

1. UTCS SPECIFICATION

The Traffic Signal Controller provide solid-state lamp switching and a conflict monitoring facility will ensure that conflicting, dangerous or disallowed traffic signal displays are not shown.

The controller consists of a rack mounted controller logic module, housed in a painted steel cabinet, which provides a frame for termination to field cables.

1.1 General Specification

The controller will operate reliably in a temperature range of 0 and +55 degree Celsius external ambient temperature, and relative humidity to 95%, non-condensing.

1.2 Controller Firmware

The controller design is based on modern high performance microprocessor and all logical functions necessary external to the microprocessor are performed by solid-state device.

Timing functions are based on digital techniques implemented by the microprocessor system.

Site specific configuration data stored in FLASH memory (non-volatile device). The site-specific configuration data could either be entered at the site through a standard PC/AT keyboard or prepared on a PC based configuration platform and downloaded at the site.

When networked the site specific data could be downloaded from the remote computer over communication line.

None of the devices require battery backup when the controller is using a GPS for date and time update. All memory devices in the controller are non-volatile.

Data integrity will be verified during every power up and during each cycle change. A corruption will invoke the Watchdog.

1.3 Controller Functionality: Basic Facilities

The standard controller will allow expansion from 16 independent lamp outputs to a maximum of 64 lamp outputs. Each output is configurable to be either a vehicle phase, a filter green, indicative green or a pedestrian phase.

The filter green (right turning) is configurable to terminate with flashing or with a linked phase.

The indicative green (left turning) is configurable to show a continuous green or flashing green.

The pedestrian phase is configurable for either flashing red aspect or flashing green or black it out during pedestrian clearance.

Green-green conflict monitoring is available.

1.4 Phases-Appearance Criteria

Any phase is configurable in the site-specific data. Each phase will be displayed for a fixed or variable duration according to traffic flow or demand, in accordance with the data entered in the controller configuration FLASH.

The controller configuration FLASH will provide for filter green arrow for left turning traffic. The filter green left arrow could have associated vehicle phase and can be configured such that it will not terminate until right of way for the associated vehicle phase is granted. Where a filter green arrow phase is defined as having 3 aspects, it will not be possible for the phase to terminate from green to red without intermediate amber.

The controller configuration FLASH can provide for Flashing filter Amber Arrow for left turning traffic. The filter turn arrow may have an associated vehicle or pedestrian phase and can be configured such that it will not terminate until right of way for the associated vehicle or pedestrian phase is terminated.

1.5 Stage/Phase – Timing intervals

The controller configuration FLASH can provide comprehensive stage phase timing interval facilities compatible with the system design.

1.6 Stages/Signal Groups

The controller can provide a maximum of 32 stages, within which any combination of phase displays are permitted in any stage. Phases can be specified for simultaneous appearance within a stage, for appearance after a specified delay, or for early termination within a stage. It is also possible for phase displays to overlap a number of stages. Specified phases can also provide leaving Amber and All Red displays independent of the running stage.

Each stage is capable of conditional and alternative phase displays, as defined by condition table in the controller site-specific configuration data.

Complex phase/staging designs is possible with the appearance of phases in multiple stages being conditional on specified conditions at the junction, such as presence of particular demands, or the state of special control signals, etc.

1.6.1 Conditioning – Each stage is configurable to appear automatically or upon demand from specified detector inputs within the controller.

1.6.2 Sequence – In vehicle actuated mode, stages will appear as demanded. When all demands are present, stages will normally appear in cyclic order.

The controller will allow as a maximum of 32 different stage sequences, with the current sequence chosen according to prevailing conditions for that time of day.

The controller can provide facilities for a number of phase equipment's any or all of which may be either:

- i. Fully actuated by on street demands and extensions
- ii. Demand dependent (vehicle or pedestrian Phases) or

iii. Fixed time phases (vehicle or pedestrian Phases)

Each phase may provide control for one of the following:

- i. Vehicular movements
- ii. Pedestrian movements
- iii. Vehicular movements controlled by Green Arrow signals

Timers are allocated to phases. The timers can control the following timed periods of each phase but are not be limited to only these:

- i. Minimum green time
- ii. Extension time
- iii. Maximum green time

Vehicle detectors shall be associated with phases and may:

- i. Demand a phase
- ii. Extend a phase
- iii. Demand and extend a phase

1.7 Statutory Timing Periods

There is no starting Red/Amber interval.

