

Specification for Traffic Signal Controller

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REGISTRATION OF AMENDMENTS

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1 INTRODUCTION

1.1 General

This Specification supersedes TR 0141C, from the date of issue. New Statutory approvals will be conducted against this Specification. (See Chapter 16.)

The technical content of this specification remains unchanged from TR 0141C except for the addition of the pedestrian signal sequence on nearside signals installed on central pedestrian refuges and the removal of the pedestrian audible facility performance requirements.

The non-technical changes to TR 2210 include clarification of certain points in TR 0141C and the addition of references to the applicable European classes set out in BS EN 12368 and BS 7987 (HD 838 S1) to ensure harmonisation with European Standards.

These references, together with the existing standard facility requirements and speed flow strategies, are now incorporated in separate annexes.

Regulations require that traffic signalling equipment must be designed to present to the road user only those signals and signal sequences defined in the Traffic Signs Regulations and General Directions 1994, Regulations 30(2)(3)(4), 31 and 37 and “The Zebra, Pelican and Puffin Crossing Regulations and General Directions 1997.”

The TSRGD also specifies the requirement for Approval for traffic control equipment (see Page 105, Chapter 16). For ease of reference this will be referred to as ‘Approval’ throughout this specification.

This specification details the functional, constructional, environmental and EMC requirements for traffic signal control equipment.

Any comments or enquiries relating to this specification should be addressed to:

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1.2 Scope

This Specification provides details of the design requirements, together with reference to other major documents for traffic control equipment for controlling vehicular, cyclist and pedestrian crossings including stand-alone Pelican, Puffin and Toucan facilities.

This document is not intended to give advice on the application of facilities. Other published advice should be referred to for timings and general configuration requirements.

The Controller Works Specification Forms are included in MCH 1827 entitled “Traffic Signal Controller TR 0141 Works Specification and Configuration Forms.”

1.3 Glossary

A glossary of terms is given in Chapter 14.

1.4 Implementation

Approvals issued against TR 0141C will remain valid. There will be no retrospective action necessary against equipment approved to TR 0141C.

It is recommended that as from the date of issue, any controller commissioned or recommissioned for use on the public highway should comply with this specification

2 EUROPEAN DIRECTIVES AND STANDARDS

2.1 European Directives

The product shall comply with all relevant statutes in force at the time of supply, and particular attention is drawn to those implementing European Directives.

2.2 Equivalent European Standards

Any requirement of the Specification for goods or materials to comply with a specified standard shall be satisfied by compliance with:
a relevant standard or code of practice of a national standards body or equivalent body of any state of the European Economic Area;

- a) any relevant international standard recognised for use in any state of the European Economic Area;
- b) a technical regulation of any state of the European Economic Area;
- c) traditional procedures of manufacture of a state of the European Economic Area where these are the subject of a written technical description sufficiently detailed to permit assessment of the goods or materials for the use specified;
- d) any method chosen by the manufacturer or supplier in accordance with UK legislation;

provided that the proposed standard, code of practice, specification, technical regulation, technical description or method complying with UK legislation provides, in use, levels of safety, suitability and fitness for purpose equivalent to those required by the specified standard.

Any requirement of the Specification to use material or an article which is defined by reference to a named supplier or manufacturer shall be satisfied by using an equivalent material or article of another manufacturer or supplier of any state of the European Economic Area provided that this material or article is, in use, as safe, suitable and fit for the relevant purpose as material or an article

complying with the requirements set out in the

specification.

Any requirement for any materials or articles to be designed, manufactured or supplied subject to a quality management scheme, product certification scheme, or approval scheme shall be satisfied by compliance with any equivalent quality management scheme, product certification scheme or approval scheme acknowledged for use by a public authority of any state of the European Economic Area, provided that the scheme ensures that the design, manufacture or supply offers, in use, equivalent levels of safety, suitability and fitness for purpose.

Where testing is carried out in a state of the European Economic Area such tests shall be carried out by an appropriate organisation offering suitable and satisfactory evidence of technical and professional competence and independence. This condition shall be satisfied if the organisation is accredited in a state of the European Economic Area in accordance with the relevant parts of the EN 45000 series of standards for the tests carried out.

Where compliance with European Specifications are appropriate, these relate to specific clauses contained within the following documents:

BS 7987 (HD 638 S1) – Road Traffic Signal Systems.

BS EN 12675 – Traffic Signal Controllers – Functional Safety Requirements.

BS EN 50293 – Electromagnetic Compatibility – Road Traffic Signal Systems Product Standard.

3 GENERAL REQUIREMENTS

3.1 Overview

3.1.1 Facilities

The controller may provide a combination of junction and stand-alone facilities described in this Specification.

Facilities in addition to those specified will also be considered for approval.

Facilities listed in Annex A as mandatory for the control of junctions, shall be provided for the applications which require the control of a junction. Similarly, for the control of stand-alone pedestrian and cyclist facilities the listed mandatory facilities shall be provided.

When the controller is to be used for a mixture of junction, stand-alone control, the mandatory facilities appropriate to all the types of control shall be provided.

Facilities listed in Annex A as standard shall be provided when required by the Works Specification.

The controller shall be capable of providing the standard facilities without redesign i.e. they will form part of the controller design.

3.1.2 Technology

The equipment shall employ microprocessor techniques and all logical functions necessarily external to the microprocessor shall be performed by solid state devices.

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

The equipment shall be of modular construction designed to allow easy disconnection and replacement of modules.

The site configuration data and controller operating programme shall be held in non-volatile store.

Facilities may be provided to change level 3 site

timing data held in non-volatile store without switching off the signals. Implementation of the new parameters shall be made via a safe signal sequence e.g. following an All-Red stage.

3.1.3 Dimensions of Mechanical Components

Unless otherwise agreed for practical reasons, all designs shall make use of the metric system of dimensions and tolerances. Where metric screws, bolts, nuts, washers, fasteners and other materials can be shown to be unavailable, or their use is not practical, then, equivalent sizes, which will permit a change to metric items when these become available, may be used. Such changes to metric items will not necessarily be retrospective.

3.1.4 Design

It shall be the design aim to ensure reliability by the use of relevant design methods and criteria. Among these are the following.

Cabling. All cabling, wire links, connectors and terminal blocks shall be suitably rated for their current and voltage.

Component Rating. All components shall be suitably rated for their function and operating conditions and shall be of assessed or good industrial quality.

Non-Expendable Items. The materials and components, excluding expendable items, shall be such as to provide a life expectancy of at least 15 years. With the agreement of the Approval Authority, components of a more limited life shall be acceptable provided that they are easily replaceable.

Voltage Level Sensors. The voltage level sensors shall each have a minimum operational life of at least 15 years.

Relays. Where relays are provided they shall have an expected life of not less than 10 million mechanical operations.

Software. All timetable programs shall be designed to cope with the dates before and after 01.01.2000.

3.1.5 Reliability

The controller shall have an MTBF prediction figure of greater than or equal to 12,000 hours continuous operation.

The data contained in MIL-HDBK 217 shall be used (where applicable) for reliability prediction.

3.1.6 Design life

The equipment manufactured to this Specification shall have a minimum design life of 15 years, with suitable maintenance.

3.1.7 Electrical Safety

The equipment shall be capable of being installed in accordance with the requirements of BS 7671.

3.2 Standard Interfaces

3.2.1 User Interface

This clause details the various controls and indications that are to be provided to enable:

- a) operation in manual method of control by authorised personnel; and
- b) adjustment of programming; and
- c) verification of the operational integrity of the controller.

3.2.1.1 Access Levels

To ensure operational safety various levels of access shall be provided. These access levels will be appropriate to the needs and skills of the authorised personnel.

The levels of access to the controller are:

Level 1

Access to the facilities associated with manual control. (See section 5.8.)

Level 2

Access is for modifying non safety data as defined in

tables 3.1, 11.1, 11.2 and 11.3 which can be modified either by local handset or remote access. It shall be possible to monitor, but not modify, facilities restricted to level 3 access. (See clause 3.2.1.2.)

Level 3

Access is for modifying safety data as defined in tables 3.1, 11.1, 11.2 and 11.3.

Level 4

Access to data appertaining to site configuration parameters which, for safety reasons, must be held in non-volatile store and shall not be changeable on-site or via levels 1, 2 or 3. (See Clause 3.1.2.)

Level 5

Access to changes to the basic program. Such facilities will require the agreement of the Type Approval Authority.

