: this test does not operate if the controller is in self test mode.	Not Running	Not run	0	0	View Log	Run Test	
Primary	Logs the Primary's Inventory and tests the link.	Not Running	Not run	0	0	View Log	Run Test	
SEC	Logs the Secondary's Inventory and tests the link.	Not Running	Not run	0	0	View Log	Run Test	
Fail Flash	Logs the FF Inventory and tests the link.	Not Running	Not run	0	0	View Log	Run Test	

Figure 118 - ST950 PCB Test Scenario

ST950 Licence Test

This scenario tests the on-board licence card.



Total Runs	Total Passes	Total Fails
0	0	0

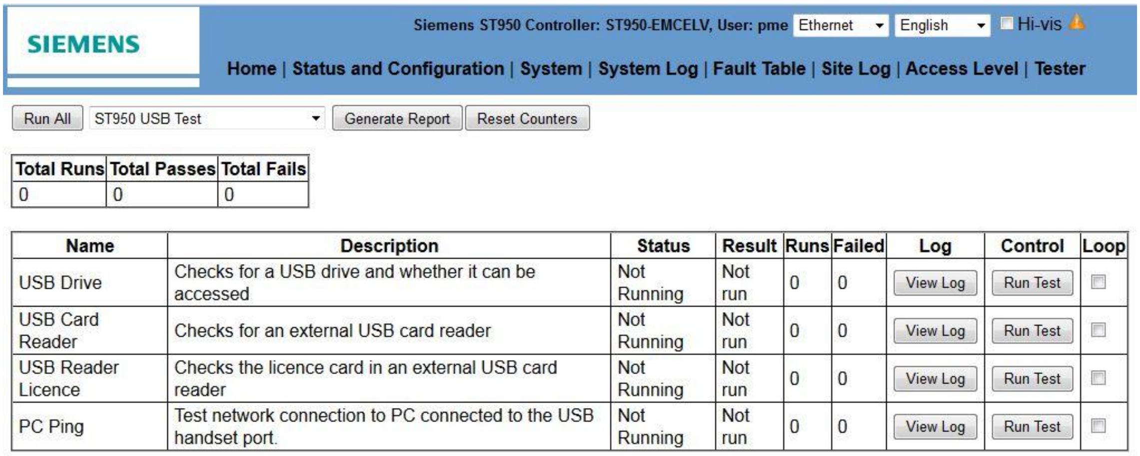
Name	Description	Status	Result	Runs	Failed	Log	Control	Loop
Licence Reader	Checks the on board licence card reader	Not Running	Not run	0	0	View Log	Run Test	
Licence Card	Checks the licence card in the on board reader	Not Running	Not run	0	0	View Log	Run Test	
Licence Inventory	Reads and logs the installed licences	Not Running	Not run	0	0	View Log	Run Test	

Figure 119 - ST950 Licence Test Scenario

ST950 USB Test

This scenario tests the USB connections. It requires the following external connections without which the related test(s) will fail:

- USB memory stick
- USB smart card reader with licence card fitted
- PC connected to USB handset port



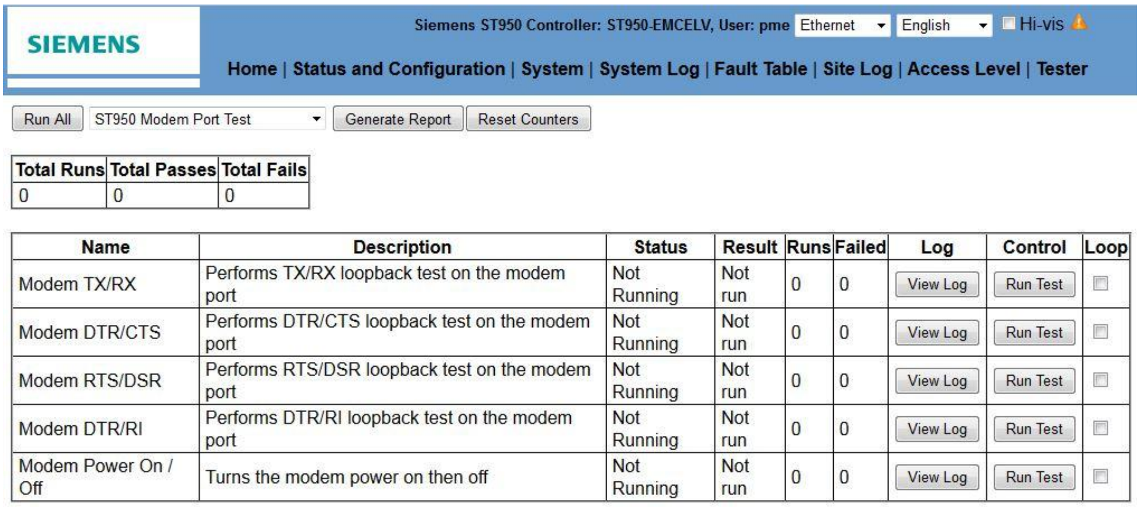
Total Runs	Total Passes	Total Fails
0	0	0