The duration of the leaving amber intervals is configurable in the range 3 to 10 seconds and normally set to 3 seconds.

A flashing red pedestrian clearance display is provided, to terminate the right of way for pedestrian phases.

Phase Minimum Green is provided to prohibit a phase losing right of way until a minimum safety period has expired. It will not be possible to terminate prematurely any minimum period. At the commencement of a phase green, the minimum green period of that phase will start to time off immediately.

Minimum Green Expiry Period – A stage change may occur after the expiry of the last phase minimum green for a phase or phases which will lose right of way on a change to the next stage to be introduced, providing no extension requests exists for the terminating phases. Phase minimum's may still be running when the stage change occurs, providing the associated phases run in the new stage. The duration of the stage minimum green period will be determined by the expiry of the minimum periods of the phases, which will lose right of way upon the change to the next stage.

Vehicle Phase Green Extensions – The passage of a vehicle over a detector loop as indicated by a detector unit which normally demands a phase may, during the green period of that phase, cause a green extension to be generated for that phase. The continued output from the detector associated with a phase shall hold that phase green signal; the cessation of the output from the loop detector shall

normally terminate the green extension requests after a fixed period – the extension time. If at the end of the extension time the stage is held by extension associated with another phase, further extension requests will be permitted.

The minimum green running period will be provided for each vehicle-actuated phase. When a phase obtains right of way, the maximum green running period will commence to time off immediately.

The maximum duration of a particular stage green is governed by the termination of the last associated phase if more than one phase is to be terminated by the stage change and if the maximum for these phases are different.

Alternative values of maximum running periods are available.

The stage will not be permitted to terminate while any of these Minimum Green timers are active, thus ensuring that the phase(s) are not terminated without running the required minimum Green time.

It is possible to allocate individual intergreen timing values to all conflicting phase transitions. Intergreen values will not be violated in the event of multiple stage changes.

Following the leaving amber period, the phase losing right of way will change to red. The controller has the facility such that during any stage-to-stage change a red condition can be generated simultaneously on all phases, which change their right of way condition at the stage-to-stage change. The necessary timing for such an all red condition will be generated from the values of the intergreen timing parameters and any related phase delays allowing for mandatory amber periods.

Limiting values – minimum green and intergreen timings are protected by minimum values stored in FLASH, below which it will be impossible to set. Unless otherwise specified, limiting values for minimum green will be 3 seconds and for intergreen 5 seconds.

1.8 Vehicle Detection

The detector equipment is a separate logic unit mounted in its own housing.

Means are provided so that a detector may be connected to demand and/or extend a phase movement as specified.

Detectors may be associated with the following demanding conditions and facilities:

- i. Demand for right of way
- ii. To arrange that a request for right of way from a nominated detector input shall be ignored until a single specified stage has been reached.

In the absence of demands on any of the arms, the system will run in cyclic order with minimum green. Stages for which there is no demand will be ignored.

1.9 Stage Selection

Stage changes will normally occur to serve the next stage in cyclic order subject to the following conditions:

- i. To enable a particular stage always to follow another
- ii. To enable a particular stage to always precede another
- iii. To prohibit certain stage-to-stage moves and substitute alternative moves to that the desired stage is eventually served.

1.10 Timing Period Ranges – Accuracy and Resolution

All timings are digitally derived from a crystal clock, and is accurate to within the tolerance of plus or minus 100 milliseconds.

1.11 Switch On Sequence

Following a controller fault that forces the lamps off, a watchdog processor (micro controller) takes over and executes the Flashing Amber plan.

Initial Cycle – Automatic demands for stages will be generated at start-up by entries in the controller site-specific data.

Lamps ON – At power up, or restart after lamps off, the controller will maintain the lamp displays in the flash-amber/flashing red state for 10seconds. The controller will perform self-testing during the 10-second start up time and will not switch on the signal displays if any fault is found which may impair the safe operation of the signals.

Starting Stage – Following the All Red display, the controller will start in a stage specified in the controller site-specific data. The appropriate mode of operation will also be established according to the prevailing conditions.

Following the 10-second flash-amber / flash-red state, the controller will display All Red for a configurable period, the default of which is 5 seconds.