3.2.1.2 Admittance to Access Levels

Level 1

Admittance shall be by means of a locked door and/or key operated switch, which in order to provide compatibility within Local Authorities, shall be a Yale Key, 10½ Section, change 900. Access to level 1 facilities shall be gained without opening the main controller door(s).

All other levels

Admittance to all other access levels shall have security protection before write access is available and shall be provided via either the main controller door(s) or the manual panel access. Admittance shall be in the form of either the operation of a key or the entry of a security code.

Level 3

Access shall only be by an operator on site i.e. at the controller, and only associated with the User Terminal. The facilities are detailed in tables 3.1, 11.1, 11.2 and 11.3.

3.2.1.3 User Terminal Interface

A controller shall be able to have a user terminal connected to it.

The terminal device will normally be associated with the display and modification of data concerned with the parameters listed in tables 11.1, 11.2 and 11.3. Other parameters may be provided and these shall be allocated to either Level 2 or 3 by agreement with the Approval Authority.

The terminal device should have a display capable of simultaneously displaying a line of information containing the specified parameter and the instruction.

Switches, or push buttons and indicators on the terminal device may be multi-purpose.

Selection between display modes shall be achieved by operation of switches or push buttons specifically provided for this purpose or by entry of a code on the switches or push buttons provided.

All timing values shall be entered and displayed in decimal format.

The controller shall be interrogated by means of mnemonics. Alternative interfaces may be approved at the discretion of the Approval Authority.

The interface shall conform with RS 232C, CCITT V24 and V28.

The Method of Connection of the User Terminal, shall be in accordance with the following:

- a) Controller; Cannon DP 25s or equivalent;
- b) Terminal Device; Cannon DP 25p or equivalent and shall have the following pin allocations:

- Pin 1 – Protective Ground
- Pin 2 – Transmitted Data from terminal to controller
- Pin 3 – Received Data from controller by terminal
- Pin 4 – Request from terminal to Send
- Pin 5 – Clear to Send from controller
- Pin 6 – Data Set Ready from controller
- Pin 7 – Signal Ground
- Pin 9 – + 5 V supply *

- Pin 10 – + 5 V supply *
- Pin 18 – Ground (0 V supply)
- Pin 19 – Ground (0 V Supply)
- Pin 20 – Data Terminal Ready to controller

The 5 volt supply* shall be a separately protected logic supply from that used for the processor. The supply tolerance shall be ±5% and the minimum current rating of 0.25 Amps.

The Bit Format shall be in accordance with the following:

START (SINGLE BIT)	1 (LSB)	2	3	4	5
6	7 (MSB)	PARITY (EVEN)	STOP (SINGLE BIT)		

Operation at minimum of 1200 Baud shall be the norm. Higher speeds may be provided.

The Mode shall be full duplex.

The Character set shall be ISO Alphabet No. 5 (ASCII).

1.	British Summer Time advance/retard.
2.	Control facilities – – insertion of demand for phase; – insertion of demand for phase green extension; – detector inhibit.
3.	Fault logs.
4.	Detector fault monitor.
5.	Current controller mode.

Table 3.1: Parameters Accessed via User’s Terminal

3.2.1.4 Remote Terminal Interface

Remote access to the controller shall be via the interface defined at 3.2.1.3.

3.2.1.5 Other Display facilities

Facilities may be provided either independent of the User Terminal, by the User Terminal or in parallel with the user terminal.

- a) Watchdog timer expired.
- b) Sum check error.
- c) Phases currently running and aspects being driven (these may be left on whilst the signals are off to aid controller checking).

Indications and a means of selection to observe the current status of phase timers, (i.e. timing/not timing) for the following:

- i) minimum;
- ii) maximum;
- iii) intergreen;
- iv) extension.
- d) Detector input states;
- e) Fault Monitor (FM) Indicator (see clause 3.3.1.2).

Visual indicators may be provided to display facilities (a), (b) and (c).

3.2.2 Interface For Parallel Data inputs

The controller parallel input interface may receive input signals from:

- a) a separate Outstation Transmission Unit (OTU) to MCE 0312 or MCE 0361 (see clause 5.7.2);
- b) a MOVA unit (see clause 5.7.1);
- c) detection equipment including pedestrian push buttons;
- d) an adjacent control box;
- e) Hurry Calls;
- f) Public Service Vehicle (PSV) demands.

The controller shall be capable of operating correctly at a minimum distance of 250 metres from any of the above and at a minimum of 400 metres distance from an OTU.

Except where otherwise stated, input signals shall be interrogated by the controller at intervals of not greater than 40 milliseconds.

The open circuit voltage, generated by the controller at the input terminals, shall not exceed 50 V dc. The short circuit current from the input terminals shall not exceed 50 mA dc. The product of the voltage and current so specified shall not exceed 2 watts.

If the input terminals are short circuited or either or both is connected to an earth potential, no damage shall be caused to any component, nor shall the wattage rating of 2 watts described above be

exceeded.

For those input terminals connected to equipment external to the controller cabinet via cables normally carrying mains voltages, the application of 250 V RMS at 50 Hz across any pair of such input terminals shall cause no damage to the controller except to the input device(s) or associated protection device of the particular input connection. Other input channels shall not be damaged.

Where relays are used as input devices they shall normally be driven from a separate power supply to that of the logic circuitry. A common power supply will be considered but comparable immunity from noise, interference and fault conditions at the input terminals must be achieved. Where relays are provided, a spark quench diode shall be connected across each input relay winding. The relays shall have an expected life of not less than ten million mechanical operations.

For the separate OTU/Controller interface each control input signal shall be switched by isolated relay contacts in the OTU. A separate signal return line shall be associated with each signal line.

Input signals from an adjacent control box shall be switched by isolated contacts in the control box. A separate return line shall be provided for each signal from the control box.

The logic '0' input state shall be assumed when the resistance across the input terminals is reduced to 250 ohms or less (typically the loop resistance of 400 metres of copper cable having a core size of 0.5 sq mm in series with a protection resistor of 180 ohms).

The logic '1' input state shall be assumed when the resistance across the input terminals increases to not less than 100 K ohms.

3.2.3 Detection Equipment Inputs

Controller detection inputs, which can be either pedestrian or vehicle inputs, (including inputs for pedestrian push buttons), shall be capable of being connected to detection equipment conforming to the following requirements:

- a) the output from the detecting equipment

shall be an isolated contact, or the solid state equivalent which may or may not be isolated. Where specified this output shall have dc isolation from earth and from supplies to the detecting equipment. If the output is polarity sensitive, a means shall be provided to protect the output device against an accidental reversal of the current flow. The correct direction of current flow shall be clearly marked on the relevant output terminals;

- a) in one state the output (logic '0') shall continuously allow a current of up to 50 mA to pass with a volt drop of no more than 2.5 V; and
- b) in the other state the output (logic '1') shall continuously present a resistance of at least 100 K ohms. The output must be able to withstand a continuous voltage across it of 50 V dc, and must incorporate adequate protection against transients.

3.2.4 Interface for Parallel Data Outputs

All controller parallel data outputs shall be in the form of either an isolated contact or the solid state alternative specified in the appropriate sections of the following clauses.

For the controller to separate the OTU interface each output signal shall be switched via isolated relay contacts in the controller. A separate signal reply line shall be associated with each signal control line.

If the controller output (reply) device is polarity conscious, this shall be clearly marked on or adjacent to the relevant terminal and a means shall be provided to protect the device against an accidental reversal of the current flow.

For the isolated contact the logic '0' state on the controller output terminals shall continuously present a maximum resistance of 180 ohms + 5% and shall be able to withstand a current of at least 50 mA. The solid state output shall continuously allow a current of 50 mA to pass with a volt drop of no more than 2.5 V.

The logic '1' state on the controller output terminals shall continuously present a resistance of

greater than 100 K ohms, and shall be able to withstand a continuous voltage of up to 75 V dc.

Output signals generated by the controller shall not be shorter than 50 milliseconds.

For those output terminals connected to equipment external to the controller cabinet via cables carrying mains voltages, application of 250 V RMS at 50 Hz across any pair of such output terminals shall cause no damage to the controller except the output device(s), or associated protection device of the particular output connection. Other output channels shall not be damaged.

Where relays are provided they shall have an expected life of not less than 10 million mechanical operations.

3.2.5 Other Interfaces

3.2.5.1 Serial Data Interfaces

Where equipment is required for connection to telecommunications lines, e.g. where an integral OTU is fitted, the equipment shall meet with the requirements of the communications network provider.