Name	Description	Status	Result	Runs	Failed	Log	Control	Loop
USB Drive	Checks for a USB drive and whether it can be accessed	Not Running	Not run	0	0	View Log	Run Test	
USB Card Reader	Checks for an external USB card reader	Not Running	Not run	0	0	View Log	Run Test	
USB Reader Licence	Checks the licence card in an external USB card reader	Not Running	Not run	0	0	View Log	Run Test	
PC Ping	Test network connection to PC connected to the USB handset port.	Not Running	Not run	0	0	View Log	Run Test	

Figure 120 - ST950 USB Test Scenario

ST950 Modem Port Test

This scenario tests the modem port and requires loopback connections between the data TX & RX, the DTR & CTS signals, the RTS & DSR signals and the DTR & RI signals. Some means of detecting when the modem power is turned on is also recommended so that its operation can be verified through observation.



SIEMENS

Siemens ST950 Controller: ST950-EMCELV, User: pme Ethernet English Hi-vis

Home | Status and Configuration | System | System Log | Fault Table | Site Log | Access Level | Tester

Run All | ST950 Modem Port Test | Generate Report | Reset Counters

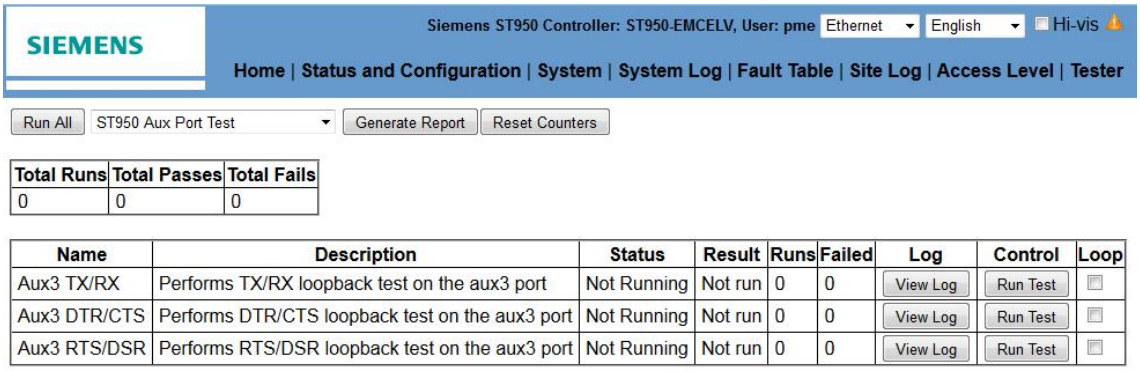
Total Runs	Total Passes	Total Fails
0	0	0

Name	Description	Status	Result	Runs	Failed	Log	Control	Loop
Modem TX/RX	Performs TX/RX loopback test on the modem port	Not Running	Not run	0	0	View Log	Run Test	
Modem DTR/CTS	Performs DTR/CTS loopback test on the modem port	Not Running	Not run	0	0	View Log	Run Test	
Modem RTS/DSR	Performs RTS/DSR loopback test on the modem port	Not Running	Not run	0	0	View Log	Run Test	
Modem DTR/RI	Performs DTR/RI loopback test on the modem port	Not Running	Not run	0	0	View Log	Run Test	
Modem Power On / Off	Turns the modem power on then off	Not Running	Not run	0	0	View Log	Run Test	

Figure 121 - ST950 Modem Port Test

ST950 Aux Port Test

This scenario tests the Aux port and requires loopback connections between the data TX & RX, the DTR & CTS signals and the RTS & DSR signals.