Phases appearing in each stage shall normally be configured to appear when the stage runs. The controller can allow special logic to be used in condition tables to provide the required operation for demand dependent appearance of phases.

If communications are present the controller will start in the mode specified by the controller's mode priority. If communications are not present, the controller will start in the fallback mode appropriate for the specific time of day as scheduled by the controller real-time clock.

1.12 Controller Inputs

The controller can interface a maximum of 32 vehicle detector inputs. All inputs are optically isolated from the controller logic.

Lamp Monitoring – No additional inputs are required for lamp monitoring. Signal lamp monitoring is integral with the solid state switching of the signal lamps. The status of each lamp drive circuit will be read directly on the output drive module.

Lamp monitoring is provided within the controller as a standard function without the need for any ancillary hardware. Lamp faults are reported to the regional control computer, resulting in a Lamp Fault (LF) Alarm. Keyboard commands will be provided for an operator at the Central Control Room (CCR) to obtain a complete report of the phases as the intersection with lamp faults. Both the aspect color and number of failed lamps will be reported.

Signal Lamp Dimming is provided for the incandescent lamps. The controller hardware and software support time based dimming control.

1.13 Pedestrian Control Facilities

Appearance – The controller site-specific data can provide independent control for each of the pedestrian movements. It is also possible for a pedestrian phase to be configured to appear alone, in conjunction with other pedestrian phases, with non-conflicting vehicle phases, or in conjunction with a combination with a combination of pedestrian and non-conflicting vehicle phases.

The controller can allow pedestrian movements to be introduced automatically or by demand, whichever is required. Vehicle movements configured to run in parallel with a pedestrian phase shall continue to hold right of way until the end of the pedestrian clearance interval.

The controller shall allow the pedestrian green and/or flashing red intervals to overlap between one or more stages with non-conflicting phases if so required.

The controller provides independent control of WAIT indicator for pedestrian phase in push button panels if provided.

The controller has a real time clock with battery backup. It is possible to update the time, date and day from the GPS satellite that enable distributed time synchronization in all the controllers. It is not necessary to set the RTC locally, if GPS is used. In the absence of GPS it is possible to set the RTC locally through keyboard. Time of day, day of week activity scheduling is made with reference to the real- time clock.

1.14 Controller Functional Requirements Operational Facilities

Modes of operation:

- i. Hurry call
- ii. Manual
- iii. ATC Mode
- iv. Cable less Linking
- v. Vehicle Actuation
- vi. Fixed Time
- vii. Night Time Flashing
- viii. Part Time

The controller will enter Flash-Amber/Flash-Red mode if a fault is detected at any time, which may cause unsafe operation on site.

At an appropriate time of day the system may isolate the local control to enter flashing amber/flashing red signal sequences. This facility is timetable programmable via timetable in the standard system operation facilities and will remain in operation until reset by the system timetable facilities on the following morning.

The controller will normally operate in the appropriate mode of control for any particular site at any particular time of the day. The system computer may direct the local controller to operate in either the mode, or to revert to its mode priority as appropriate.

The controller can accept demands for operating modes as follows:

- i. An actuation at the designated controller input will demand the Hurry Call mode.
- ii. Connecting a manual pushbutton will demand the Manual mode.
- iii. The system computer may command the controller to operate in any of the modes as appropriate.
- iv. The controller timetable may command the controller to operate in either the cable less linking or vehicle actuated mode.

The controller shall provide control of “Time of Day” functions. Standard timetable control functions include:

- i. Signal aspect dimming
- ii. Signal plan selection

Timetable scheduling – The controller clock time is used to activate the timetable requests by time of day and day of week. Timetable events shall be scheduled within a day by the hour, minute and second from the real time clock so that the resolution can be to the nearest 1 second within any day.

The day of week will be specified by a day code.

Manual Switch – A switch is provided to control lamp status and provide for manual sequencing of the signal displays. The switch is directly accessible from the controller requiring the opening of a door.

Plan Selection – The active plan will be selected by day of week, hour, minute and second of the day.

Plan changes will not cause unsafe signal displays, such as very short green times or incorrect stage sequences.

1.15 Vehicle Actuated Mode of Operation

Stage Appearance - When operating in vehicle actuation mode with vehicle actuated operation, stages will be serviced in cyclic order in accordance with the sequence in the controller site-specific data. Stages and phases will only appear

if a demand has been registered or is currently active. Stages and phases, which have a demand registered, will not be skipped in any cycle.