3.2.5.2 Controller Operation

Where access to the controller operation is via an interface, or integral unit, other than through the RS232 serial port; measures shall be taken to ensure that admittance to access levels and timing parameters, as defined for the serial interface, are maintained. Reference clauses 3.2.1 and tables 11.1, 11.2 and 11.3.

3.2.5.3 Module Interfaces

Different modules using similar interconnection techniques shall not be readily interchangeable such that damage or malfunction may occur to either the module or the controller.

3.2.5.4 Test Equipment Interfaces

The manufacturer may provide interfaces for test or diagnostic equipment.

3.3 Controller Case

3.3.1 Housing

3.3.1.1 Construction

The controller housing shall meet the following requirements:

- a) the controller housing shall be manufactured from suitable material to provide mechanical protection of the controller equipment in the intended environment. It shall be designed to maintain the mechanical, environmental and EMC protection for a minimum of 15 years, with suitable maintenance;
- b) if the housing is to be constructed from non-metallic material the manufacturer shall satisfy the Approval Authority that the case will provide adequate protection to the control equipment, including fire;
- c) where any part is below ground level, it may alternatively be constructed of non-metallic material. If constructed from steel to BS 1449, it shall either be finished with hot metal spray, to BS EN 22063 Part 1, and coated with a bituminous finish or hot dip galvanised to BS 729; or alternatively the material may be stainless steel;
- d) the method of fastening the main door(s) shall ensure that the door seal remains operative. All door(s) shall be secured against unauthorised entry by a suitable lock(s).
- e) the base of the controller shall be capable of being sealed against the ingress of gas. Optionally, a ventilated plinth to MCH 1398 may be specified.

3.3.1.2 Fault Monitor (FM) Indicator

The provision of an FM indicator shall be optional, as required in the Works Specification. Where provided, the housing shall be so constructed as to provide an FM indicator. The FM indicator shall be easily visible from the outside of the signal controller case and be of such intensity that it may be readily seen under conditions of bright sunlight.

3.3.2 Accommodation of Ancillary Equipment

Where required by the Works Specification, the controller case shall provide the space and means for support for one, or more, of the following ancillary units of equipment;

- a) OTU (and LMU);
- b) OMCU or OMU;
- c) MOVA control unit;
- d) PSV detection equipment;
- e) PSTN or data circuit termination;
- f) detector units.

The equipment mounting rack may be either:

- a) full width to IEC 297 standard 483 mm (19 inches), height 222 mm (5U), and depth 306 mm; or
- b) half width to IEC standard.

Provision shall be made for ancillary units not to project more than 26 mm in front of the mounting rack. This measurement of 26 mm is not included in the 306 mm specified above.

The fixing nuts shall be M6 captive.

Fixing centres for IEC 483 mm standard 3, 4 and 5U, height rack systems shall be provided.

Access to the rear of the ancillary unit should be provided when the unit is fitted in the position allocated within the controller cabinet. Where there is no direct access to the rear of the unit, the unit shall be mounted on sliding rails or other means to facilitate access.

Where a data or PSTN connection is required, provision shall be made within the controller, to house the necessary interface equipment, as required in the Works Specification.

3.3.3 Cable Terminations

The controller earthing standards shall comply with the relevant sections of BS 7671.

3.3.3.1 Earth Continuity

A cable earth continuity connection bar shall be fitted within the controller case. This connection bar shall be electrically connected to the earthing terminal and the controller case including access doors. All low voltage dc supplies that are not required to be at some potential to earth shall have one side of the supply bonded to this earth.

3.3.3.2 Insulation Resistance

The insulation resistance of the mains leads, excluding third party equipment, shall be tested in accordance with BS 7671. The insulation resistance shall not be less than 1M ohm. During tests of the low voltage side of the controller the logic power supply unit(s), lightning surge arrestors and mains filter(s), if fitted, shall be disconnected.

3.3.3.3 Protection against Shock

Any connections or bare wiring carrying a voltage greater than 50 V ac or dc shall be properly guarded/insulated to protect against the danger of electric shocks in accordance with BS 7671.

All removable covers and panels which expose points with a nominal voltage greater than 50 V ac or dc shall be clearly labelled with an appropriate warning, either in the English language or Internationally agreed symbols. To comply with the Safety Signs Regulations 1980, this shall be in accordance with BS 5378.

3.3.3.4 Armoured Cables

For armoured cable terminations, the manufacturer may choose to provide any of the following methods:

- a) lugged earthing plate;
- b) gland plate;
- c) ferrule and clamp.

Access to the above shall not require equipment to be removed.

3.3.3.5 Feeder Cables

Feeder cables, from inductive loop detectors and plastic ducts for special services (i.e. telephone cables), shall normally be held in position by a suitable mechanical support method.

3.3.3.6 Termination Panels

Cable cores shall normally be terminated on termination panels to form part of the housing assembly and it shall be a design aim that the control equipment shall be capable of removal for maintenance without disconnection of the incoming cable terminations.

3.3.3.7 Electricity Supply Company Terminations

Space shall be provided for the Electricity Supply Company's cable termination and cut-out to be mounted within the housing on a termination panel to form part of the housing, preferably at the rear or side. The control equipment shall be capable of removal without disconnection of the Electricity Supply Company cable termination or removal of the termination panel. A space of at least 200 mm (height) x 200 mm (width) x 100 mm (depth) shall be provided on the mounting board for the Electricity Supply Company's cut-out and cable termination.

The controller mains termination shall normally be made at the device described at clause 3.4.1.4.

3.3.3.8 Mounting Board

The equipment specified in clauses 3.3.3.7 and 3.3.3.8 shall be mounted to comply with the Electricity Supply Company requirements. Suitable means may be either a wooden board of minimum thickness 10 mm, or plywood of minimum thickness 12 mm, suitably protected from decay in accordance with BS 4072.

3.3.3.9 Protective Earth Conductors for wiring of External Equipment

Accessible conductive parts shall be connected to the protective earth conductor incorporated in the cables or a separate PE cable in accordance with class L1 of the tables in Annex B

3.3.3.10 Accepted Methods of Earthing

Extraneous bodies shall be connected to each other in accordance with Class M1 in Annex B

3.3.3.11 Terminations

The system shall be classified in accordance with Class H0 of the tables in Annex B

3.4 Power Distribution**3.4.1 Mains Supply**

All equipment shall be suitable for operation in accordance with this Specification when connected to the UK mains supply. It should be noted that the UK mains supply is subject to small variations in both voltage and frequency.

The operating voltage range of the equipment shall be 230 V ac +10% to -13% in accordance with Class A1 of the tables in Annex B.

The operating frequency range of the equipment shall be 50 Hz \pm 4% in accordance with Class F2 of the tables in Annex B.

3.4.1.1 Low Voltage

In accordance with Class B0 of the tables in Annex B there is no requirement for automatic switch-off. Similarly, in accordance with Class C0 there is no requirement to provide any auxiliary state switch response voltage.

3.4.1.2 Over Voltage

In accordance with Class D0 of the tables in Annex B no protective devices are required to protect in the event of over voltage.

3.4.1.3 Voltage Dip

The system is required to comply with Class E2 of the tables in Annex B in respect to duration of dips in supply voltage.

In the event of a mains supply failure being detected the controller shall shut down without a malfunction occurring. On restoration of the mains supply, the controller shall conform with the start-up requirements specified in clause 4.5.

3.4.1.4 Isolator Switch

A double pole switch with a fuse of appropriate rating and time/current characteristic in the live lead, or approved alternative e.g. a circuit breaker with appropriate rating and time/ current characteristic, shall be provided to isolate the mains supply from all equipment in the controller housing. The device provided must be lockable in the off position.

3.4.1.5 Controller Equipment Switch

A separate switch and fuse, or circuit breaker, which does not break the neutral connection, shall be provided to disconnect the controller equipment from the mains supply.

The power required, and protection capacity of the mains supply shall be stated in the equipment documentation. Sufficient protection shall be provided within the controller to ensure adequate protection of internal supplies and circuitry.

Cable connections shall be provided to connect to the mains supply. These shall be of suitable rating, double insulated, at least 100 mm in length and connected to the device provided in clause 3.4.1.4.

The power supply unit(s) shall be designed in a modular fashion to facilitate their removal and/or replacement.

Suitable monitor points, or monitor circuits, are to be provided to measure the output supply voltage(s).