SIEMENS

Siemens ST950 Controller: ST950-EMCELV, User: pme Ethernet English Hi-vis

Home | Status and Configuration | System | System Log | Fault Table | Site Log | Access Level | Tester

Run All | ST950 Aux Port Test | Generate Report | Reset Counters

Total Runs	Total Passes	Total Fails
0	0	0

Name	Description	Status	Result	Runs	Failed	Log	Control	Loop
Aux3 TX/RX	Performs TX/RX loopback test on the aux3 port	Not Running	Not run	0	0	View Log	Run Test	
Aux3 DTR/CTS	Performs DTR/CTS loopback test on the aux3 port	Not Running	Not run	0	0	View Log	Run Test	
Aux3 RTS/DSR	Performs RTS/DSR loopback test on the aux3 port	Not Running	Not run	0	0	View Log	Run Test	

Figure 122 - ST950 Aux Port Test

46.6.2 Self Test Configuration

It is possible to configure Self Test using files on a USB memory stick. Turning on a controller with a stick containing such files fitted causes the configuration on the stick to be loaded into and used by the controller. This loaded configuration is discarded when the controller is next turned off.

User Defined Scenarios

In cases where one of the built in scenarios does not contain the group of tests desired, it is possible for the user to define one or more scenarios containing the exact mix of tests required. This is achieved by adding a file defining each scenario required to a directory named *testscenario* in the top level directory of a USB memory stick.

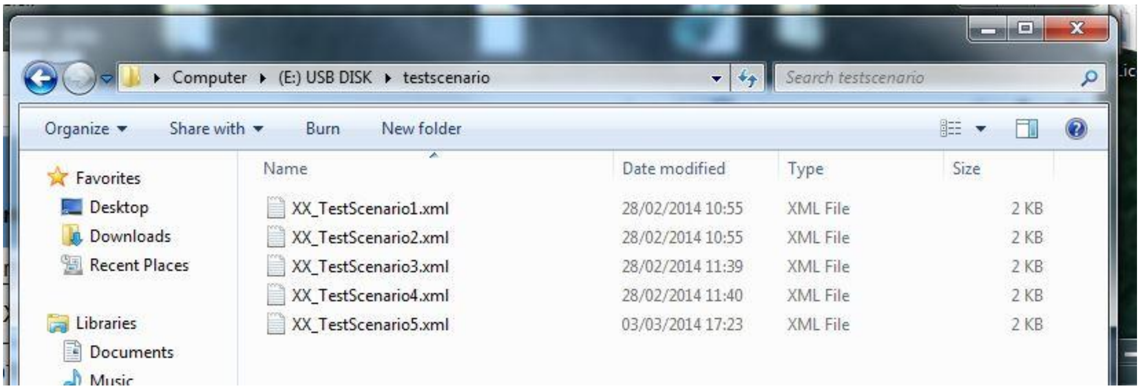


Figure 123 - Example contents of the testscenario directory

Each file in the *testscenario* directory defines a scenario using XML of the following form.

```
<testscenario id="testScenario1" name="Test Scenario 1">
  <test>SystemVersion</test>
  <test>Primary</test>
  <test>Secondary</test>
  <test>FF</test>
</testscenario>
```

Where the XML tags are used as follows:

- *testscenario* defines the scope and identity of the scenario. It has the following properties:
  - *id* – this is a unique id
  - *name* – this is the scenario name displayed to the user by the controller
- *test* defines the individual tests using the test IDs in Table 13

Test Configuration

The scenario used during this phase of the self test can be selected using the drop down menu at the top of the Tester web page. Alternatively it is possible to configure this and other items using a file named *gvp_config_default.xml* located in the top level directory of the USB memory stick. This file allows configuration of the following:

- The default scenario to use. This may be one of the built in scenarios or one defined in the *testscenario* directory.
- The configuration of the Ethernet port. This will be necessary when the Ethernet port has not been configured in the controller in the usual manner.
- The peer to ping during the Ethernet ping test.