Fixed Appearance – Entries in the controller site-specific data shall provide artificial demands for stages, which have fixed duration. The controller site-specific data also provides artificial extension for such stages up to the Maximum Green time.

Minimum Green – A stage will not terminate until the Minimum Green interval has completed timing. Similarly a stage will not be terminated until the Minimum Green time for any late-introduced phase has completed timing. This applies for all modes of operation. Also, a stage will not terminate until all pedestrian movements, which are not required to overlap to the following stage, have completed pedestrian green and flashing red timing. This applies for all modes of operation.

Fixed Time Operation – The fixed time operation or the vehicle-actuated operation shall be determined on site by the controller site-specific data and mode priorities.

A preemption input may be used to demand the Hurry Call mode to give right of way to emergency vehicles. The Hurry Call mode has the highest priority of operation and causes all lower modes of operation to be suspended while the Hurry Call is active. The Hurry call is requested by one of the inputs as configured by the controller site-specific data.

1.16 ATC Mode

The controller hardware has interface for data communications equipment to communicate with the ATC system computer.

Control and Monitoring – The ATC system computer will provide control and monitoring facilities at one-second resolution. The local controller will reply with the status of the current stage, the current interval, etc., and responses to any specific data requests received from the ATC system computer.

Change of Mode – The presence of a demand for a higher priority mode shall cause the controller to change to the higher priority mode, i.e. the Hurry Call mode or Manual mode. The controller shall change to local control mode when there is loss of communication with the ATC system computer for a number of seconds.

System monitoring – The ATC system computer will monitor and control the operation of controllers at intervals of not greater than once per second. The monitoring facilities and commands of the ATC system computer are independent of the local traffic signal controller operating mode. Each local traffic signal controller is capable of returning indications of status at the specified system interval to the ATC system computer for the following entries:

- i. Signal lamps on/off
- ii. Lamp fault

- iii. Controller fault
- iv. Controller Hurry Call
- v. New entry in Fault/Error log
- vi. Current Stage
- vii. Current Stage Demands
- viii. Alarm Status for special facilities
- ix. Detector Status
- x. Phase / Stage Displaying Green

1.17 Controller User Interface

Facilities – Facilities located inside a flap secured by key will permit the local controller lamps to be switched On or Off, to select Amber Flashing operation, to assume Normal Operation and to permit the selection and control of MANUAL mode.

Facilities within the Controller Cabinet – Access to the controller housing will be by a controller key that fits a secure, vandal proof compression lock at the top and bottom of the door.

Monitoring – The LCD display inside the controller will display the current stage executed and other relevant parameters.

Status LED's provided to give indication of the state of the hardware and software. The status LED's include:

- i. CPU is operating normally
- ii. Watchdog activated
- iii. Communications
- iv. Power is OK

1.18 Controller Safety and Reliability

Fault detection – The controller employs a number of different fault checking processes, including both hardware and software checks using the processors. The processor is monitored continuously for its healthy operation. A fault detected will invoke the watchdog controller, the entire data bus will be isolated and the flashing amber / flashing red program executed from an independent memory. Failure of components (integrated circuits) will also be identified and the system will be put in the watchdog mode if the failure is fatal. The occurrence of a conflict in signal displays will cause the signal displays to be switched to flash amber/flashing red immediately by the conflict monitor. Configuration faults that cause unsafe signal displays will not accept the configuration data.

1.19 Fault Log & Diagnostic Facilities

The controller has a Fault/Error Log in a non-volatile RAM. The Log will provide storage for Errors, which are detected, such as lamp failure. These will not cause the signal displays to be blacked out.

Detector Fault Monitor – Detector fault monitoring is a system function supported directly by the controller. The system will provide periodic messages from the UTC system to the controllers to interrogate the controller for current detector alarms.

Any detectors which did not change state in an alarm checking interval will be flagged as faulty.

1.20 Phase Driver Monitor

The output switching circuits will monitor the driven state for each phase aspect to check that the output state corresponds to the drive signals from the processor. If a discrepancy is found then an appropriate action will be imposed and record the fault in the Fault/Error log. The controller has a comprehensive conflict detection mechanism for conflict monitoring.