3.4.2 Lamp Supply

A switch shall be provided to immediately remove the supplies to all vehicle and pedestrian signal lamps, indicators (wait and demand accept) and audible/tactile units, without interfering with the supply to the controller operating circuits. When the lamps are switched on again the controller shall conform to the start-up requirements specified in clause 4.5.

A separate fuse or circuit breaker shall be provided to immediately remove the supplies to all vehicle and pedestrian signal lamps, indicators and audible/tactile units, subject to the red lamp monitoring requirements of chapter 9.

3.4.3 Lamp Switching Circuits

Signal lamp switching shall be either by relays or solid state devices which shall have a minimum life of 10 million operations. The load to be applied when assessing this figure shall be equivalent to 10 lamps driven from lamp transformers from a cable with characteristics of a typical installation of 200 metres.

The controller shall comply with Class K1 of the

tables in Annex B whereby each phase drive equipment shall be capable of switching between 0.1A and 4 amps per phase colour at the normal mains voltage and the corresponding load in the dimmed condition.

3.4.4 Lamp Dimming

Provision shall be made for a photocell (to TR 0102) to control the intensity of all signal lamps and pedestrian indicators. At full intensity, the signals shall be supplied from the mains voltage supply, and at low intensity from an auto transformer or other approved device.

Auto transformers used for dimming signal lamps shall be tapped to provide RMS voltages of 120 V \pm 5 V, 140 V \pm 5 V and 160 V \pm 5 V at nominal supply voltage and full load conditions. Only one of these voltages will be connected in any one controller. The normal dimmed voltage is 160 V and this shall be supplied unless stated otherwise in the Works Specification.

If dimming of the lamps is achieved by other means, approval from the Approval Authority shall be obtained.

Where such alternative devices are used for lamp dimming, it shall be possible to provide light intensity/luminance levels equivalent to those obtained by use of the transformer specified above.

Failure of the photocell during a 24 hour period shall cause all signals and pedestrian indicators to switch to full intensity.

3.4.5 Ancillary Equipment Supply

Where a separate OTU, Remote Monitoring Outstation or MOVA unit is fitted a 5 amp fused supply shall be provided. The outlet details of this supply shall be as given in the Works Specification.

If a 13 amp socket outlet is provided, it be protected by a residual current device of maximum rating 30 mA residual current to the requirements of BS EN 61008.

Any supplies provided for ancillary equipment shall not be disconnected by the switch or other device provided to disconnect the controller from the mains supply.

3.4.6 Audible and Tactile Interlock

Where specified in the Works Specification, a 9 to 30 V dc audible and/or tactile interlock voltage supply shall be provided in accordance with TR 0155 and TR 0157, as follows: 100 mA minimum for junction controllers and 50 mA minimum for stand-alone controllers.

3.4.7 Detector Power Supply

An appropriately rated power supply, of 0.5 amps or greater, shall be provided for detector equipment as required in the Works Specification. The supply shall be one or more of the following:

- a) 24 V ac RMS +15% to -25%;
- b) 24 V dc $\pm 20\%$.

The power supply(s) shall be suitably protected preferably by either a separate fuse or circuit breaker.

For reasons of safety, all low voltage dc supplies that are not required to be at some potential to earth shall have one side of the supply bonded to the earth bar.

3.4.8 Demand Accept Indicator Supply (Puffin)

Where specified in the Works Specification a suitably rated output power supply shall be provided to illuminate the Puffin pedestrian demand accept indicator. (See TR 2181.)

3.4.9 Sign Power Supply

If Regulatory Signs are fitted then a separate fuse or circuit breaker shall be provided for their power supply.

Any isolators provided to remove supplies to signs shall be separate to and will not affect the requirements of clause 3.4.2.

The isolator shall be clearly marked and labelled.

Provision shall be made for either:

- a) the supply to the Regulatory Signs only being disconnected when either the controller equipment switch specified in clause 3.4.1.5 or the isolator switch

specified in clause 3.4.1.4 is in its off position; or

- b) an isolator being provided to remove the regulatory lamps supply without interfering with the supply to the controller operating circuits. Earthing and safety requirements shall comply with BS 7671.

3.4.10 Solar Cell Power Supply

If a solar cell is fitted, then a separate fuse or circuit breaker shall be provided for the power supply.

3.4.11 Maintenance Supply

Up to two switched dual 13 amp socket outlets shall be provided for maintenance tools and test equipment only. These sockets, to BS 1363, shall not be isolated by the controller equipment switch specified in clause 3.4.1.5 and shall be protected by a residual current device of maximum rating 30 mA residual current to the functional requirements of BS EN 61008. This socket shall be protected by a 5 amp fuse.

A label shall be affixed in the proximity of the socket provided which shall read either:

- a) MAINTENANCE PURPOSE ONLY,
5 AMP MAXIMUM or,
- b) may be abbreviated to read,
MAINTENANCE ONLY, 5 A MAX.

3.4.12 Standby Power Supply

In the event of mains failure, or disconnection, the Master Time Clock System shall have its operation supported by a fully charged standby power supply source for at least 30 days under normal operating conditions. Similarly any data held in volatile store shall be maintained for at least 3 months.

Where a rechargeable power source is used, a period of eight hours shall be permitted for the source to become fully recharged following restoration of the mains supply.

The standby power supply source shall be connected via an in-series removable wire link or switch/plug socket, as required, to ensure that the source is available immediately after commissioning.

The standby power supply source shall be maintained immediately after being switched on in the event of mains failure or disconnection. Upon restoration of power, an entry shall be made in the fault log if the standby power supply source has failed.

3.5 Safety Requirements

3.5.1 Requirements of Signal Intensity for Safety.

The signal limits for safety shall be to Class AF5 in accordance with the tables in Annex B

3.5.2 Requirement for signal states

If a failure could lead to a signal state endangering the traffic, as defined in BS EN 12675 a functional independent safeguarding facility shall lead to a safe state of operation as defined in BS EN 12675. This safeguarding facility shall become active within a time interval specified according to Class AG5 of the tables in Annex B, i.e. within 500ms.

To ensure that the above requirements are obeyed, a failure mode analysis and functional tests complying with BS EN 12675 shall be performed in accordance with Class X1 of the tables in Annex B.

3.5.3 Location of monitoring elements for detection of absent signals.

In accordance with Class N0 of the tables in Annex B there are no requirements for location to be specified.

3.5.4 Location of monitoring elements for detection of unwanted displays.

In accordance with Class P0 of the tables in Annex B there are no requirements for location to be specified.

3.5.5 Test of impedance

The completed installation shall be tested in accordance with Class AA1 of the tables in Annex B.

3.5.6 Insulation of live parts to earth.

The completed installation shall be tested in accordance with Class RI of the tables in Annex B.

3.5.7 Maintenance requirements

The actual procedures which are to be carried out under maintenance shall be specified by the customer who may request a sub set of those recommended by the manufacturer and additions may be requested by the customer in accordance with Class Y1 of the tables in Annex B.

4 PHASES AND STAGES

4.1 Phases

4.1.1 General

The operation of the controller defined in this Specification is stage based. All timings and demands are phase based and the control philosophy is designed to select the duration and the order of the stages to give right-of-way to phases in an optimum manner.

The above shall not preclude the use of a phase based system of operation.

A controller shall provide facilities for a number (to be specified in the Works Specification but which shall be capable of expansion to not less than eight phases) of phase equipments any or all of which may be either:

- a) fully actuated by 'on-street' demands and extensions (vehicular phases only);
- b) demand dependent (vehicular or pedestrian phases); or
- c) fixed time (vehicular or pedestrian phases).

Such phase equipment may be fitted, as required, for specific applications.

The number of phases available may be limited by the controller design.

Timers shall be allocated to phases. The timers shall control the following timed periods of each phase:

- a) minimum green time;
- b) intergreen;
- c) extension time;
- d) maximum green running period;
- e) red/yellow;

- f) yellow;
- g) blackout;
- h) flashing yellow.

4.1.2 Minimum Green Period

A minimum green period shall be provided for each phase. A phase shall not lose right-of-way until the minimum green period, has expired. (This safety period also allows vehicles to move across detectors, thus permitting vehicular extensions to occur and, hence, establish the phase movement). It shall not be possible to terminate prematurely any minimum period.

At the commencement of a phase green, the minimum green period of that phase shall start to time off immediately.

Under the vehicle actuated method of control, 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 exist for the phase(s) losing right-of-way. Phase minimums 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 running period of the phase(s) which will lose right-of-way upon the change to the next stage.