The *gvp_config_default.xml* defines the values of these items in XML of the following form:

```
<cfgitems>
    <!-- Test Scenario -->
    <item name="tester/defaultscenario">
        <data>testScenario4</data>
    </item>

    <!-- Ethernet configuration -->
    <item name="network/eth0/mode">
        <data>1</data>
    </item>
    <item name="network/eth0/ipaddress">
        <data>172.16.30.88</data>
    </item>
    <item name="network/eth0/netmask">
        <data>255.255.255.0</data>
    </item>
    <item name="network/eth0/broadcast">
        <data>0.0.0.255</data>
    </item>
    <item name="network/eth0/gateway">
        <data>172.16.30.1</data>
    </item>
    <item name="ethtest/eth0peer">
        <data>172.16.30.98</data>
    </item>
</cfgitems>
```


46.6.3 Monitoring

The progress of this phase of the self test can be monitored through the Tester web page or 25 way serial handset port. The results are also recorded in the System Log.

Tester Web Page – Results Summary

SIEMENS

Siemens ST950 Controller: ST950-EMCELV, User: pme | Ethernet | English | Hi-vis

Home | Status and Configuration | System | System Log | Fault Table | Site Log | Access Level | Tester

Run All | ST950 System Test | Generate Report | Reset Counters

Total Runs	Total Passes	Total Fails
27	27	0

Name	Description	Status	Result	Runs	Failed	Log	Control	Loop
Heart	Checks for a Heart and whether it can be accessed	Not Running	Run and passed	3	0	View Log	Run Test	
Licence Reader	Checks the on board licence card reader	Not Running	Run and passed	3	0	View Log	Run Test	
Licence Card	Checks the licence card in the on board reader	Not Running	Run and passed	3	0	View Log	Run Test	
Licence Inventory	Reads and logs the installed licences	Not Running	Run and passed	3	0	View Log	Run Test	
System Version	Checks that the system version data can be accessed	Not Running	Run and passed	3	0	View Log	Run Test	
GSPI	Reads and logs the GSPI Inventory	Not Running	Run and passed	3	0	View Log	Run Test	
Primary	Logs the Primary's Inventory and tests the link.	Not Running	Run and passed	3	0	View Log	Run Test	
SEC	Logs the Secondary's Inventory and tests the link.	Not Running	Run and passed	3	0	View Log	Run Test	
Fail Flash	Logs the FF Inventory and tests the link.	Not Running	Run and passed	3	0	View Log	Run Test	