1.21 Electrical Specification

Mains Power Supply – The controller is designed to operate with wide variations in nominal mains supply and be tolerant to variations in supply voltage.

An interruption in the mains power as less than 50ms will not cause any disruption to normal controller operation. The controller will shutdown in an orderly fashion as a consequence of a power failure.

A main fuse and switch rated to a minimum of 20 Amps will be provided. The main switch will remove power from all circuits within and fed from the traffic controller.

1.22 Lamp Circuit Isolation / Protection

A toggle switch is provided to switch off the signal lamps without affecting the operation of the controller logic. The lamp circuits (red/amber/green) for each phase are protected by separate fuses.

Signal Lamp Switching is by solid-state relay switches. The rated lamp load is 5 amps continuous for each aspect for each phase at 250V 50Hz.

Signal Lamp Dimming is provided for all signal displays.

The battery will protect the real time clock against loss of power. Data will not be corrupted in the clock due to loss of mains power, or the removal of any circuit cards from the logic module.

2. UTCS SPECIFICATION (Intersection Controller)

CDAC UTCS is used as the intersection controller. Hardware specification of UTCS is as follows.

1. CPU Card
 - 1.1. Processor : 80188, 12MHz
 - 1.2. Real Time Clock : Using Crystal oscillator or GPS
 - 1.3. Battery Backup : 3 months for RTC
 - 1.4. Memory
 - 1.4.1. Signal Plans : 128K x 8 FLASH memory
 - 1.4.2. Program : 128K x 8 EPROM
 - 1.4.2. Error log : 128K x 8 NV RAM
 - 1.4.3. Scratch Pad : 128K x 8 RAM (Battery backed)
2. Keyboard : Standard PC AT Keyboard
3. Display : 40 Characters x 4 Lines, Back lit LCD
4. Detector Interface card
 - 4.1. No. of Detector Inputs : 32
 - 4.2. Input Level : 24V to 30V DC
 - 4.3. Input Current : 20mA per Channel
 - 4.4. Output Level : TTL compatible
 - 4.5. Isolation : Optical
5. Lamp Driver card
 - 5.1. Switching : Solid State (Zero Crossing)
 - 5.2. No. of Outputs : 16 per card
 - 5.3. Type of Load : Incandescent Lamp / LED
 - 5.4. Input Level : TTL compatible
 - 5.5. Max. Output Voltage : 230V AC
 - 5.6. Min. Output Voltage : 50V AC
 - 5.7. Max. Output Current : 5A
 - 5.8. Min. Output Current : 0.05A
 - 5.9. Coupling : Optical
 - 5.10. Output Type : AC
 - 5.11. Breakdown Voltage : 4000V AC
 - Input to Output
 - 5.12. Output Fuse : Glass Cartridge
 - 5.13. Output Termination : Combicon Connector
 - 5.14. Indication : LED
6. No. of Lamp Driver cards : 4
7. Hurry Call
 - 7.1. No. of Hurry Calls : 4
 - 7.2. Selection : Toggle Switch

- 8. Manual Control
 - 8.1. Selection : Toggle Switch
 - 8.2. Manual Control : Heavy Duty Push Button Switch

- 9. Forced Flash
 - 9.1. Selection : Toggle Switch

- 10. Communication
 - 10.1. MODEM : RS 232 C
 - 10.2. PC : RS 232 C
 - 10.3. GPS : RS 232 C
 - 10.4. Controller-to-Controller : RS 485 (Two Ports)

- 11. Battery : 3V 100mA Button Cell

- 12. System Power Supply :
 - 12.1. Type : SMPS, Open frame
 - 12.2. AC Input : 85 – 265VAC, 50Hz
 - 12.3. DC Output : 5V, 3A

- 13. Mains Power : 230V AC \pm 10%, 50Hz

3. Vehicle Detector

- 3.1 No. of Channels : 4
- 3.2 Power Requirement : 230V AC, 50Hz
- 3.3 Presence / Pulse Relay : 0.5 Amps
- 3.4 Indicators : Power, Detect State
- 3.5 Detector Tuning Range : 15-1500mH
- 3.6 Frequency : Two-Step Adjustable
- 3.7 Protection : Loop isolation transformer, Zener Diode and MOV protection of loop input

4. Central Control Room