4.1.3 Intergreen and Interstage Periods

4.1.3.1 Red/yellow and Yellow

On a move from one stage to another, the running phases not required in the new stage shall cease to show green. The phase(s) shall then display the yellow for a period preset at three seconds, followed by a red.

After a period, which may be either fixed or variable All-Red, following the termination of the green, on the phase(s) losing right-of-way, the signalled

phases gaining right-of-way in the new stage, shall show both the red and red/yellow display followed by green, for the minimum green period.

Following the fixed or extended All-Red periods (if any), the red/yellow display on those phases gaining right-of-way shall be shown for a preset period of two seconds. For pedestrian/cyclist phase requirements see chapter 6.

Following the loss of right-of-way on a running vehicular phase, the yellow for that phase shall appear for a period preset at three seconds.

4.1.3.2 Intergreen Periods

The intergreen period is the period between one phase losing right-of-way and another phase gaining right-of-way. It shall be possible to allocate individual intergreen timing values to all conflicting phase transitions. Intergreen values shall not be violated in the event of multiple stage changes.

Timers shall control the appearance and disappearance of phase greens during the interstage periods. Such timers shall generate the phase-to-phase intergreen periods and shall have the capability of delaying the disappearance of any phase green with respect to the end of a stage at any stage transition. Such delays shall be of defined fixed duration. It shall also be possible to advance the appearance of any phase green, but this must not infringe the minimum intergreen.

In the event of non-correlation between intergreen timing values or delay periods, the green for phases gaining right-of-way shall be delayed such that no intergreen period is reduced below its programmed value and no delay period is reduced below its programmed value. Figure 4a shows the operation of phase delay periods.

A phase, which is required to show green in consecutive stages, shall continue to show green during the period between the stages (i.e. during the interstage period). Such a phase is commonly known as an 'overlap phase'.

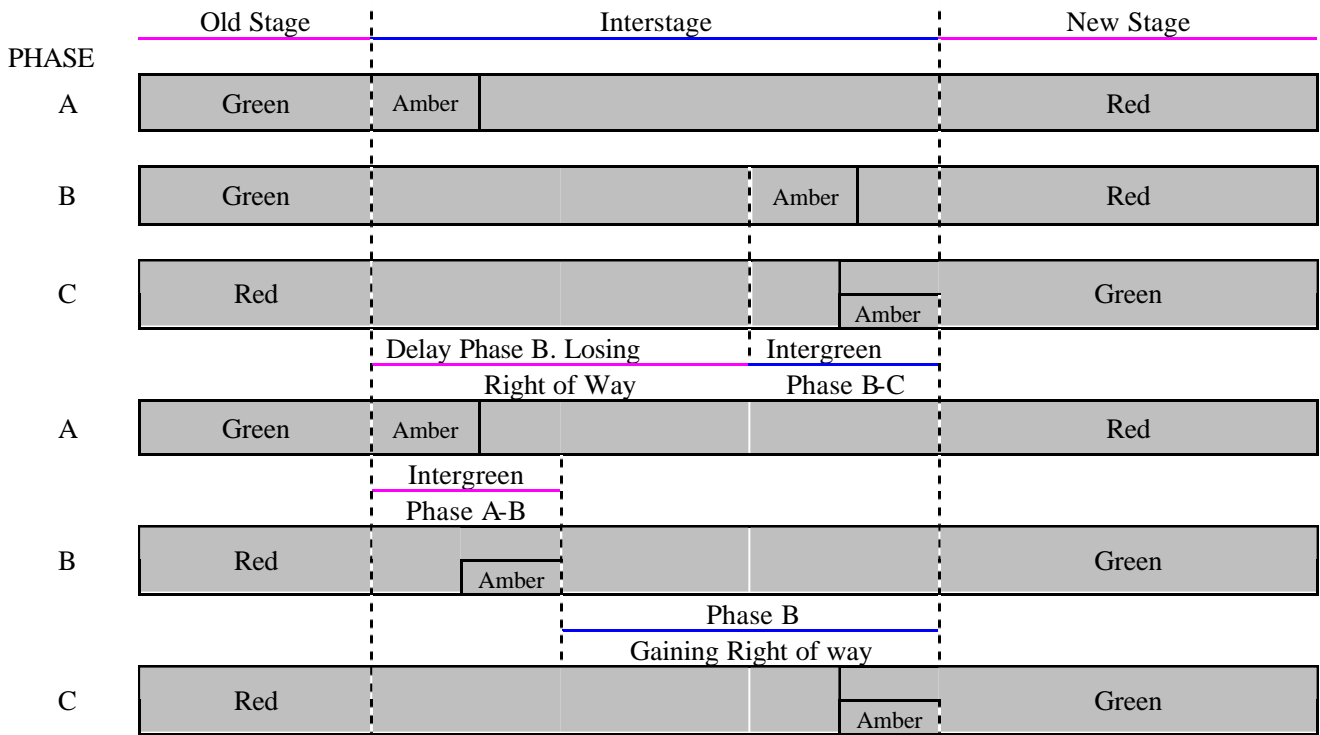


Figure 4a – Phase Change Delays (examples of the use of phase change delays)

4.1.3.3 All Red Period

Following the yellow period, the phases losing right-of-way shall change to red. The controller shall include the facility such that during any stage-to-stage change a red condition can be generated simultaneously on phases which change their right-of-way condition at the stage-to-stage change.

The necessary timing for such an All-Red condition shall be generated from the values of the intergreen timing parameters and any related phase delays allowing for mandatory yellow and red/yellow periods.

The timing of the stage to stage movement shall be capable of being increased by red extending detectors as specified in clause 4.3.2.

4.1.3.4 Independent Intergreens

Note: One of the effects of parallel stage-streaming with no cross linking restrictions (see clause 4.2.6) is to allow intergreens taking place in the different stage-streams to do so independently of one another over the whole signal cycle. Where the phases of one-stream conflict with one or more phases of another stream, non cross linked parallel stage-streaming is not appropriate, but there may still be a requirement for 'independent-intergreens' at certain points in the signal cycle.

It shall be possible to specify that certain interstage periods may give rise to such 'independent intergreens' in a manner which allows independent action to take place between those phases which do not conflict, whilst ensuring the normal intergreen security between those phases which do conflict.

4.1.4 Extension and Maximum Running Periods

These periods are specified in clauses 5.3.2 and 5.3.3.2.

4.1.5 Phase Equipment

Each phase shall provide control for one of the following:

- a) vehicular movements;
- b) pedestrian movements;
- c) cyclist movements;

- d) vehicular movement controlled by Green Arrow signals;
- e) dummy phase;
- f) traffic sign;
- g) public service vehicle signals.

Vehicle phase equipment shall provide control and drive capability for the signal heads comprising red, yellow and green aspects.

The green aspect of the three aspect signal may be a left turn, right turn, ahead only green arrow as well as a full green as required by the method of control and complying with the Traffic Signs Regulations and General Directions.

Pedestrian phase equipment shall provide control and drive capability for the authorised signal displays, including red and green men plus pedestrian indicators.

Cyclist phase equipment shall provide control and drive capability for the authorised signal displays.

A Filter Green Arrow phase equipment shall comprise the control and drive capability for one or more parallel Green Arrow aspects.

An Indicative Green Arrow phase equipment shall comprise the control and drive capability for one or more parallel Green Arrow aspects.

Phase equipment may be used to control an authorised traffic sign.

Public Service Vehicle phase equipment shall provide control and drive capability for the authorised signal displays.

4.1.6 Dummy Phases/Stages

In the situations where timings or detector operation have to be associated with a traffic movement, which is not uniquely signalled, a dummy phase may be required to provide suitable time periods or to condition stage changes even though no signal aspects are associated with the phase.

Note: It should be noted that in order to achieve

some of the facilities mentioned in this Specification the use of dummy stages and/or phases may be required. The facilities to be provided on a controller shall be specified in the Works Specification.

4.2 Stages

4.2.1 General

The controller shall provide facilities for a number of stages which shall include an All-Red stage. The number of stages to be provided on any controller shall be specified in the Works Specification. The controller design may limit the number of stages available. The available phases, which must be a minimum of 8 phases, are allocated to these stages in any combination subject to the method of control, the traffic requirements and safety considerations.

It shall be possible to have different allocations of phases to stages for Manual Control, Vehicle Actuation or Fixed Time operation in Urban Traffic Control Schemes and in Cableless Linking Schemes. (See Chapter 5.)