Figure 124 - Self Test Stage 3 Results Summary

Tester Web Page – Test Log

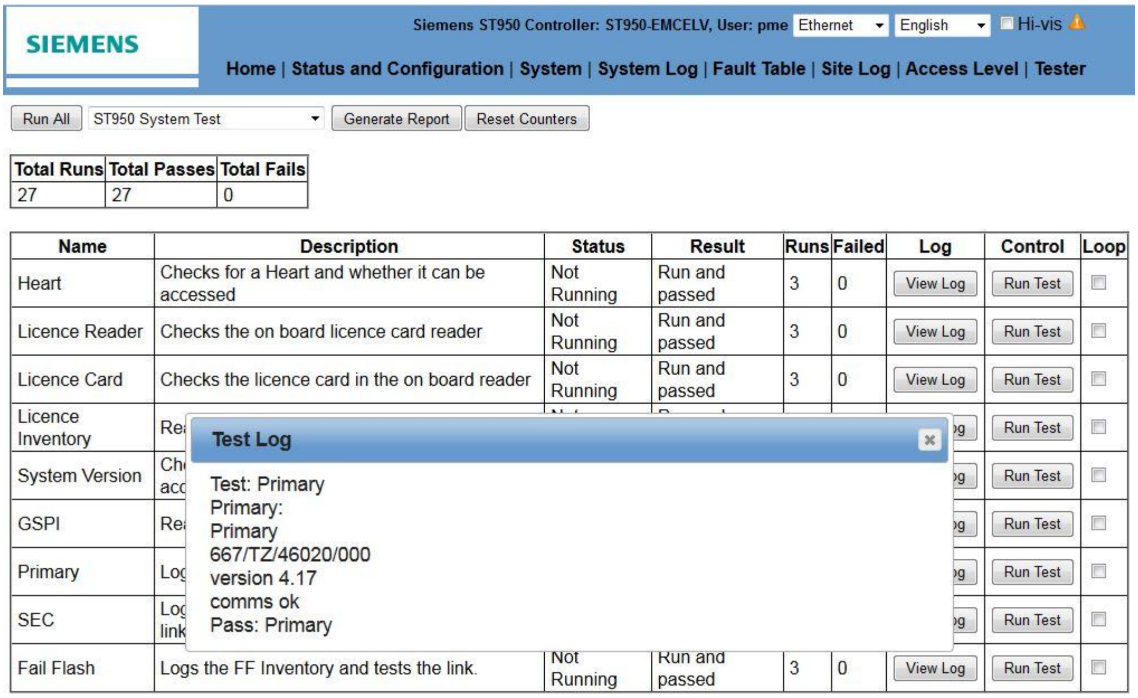


Figure 125 - Self Test Stage 3 Test Log

System Log

SIEMENS

Siemens ST950 Controller: ST950-EMCELV, User: pme Ethernet English Hi-vis

Home | Status and Configuration | System | System Log | Fault Table | Site Log | Access Level | Tester

System Log

This page was generated at (controller time) Wed 19 Mar 2014 10:01:08 GMT

Filter by Module: Filter by Severity Level: All

Number of Display Lines: 99 Newest at top of page Oldest at top of page Colour Redisplay

Oldest Older Newer Newest Export Log File

Page 32 of 32.

Date	Level	Module	Message
Wed 19 Mar 2014 09:51:39 GMT	Notice	TestCase	Pass: Licence Card
Wed 19 Mar 2014 09:51:39 GMT	Notice	TestCase	facility: 12
Wed 19 Mar 2014 09:51:39 GMT	Notice	TestCase	Licensed facilities:
Wed 19 Mar 2014 09:51:35 GMT	Notice	TestCase	73s8010c serial 00 00
Wed 19 Mar 2014 09:51:35 GMT	Notice	TestCase	Reader:
Wed 19 Mar 2014 09:51:35 GMT	Notice	TestCase	Test: Licence Card
Wed 19 Mar 2014 09:51:35 GMT	Notice	TestCase	Pass: Licence Reader
Wed 19 Mar 2014 09:51:35 GMT	Notice	TestCase	73s8010c serial 00 00
Wed 19 Mar 2014 09:51:35 GMT	Notice	TestCase	Reader:
Wed 19 Mar 2014 09:51:35 GMT	Notice	TestCase	Test: Licence Reader
Wed 19 Mar 2014 09:51:35 GMT	Notice	TestCase	Pass: Heart
Wed 19 Mar 2014 09:51:35 GMT	Notice	TestCase	data read OK
Wed 19 Mar 2014 09:51:35 GMT	Notice	TestCase	data write OK
Wed 19 Mar 2014 09:51:29 GMT	Notice	TestCase	Heart:
Wed 19 Mar 2014 09:51:29 GMT	Notice	TestCase	Test: Heart
Wed 19 Mar 2014 09:51:29 GMT	Notice	TestCase	Pass: Fail Flash
Wed 19 Mar 2014 09:51:29 GMT	Notice	TestCase	comms ok
Wed 19 Mar 2014 09:51:28 GMT	Notice	TestCase	version 1.0
Wed 19 Mar 2014 09:51:28 GMT	Notice	TestCase	667/TZ/46041/000
Wed 19 Mar 2014 09:51:28 GMT	Notice	TestCase	Fail Flash
Wed 19 Mar 2014 09:51:28 GMT	Notice	TestCase	Fail Flash:

Figure 126 – Self Test Stage 3 System Log

Handset – Initial

```
...
PRI INV done
EFC INV start
Test: System
Version
System Version:
File system
667/TZ/46059/000
Siemens ST950
Controller
vers: 1.3
Platform
linuxEFC
Hardware
667/1/46010/001,C,2
012/09/06,ST950 CPU
Card
SN: 09162092
```

```
Mac Address:
00:30:E6:FE:14:57
Pass: System
Version
Test: Primary
Primary:
Primary
667/TZ/46020/000
version 1.4
comms ok
Pass: Primary
Test: SEC
SEC:
SEC
667/TZ/46040/000
version 1.0
comms ok
Pass: SEC
Test: Fail Flash
Fail Flash:
Fail Flash
667/TZ/46041/000
version 1.0
comms ok
Pass: Fail Flash
Test: GSPI
GSPI Inventory
GSPI:1 HW:
Prt:667/1/47221/000
Iss:2
Serial:09229035
Wimag Std IF Card
GSPI:1 FW:
Prt:45350
Iss:0.0.3.134
GSPI:1 HWID: 4
24in 8out
link OK
Pass: GSPI
Test: Ethernet Ping
Ping:
i/f OK
172.16.100.254 OK
Pass: Ethernet Ping
Test: PcPing
USB PC:
172.29.100.10 XX
Fail: PcPing
Test: Licence Rdr
```

```
Licence Card:
73s8010c serial 00
00
Pass: Licence Rdr
Test: Licence Card
Licence Card:
73s8010c serial 00
00
facility: 6
facility: 7
facility: 8
facility: 9
facility: 10
Pass: Licence Card
Test: USB Card
Reader
USB Card Readers:
No USB Card Readers
Fail: USB Card
Reader
Test: Heart
Heart:
data write OK
data read OK
Pass: Heart
Test: USB Drive
USB Drive:
cannot mount
Fail: USB Drive
Test: Modem
Modem:
loopback:
TXD-RXD not conn
DTR-CTS not conn
DTR-RI not conn
RTS-DSR not conn
Fail: Modem
Test: Aux3
Aux3:
loopback:
TXD-RXD not conn
DTR-CTS not conn
RTS-DSR not conn
Fail: Aux3
EFC INV done
...
```

Handset - Soak

```
…
PRI SOAK1 done
PRI SOAK start
EFC SOAK start
PRI SOAK (1) done
System Version:PASS
Primary:PASS
SEC:PASS
Fail Flash:PASS
GSPI:PASS
Ethernet Ping:PASS
PcPing:PASS
Licence Rdr:PASS
Licence Card:PASS
Heart:PASS
EFC SOAK (0) done
System Version:PASS
Primary:PASS
SEC:PASS
Fail Flash:PASS
GSPI:PASS
Ethernet Ping:PASS
PcPing:PASS
PRI SOAK (2) done
Licence Rdr:PASS
Licence Card:PASS
Heart:PASS
EFC SOAK (1) done
...
```

47 Outstation Support Server

The Outstation Support Server (OSS) provides centralised monitoring and management of controllers and other types of outstation. Installation, licensing, maintenance and use are fully described in 667/HB/31760/100 (Outstation Support Server Handbook).

Controller specific aspects on the OSS are described here.

47.1 Configuring Controller to use OSS

A controller needs the following items to be configured in order for it to be able to connect to and use an OSS:

- Unique Site Name - this name must be unique among all the outstations registered with an OSS.
- OSS Address

Interaction with an OSS is enabled and disabled using the following item:

- Enable OSS Interface

Backup of the system (not IC4) configuration is enabled and disabled using the following item:

- Enable OSS Backup

This configuration can be performed using either the web or WIZ interface.

47.1.1 Configuring Controller to use OSS using the Web Interface

The items can be set through the appropriate comms web page.

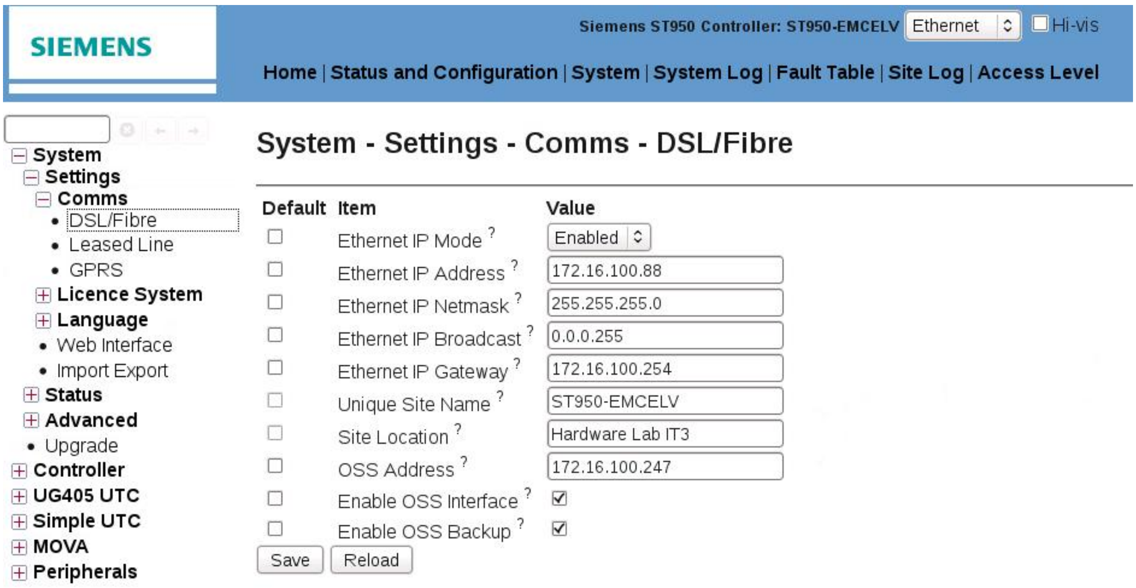


Figure 127 OSS connection configuration items

47.1.2 Configuring Controller to use OSS using WIZ

The items can be set through WIZ by selecting the items shown in bold in the menus shown:

1> Config/Status
2> Active Faults
3> Tester
4+ System Log

1> Basic Config
2> Date and Time
3> Inventory
4> Status

1> Eth IP Mode
2> Eth IP Address
3> Eth IP Netmask
4**+** Eth IP Broadcast

1- Eth IP Gateway
2> Site Name
3> OSS Address
4+ Enable OSS

1- Enable OSS backu

47.2 Updating Firmware from OSS

The OSS can be selected as the update source when updating the firmware in the controller.

47.2.1 Updating Firmware from OSS using Web Pages

When using the web interface, the System - Upgrade web page shows the applicable packages available at the OSS. This list will be empty when there are no updates available. To initiate an update, press the *Use* button next to the desired package. The update proceeds as described in the Firmware Update section.

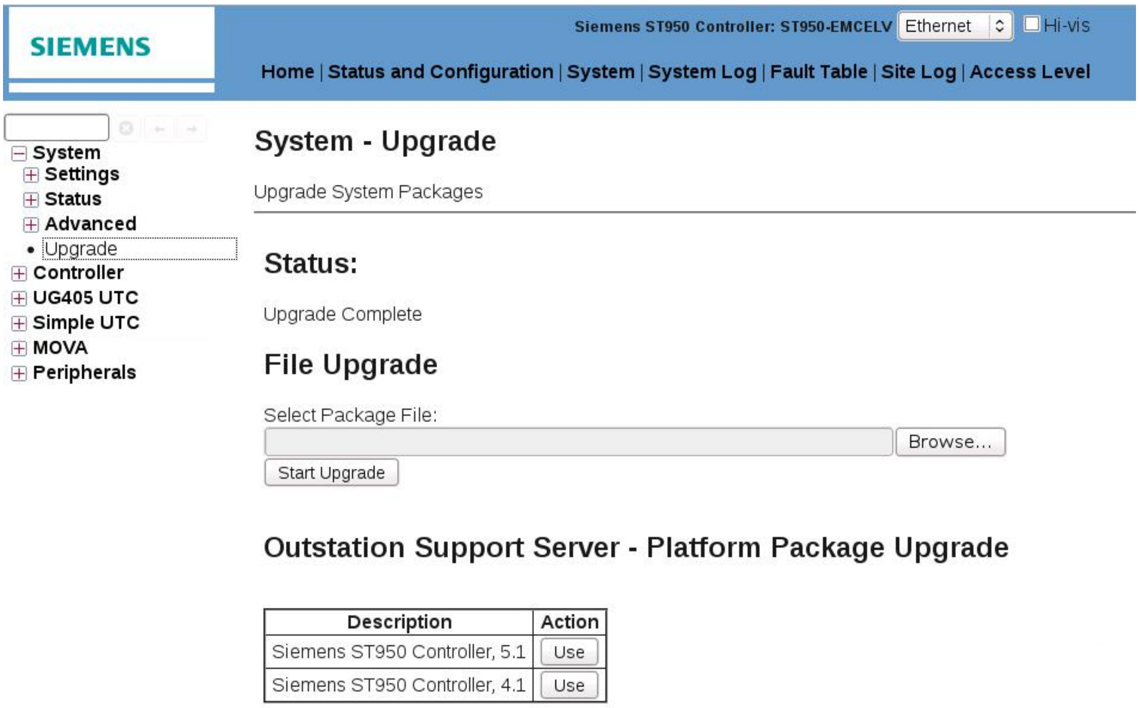


Figure 128 Update packages available from OSS

47.2.2 Updating Firmware from OSS using WIZ

Only the latest package can be used when using WIZ. The update is initiated as follows (selected options shown in bold font) and proceeds as described in the Firmware Update section.