The allocation of phases to stages is conditioned by the traffic requirements and safety constraints.

4.2.2 Stage Selection

In the vehicle actuated method of control the controller shall examine phase demands and identify those stages which will satisfy these demands. Stage changes shall normally occur to serve the next stage (as required at the time of serving) in cyclic order, subject to the constraints of clause 4.2.3.

Where more than one stage can allow a demanded phase to run, the stage which satisfies most demanded phases shall appear in preference to a stage satisfying a lesser number of phase demands, always providing that any intervening (i.e. in cyclic order) stages which would normally run demanded phases not appearing in that stage (i.e. the stage satisfying most demanded phases) are not skipped. Alternatively other conditions may be specified.

In the vehicle actuated method of control, stages shall appear as demanded. When all demands are present, stages shall normally appear in cyclic order. During UTC, Cableless Linking and Manual method of control, stages shall normally appear as called.

Dependent upon the method of control, the effect of the vehicle detectors on the controller may be overridden and restrictions may be applied to the changes which the controller is allowed to make.

4.2.3 Stage-to-Stage Movement Constraints

It shall be possible to achieve the following stage-to-stage movement constraints to ensure that the controller presents safe light sequences to vehicular and pedestrian traffic movements:

- a) to enable a particular stage always to follow another;
- b) to enable a particular stage always to precede another;
- c) to prohibit certain stage-to-stage moves and substitute alternative moves so that the desired stage is eventually served; and
- d) to prohibit certain preset stage-to-stage movements.

The controller's capability to provide alternative stage-to-stage movements shall be subject to the following requirements:

- a) where a request for a change of stage would violate the traffic engineering requirements of the junction, the controller shall not allow the change to take place directly but shall interpret the demand as a demand for an intervening stage and the desired stage. The desired stage shall, therefore, be served by an acceptable route;
- b) when the controller reaches an intervening stage as a result of demands placed in this manner it shall be free to operate as if the demand had been placed by the roadside detection equipment; and
- c) the controller shall also be free to service roadside demands for other stages en route to the desired stage.

It shall be possible to provide either prohibited or alternative movements for each method of control as follows:

- a) Urban Traffic Control (Prohibited or alternative moves as specified);
- c) Cableless Linking (Prohibited or alternative moves as specified);
- c) Manual Control (Prohibited Moves only);
- d) Hurry Call (Alternative Moves only);
- d) Vehicle Actuated (Alternative Moves only).

At least four unique sets of prohibited or alternative movements may be specified in the Works Specification.

4.2.4 Fixed Green Stages

In certain circumstances, where a pedestrian movement or clearance periods are required, a fixed green period may be allocated to the respective stage. Alternatively this facility may be provided by means of a dummy phase.

4.2.5 Parallel Pedestrian and/or Cyclist Phase

Pedestrian or pedestrian and cyclist phases, which run in parallel with vehicular phases, shall normally be introduced subject to the operation of a manually operated pedestrian push button or push button and bicycle detection which shall then introduce a stage which runs the phase. Alternatively they may be automatically introduced. The phase green shall be given for a fixed period controlled by the phase minimum green timer, or be extended by a vehicular phase running in parallel with it.

4.2.6 Parallel Stage Streams

4.2.6.1 General

Where detailed in the Works Specification, it shall be possible to allocate the available stages into a minimum of two stage streams. Any split in the number of stages allocated to each stage stream shall be possible, and the streams shall be capable of operating independently of one another at all times during the signal cycle.

4.2.6.2 Stage Stream Restrictions

It shall be possible to restrict the independent operation of stage streams in the following ways:

- a) by direct influences between stage streams. It shall be possible for one stage stream to have its stage changes conditioned by the state of another stage stream, and/or;
- b) by declaring conflicts (and phase intergreens) between selected phases in the different stage streams.

4.2.6.3 Pelican, Puffin and Toucan Facilities

Where Pelican and Puffin facilities are provided it shall be possible for one or more stage streams to be programmed to provide any of the signal sequences specified in clauses 6.3, 6.4, 6.5, 6.6 and 6.7.

4.3 All-Red Stage and Extended Red Period

4.3.1 All-Red Stage

Note: An All-Red Stage is a stage during which all signal phases show red.

The All-Red stage shall have a minimum period which may be extended by the relevant detectors up to a maximum period.

The All-Red stage may be called automatically. It shall commence when the last phase to lose right-of-way changes to red and it shall end when the first phase to gain right-of-way changes from red.

Any stage may be allocated as an All-Red Stage.

The All-Red condition under the manual method of control may be considered as an All-Red stage. However, during manual method of control this stage shall not be extended by All-Red detectors.

Pelican, Puffin and Toucan facilities will normally cycle to return to the vehicle green period.

In the absence of any demands, pedestrian and pedestrian/cycle facilities may be held at All-Red, if so required in the Works Specification.

4.3.2 Extended Red Period

4.3.2.1 General

An extended red period as part of the intergreen described in the following clauses can be used to extend the red condition between phases which are losing right-of-way and those phases which are gaining right-of-way at a stage to stage change. This excludes any overlapping phases which have right-of-way.

4.3.2.2 Red Extension Period

It shall be possible to extend the red period beyond the period determined by the intergreen timing. The continued output from a detector(s) associated with the extended red period facility shall cause the condition to be held, subject to a preset maximum period. The cessation of the output from the appropriate detector(s) shall cause the red condition to be held for a fixed time period – the red extension period.

During this red extension period the phase change delay timing shall be suspended (any further delays given to phases obtaining right-of-way after the extended red condition shall occur unchanged).

It shall be possible to programme different values of the red extension period for each detector.

Note: It should be noted that if alternative extension or maximum timings are required for different red periods this can be achieved by the use of a separate stage or phase. Care should be taken to ensure that any All-Red extensions operate as required during the modes of Manual, Cableless Linking, Urban Traffic Control and Hurry Call.

4.3.2.3 Extended Red Under Different Methods of Control

During Manual, Cableless Linking, Urban Traffic Control and Hurry Call methods of control, as required by the Works Specification, the red extension periods and maximum periods shall either:

- a) operate as normal, i.e. dependent upon detector inputs, or;
- b) shall automatically extend the red period up to the maximum value.

During the Fixed Time method of control, the controller shall automatically extend the red period up to the maximum value.

4.4 Green Arrow Displays

4.4.1 Indicative Green Arrow

4.4.1.1 General

Where the indicative green arrow is not part of a three light signal it shall always be illuminated during a selected stage(s), and shall be terminated by a yellow signal of the associated approach phase, unless required otherwise by the Works Specification.

It shall be possible to arrange that an indicative green arrow phase shall not run unless a demand exists for an opposing or other specified phase.

4.4.1.2 Intergreen

Where the green arrow is illuminated on consecutive stages it shall remain illuminated during the intergreen between the stages.

Means shall be provided so that at sites where an early cut-off is employed, the indicative green arrow shall be illuminated after a predetermined intergreen period, with respect to the phase losing right-of-way until the end of the early cut-off period.

It shall be possible to delay the introduction of an indicative green arrow with respect to the end of a stage at any stage-to-stage transition. Such delays shall be of defined fixed duration.

4.4.1.3 Operation Under Different Methods of Control

Under the manual method of control the demand dependent indicative green arrow shall always appear in the relevant stage.

Under the CLF method of control the indicative green arrow shall appear as in the VA method of traffic control unless otherwise specified in the Works Specification.

Under the Fixed Time method of control the indicative green arrow shall always appear during the

relevant stage unless otherwise specified in the Works Specification.

If the indicative green arrow is illuminated on a change of method of control the controller shall obey the permitted movements restrictions appropriate to the method of traffic control to which the controller is changing.

4.4.2 Filter Green Arrow

4.4.2.1 General

Where the green arrow aspect is not contained in the sequence of a three light signal it shall either always be illuminated during a selected stage(s) or shall only appear during the stage(s) if demanded from on–street detection. The green arrow shall normally be illuminated without the associated approach green being illuminated, as required in the Works Specification.

It shall be possible to arrange that a demand for the filter arrow also demands the associated approach phase. This facility may be provided by use of a separate stage.

The green arrow shall either be terminated when the associated approach phase changes to the full green signal or when the associated approach phase changes to yellow.

A combination of the appearance of green arrows may be considered as the equivalent of a full green display.

4.4.2.2 Intergreen

It shall be possible to delay the introduction of a filter indicative green arrow with respect to the end of a stage at any stage to stage transition. Such delays shall be of defined fixed duration.