1> Config/Status
2> Active Faults
3> Tester
4**+** System Log

1- Load Sys Config
2> Save Log
3> Save Site Info
4**+** Fetch Sys Config

1- Upgrade
2> Digital IO
3> Reboot
4+ TCPDump

1> OSS
2> USB Drive

47.3 Saving and Restoring System Configuration

If the *Enable OSS Backup* option is enabled, the system configuration is periodically saved to the OSS (this does not currently include the controller IC4 configuration).

47.3.1 Restoring System Configuration Using Web Pages

A saved system configuration may be restored by selecting the *Use* button associated with the desired configuration on the System - Settings - Import Export web page.

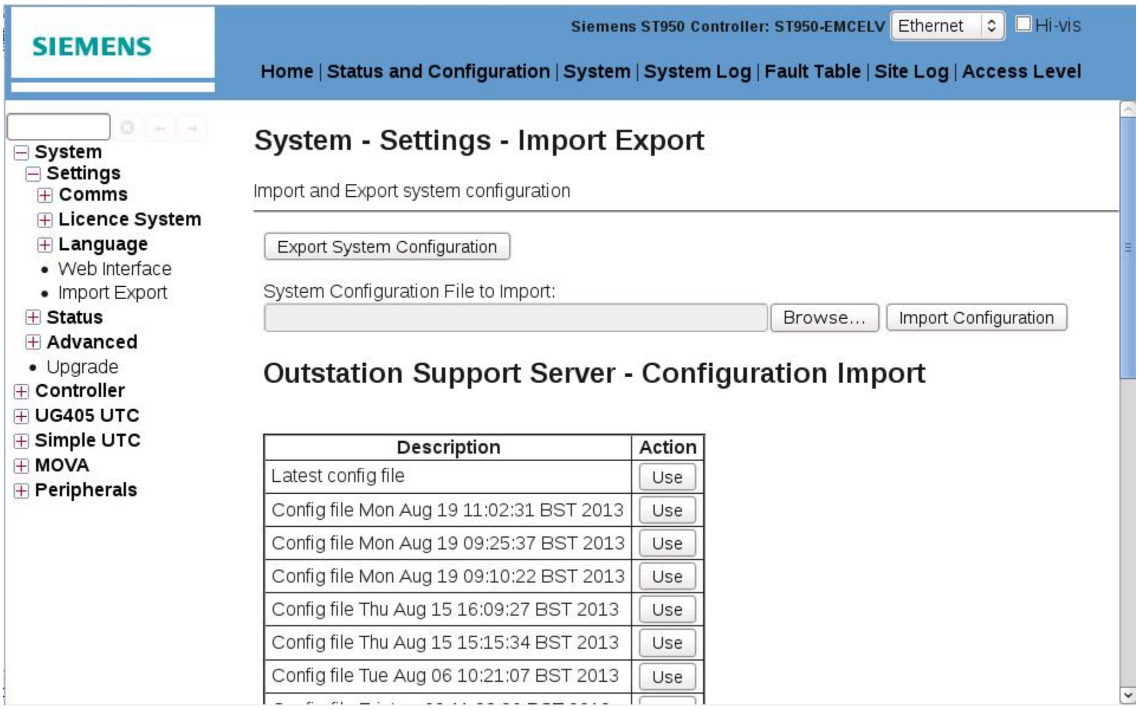


Figure 129 List of system configurations to restore

47.3.2 Restoring System Configuration Using WIZ

Only the latest system configuration can be restored when using WIZ. The restoration is performed as follows (selected options shown in bold font).

1> Config/Status
2> Active Faults
3> Tester
4**+** System Log

1- Load Sys Config
2> Save Log
3> Save Site Info
4+ Fetch Sys Config

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