4.4.2.3 Operation Under Different Methods of Control

Under the manual method of control, the demand dependent filter green arrow shall not appear unless required by the Works Specification. Where this is required, the stage running the main movement must be selected to terminate the green arrow. If another stage is selected, movement to this stage shall be prevented and the appropriate indication be given on the police control facility (where applicable).

(Option) Under the UTC method of control the filter green arrow may always appear in a particular stage, be demand dependent, or may appear during the intergreen between the stage in which the arrow would normally appear and the stage which would normally cancel it. On reaching the green of this stage the arrow may terminate or continue to the end of the green.

Under the CLF method of control the filter green arrow shall appear as the VA method of traffic control unless otherwise specified in the Works Specification.

Under the Fixed Time method of control the filter green arrow shall always appear unless otherwise specified in the Works Specification.

If the filter green arrow is illuminated on a change of method of traffic control, the controller shall obey the permitted movements restrictions appropriate to the method to which the controller is changing.

4.5 Controller Start Up Sequence

4.5.1 General

Where junction, junction linked pedestrian and stand–alone Pelican and Puffin facilities are provided within the same controller, then each facility shall function independently of the other with regard to start up requirements.

The facility may be provided to configure each facility to enable a linked start up sequence.

4.5.2 Junction Control

On restoration of the mains supply to the controller or remote switch–on of the lamps for part–time control, the traffic signals shall not be shown for a period of between 7 and 10 seconds ('All off' period following power up). After the expiry of this period, the controller shall recommence operation with the establishment of the stage pattern subject to the following constraints:

- a) vehicular phases which in Stage 1, or any other nominated 'start–up' stage, will show a red signal, shall commence with an yellow signal for a period of 3 seconds followed by red;
- b) during the yellow period the signals for

vehicular phases which will eventually show green, or green arrow, during stage 1 show the all signals off condition. They shall then show a full green signal at the end of a timed period known as the starting intergreen period. This period shall start at the commencement of the red signals of (a). It shall be possible to preset the starting intergreen period; all pedestrian and cycle signals shall be set to show red at the start of the yellow in (a).

- c) On restoration of the mains supply to the controller, demands shall be inserted (in appropriate modes of operation) for all phases to ensure that no vehicles are trapped against a phase.

4.5.3 Pelican Control

On restoration of the mains supply to the controller, the signals shall not be shown for a period of between 7 and 10 seconds ('All off' period following power up). After the expiry of this period, the controller shall recommence operation at the start of the flashing yellow to vehicles/flashing green man period to pedestrians with a stored pedestrian demand.

4.5.4 Puffin/Toucan Control

On restoration of the mains supply to the controller, the signals shall not be shown for a period of between 7 and 10 seconds ('All off' period following power up). After the expiry of this period the controller shall recommence operation in accordance with the following sequence.

The pedestrian (and cyclist) signals shall be set to show the red man. At the end of a timed period, the starting intergreen, a full green signal shall be shown to vehicles. A stored demand for pedestrians/cyclists shall be inserted.

4.6 Traffic Regulatory Signs

Signs may be switched on or off at specific times, usually under part time control. This action may, (if required), also be delayed until the appearance of specified phase green signals or alternatively the appearance of a specified stage.

5 METHODS OF CONTROL

5.1 General

The following methods of control apply to junction and stand-alone facilities, where relevant.

Any combination of the following methods of traffic control may be provided, as specified in the Works Specification.

- a) Fixed Time (FT);
- b) Vehicle Actuated (VA);
- c) Cableless Linking Facility (CLF);
- d) Part-time (PT);
- e) Hurry Call (HC);
- f) Urban Traffic Control (UTC, SCOOT, MOVA);
- g) Manual;
- h) Vehicle Priority (VP);
- i) Pedestrian Actuated (PA) (see clause 6.3.4); and
- j) other approved control method.

Note: Control method (f) currently disables speed discrimination/speed assessment strategies defined in 7.5.4.1 and 7.5.4.2.

5.1.1 Priority Structure

The methods of control shall have a priority structure. The method operated by the controller shall be the highest priority for which a request exists, and which is currently available. Any priority structure is available but a suggested arrangement is listed and will be used unless specified in the Works Specification.

- 1) Hurry Call (Highest Priority);
- 2) Manual Control;

- 3) Vehicle Priority (e.g. PSV see clause 5.10);
- 4) Urban Traffic Control (UTC, SCOOT, MOVA);
- 5) Manually selected other modes (e.g. VA, fixed time);
- 6) Cableless Linking Facility (CLF);
- 7) VA or Fixed Time (Lowest Priority).

5.1.2 Changing Methods of Control

Switching between different methods of traffic control shall be determined from the requests in accordance with the priority structure outlined above or as otherwise specified in the Works Specification. Stages shall then be served in accordance with the requirements of the new method of traffic control. Switching between methods of traffic control shall not cause any of the safety timings, (e.g. minimum green and intergreen), to be overridden.

The controller shall then proceed to service demands for right-of-way in accordance with the new method of control.

The controller shall assume the new method of control within 2 seconds of a higher priority method request being entered or removed, except where otherwise detailed in the Works Specification.

Any changes in the method of control shall eliminate the risk of vehicles and pedestrians being excessively delayed or trapped due to lost demands or extensions. This shall be performed on every control method change by either inserting demands on all non running phases or by continuously assessing demands and extensions against the associated greens and inserting the outstanding demands and extensions.

5.2 Fixed Time (FT) Operation

With this method of control, the stages shall appear in a specified order for the currently active stage maximum periods or alternative fixed time periods. Input signals from the detection systems or pedestrian push buttons shall be ignored.

Fixed-time method of control shall be introduced by a switch or push button on the Manual Control Panel.

It shall be possible to define the stage sequence for the Fixed-time method of control.

Extended Red, where provided, shall run to the maximum value for that intergreen, to ensure that a safe consistent fixed cycle is generated when operating this method of traffic control.

Any phases which may run conditionally within stages in the Vehicle Actuated method of control shall always run if the appropriate stage appears in the Fixed-time method of control.

After power is restored, following a power failure, if the controller is switched to Fixed-time then it shall continue to work in the Fixed-time mode.

5.3 Vehicle Actuated (VA) Operation

5.3.1 Introduction

The controller shall systematically give green (right-of-way) to demanded vehicular or pedestrian phases. Once a phase has been given right-of-way, this right-of-way shall continue for a preset minimum period – the minimum green period. Vehicular phases greens may be extended by requests from ‘on street’ detection; each such request shall cause the controller to give the associated phase its preset green extension time.

If a conflicting, or opposing, phase demand exists, the running phase green may be extended up to the phase maximum green time, at which time the controller shall attempt to serve one, or more, of the conflicting, or opposing, demanded phases, by calling a new stage.

5.3.2 Extension of Vehicle Phase Green

The passage of a vehicle through a detection zone 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 or detectors associated with a phase shall hold, subject to the maximum green running period, that phase green signal. The cessation of the output from the detector shall normally terminate the green extension request after a fixed extension period, subject to the cessation of extensions from other associated detectors. (See Figure 5a.)

If at the end of the extension time the stage is held by extensions associated with another phase, further extension requests shall be permitted (subject to the maximum green running period).

It shall be possible to arrange that selected detector input(s) do not extend a phase during a single selected stage.

It shall not be possible for the relevant phase green periods to be terminated before extension inputs that have been accepted are actioned or legitimately overridden (e.g. by MAX or UTC force bit).

Where a speed discrimination or speed assessment system is used this may also cause an extension to a phase green period. (See chapter 7.)

5.3.3 Termination of Vehicle Phase Green

5.3.3.1 Gap Change

A gap change of stage shall occur when the following conditions are satisfied:

- a) a demand for right-of-way for a conflicting phase exists;
- b) the minimum green running periods of phases which will lose right-of-way have expired; and
- c) the vehicle green extension timers have expired on all phases which will lose right-of-way upon the change to the next stage.

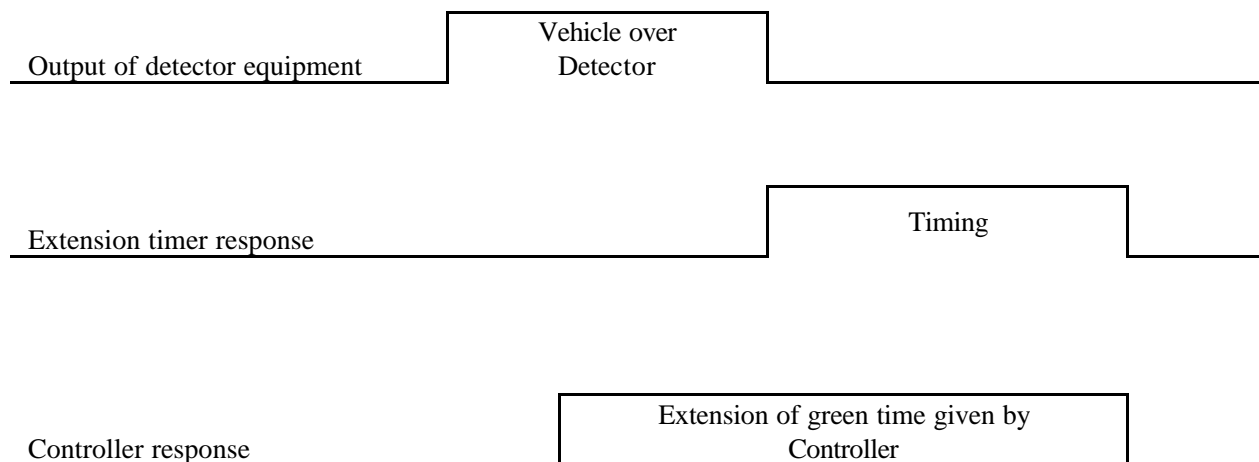


Figure 5a – Detector Logic

5.3.3.2 Maximum Green Change

The maximum green running period shall be provided for each vehicle actuated phase such that when a phase obtains right-of-way, the maximum green running period shall start to time off immediately. If there is a demand for any conflicting, or opposing phase, or, if there is no conflicting, or opposing demand present, it shall start to time off upon the receipt of a subsequent demand for any conflicting, or opposing phase.

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

Alternative values of maximum running periods shall be available.

After the termination of the last phase maximum green for phases not served by the next stage to be introduced, a stage change shall occur to serve the conflicting demanded phase(s). This change may take place irrespective of whether the maximum or minimum green periods for the phase(s) also served by the new stage have expired.

5.3.4 Quiescent Signal State

In the absence of demands, the signals may reside on All-Red, as required in the Works

Specification.

5.4 Cableless Linking Facility (CLF)

Note (a): The cableless linking facility, or CLF, allows a method of linking traffic signals along a route and/or in an area using timing information derived from their master time clock systems.

Note (b): All signal controllers in a linked system are related to a common cycle time for any particular traffic plan. The Master Time Clock System (MTCS) instructs the controller to change from one traffic plan to another and during the plan when to exert specific influences (e.g. to move from one nominated stage to another).

In this way a variety of signal linking can be achieved ranging from a simple co-ordinated two controller link to a fully co-ordinated multi-plan system, or to act as a standby system in a Computer Controlled Urban Traffic Control System.

5.4.1 Plan Facilities

5.4.1.1 Timing Periods

The necessary timing signals for the execution of a specific plan shall be derived from the group timer using the following periods:

- a) **Offset Time** – The offset time shall relate the start of the timing cycle on the individual

controller to reference time. Alternatively offset times can be derived by varying the times of introduction of particular plans on linked controllers;

- b) **Cycle Time** – The cycle time shall be equal to the summation of the individual.
- c) **Group Start Time** – Group start time shall be the time that each group commences from the start of the cycle time.

5.4.1.2 Group Influences

The function of each group and the number of groups within a cycle shall be programmable within the individual plan to exert one of the following influences at a time upon the main controller.

- a) **Immediate** – An immediate move to the specified stage, subject to the constraints imposed by safety timings and stage to stage movement restrictions.
- b) **Demand Dependent** – That is, an immediate move to a specified stage if demanded by street demands.
- c) **Isolate** – Allow unrestricted local Vehicle Actuated method of traffic control to operate. Phase maximum periods shall have no effect.
- d) **Hold** – The hold influence shall not allow any stage-to-stage changes to occur.
- e) **Prevent** – The prevent influence shall prevent all stage to stage moves except, if demanded by street demands, a move to the stage specified by the next group in cyclic order providing that no extensions exist for the phases losing right-of-way.

The plan may also allow stages to be introduced or deleted, within the constraints of the basic stage/phase definitions. Hence, phases may be allowed to run or be prevented from running. The stage structure changes made by a plan (by including or deleting stages) shall only apply whilst the controller is operating the Cableless Linking method of control.

5.4.2 Changes to Method of Control and Plan Changes

If the method of control is to change to CLF, implementation of the ‘new’ stage may be delayed until the start of the next group timing period. This delay shall also apply if a plan change occurs whilst operating the CLF method of control.

It shall be possible to modify the timings of a plan that is currently in operation.

When a new plan is implemented by the timetable it shall always commence with the first group.

5.4.3 CLF Control of Parallel Stage Streams

It shall be possible to allocate the groups of the group timer to the stages of different stage streams. For each stage it shall be possible to specify the particular group influence which shall apply.

It shall be possible for the group timings for any stage stream to be independently adjusted from those of other stage streams.

5.5 Part Time Operation

The traffic signals may be switched on or off at specific times or for specific tasks or reasons. Switch-on of lamps shall be as defined in clause 4.5. If the controller is in a standby mode (i.e. power on) then the 7–10 seconds delay, reserved for a cold start (i.e. from power off) may be ignored.

The signals shall be switched off under part-time control during a nominated stage provided that all minimum running periods have expired. Red lamp monitoring shall be provided as specified in clause 9.11.

5.6 Hurry Call (HC)

Note: The purpose of the Hurry Call is to enter a priority demand for a particular stage to ensure that a green signal is given to certain vehicles. Hurry Calls may be used at junctions, or stand-alone signals 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. This Specification enables stand-alone pedestrian facilities to reside on All-Red signals

which may now be influenced by Hurry Call demands subject to protection of safety timings.

5.6.1 Changing to Hurry Call Method Of Control

The Hurry Call request for a stage shall normally be generated from special on-site detectors or from a remote push button. Where more than one request exists, it shall be possible to prioritise the requests.

On receipt of a Hurry Call request the controller shall go into the Hurry Call method of control after a preset delay, (the Hurry Call Delay Period), providing the controller is not in a higher priority method of control.

On expiry of the Hurry Call Delay Period, the controller shall move immediately to the requested stage, provided that the intergreen timings and minimum green timings associated with any phases losing right-of-way in the currently running stage have expired. Extensions for running phases shall be ignored.

If the requested move to the Hurry Call stage is not permitted directly, the controller shall move via the All-Red stage or other specified permitted stage movements to the Hurry Call stage. If the move is accomplished via intervening stage(s) these stage(s) shall terminate when their phase minimum running periods have expired.

5.6.2 Hurry Call Hold

Once the Hurry Call stage has been reached, it shall be possible for the equipment to hold the stage for a preset period – the Hurry Call Hold Period. No stage change shall take place until the preset Hold Period has expired even though phase minimum green, maximum and extension timings will not be reset or held during the Hold Period. After the Hold Period the equipment shall revert to the next requested lower priority method of control.

5.6.3 Changing From Hurry Call Method of Control

An input shall be provided to cancel the effect of the Hurry Call and return the controller to the next requested priority method of traffic control.

The Hurry Call shall be prevented from being

recalled for a preset period, known as the Hurry Call Prevent Period. The controller shall remain in the current method of control during this period unless other overriding priority control method(s) are requested. Hurry Call requests input during the Hurry Call Prevent Period shall be invalid. The Hurry Call Prevent period will commence timing when the Hurry Call stage is reached during Hurry Call method of control. The cancel signal, from the prevent period timer, shall cause the Hurry Call Prevent Period to be cancelled.

It shall be possible to insert a revertive demand such that if a phase green is terminated with the extension timer running, a demand for a return to that phase shall normally be inserted. Where required the demand may alternatively be specified for another specified phase.

5.6.4 Interface

A Standard Interface as defined by clauses 3.2.2 and 3.2.4 of this Specification shall be provided for connection to the Hurry Call request and cancel inputs. Condition '1' on the Hurry Call or Cancel inputs shall cause the controller to action the Call or Cancel within 250 milliseconds of the '0' to '1' transition. For logic state conditions see 5.7.2.1.

When requested in the Works Specification, a Standard Interface shall be provided to indicate the period from when a valid Hurry Call is received until the Hurry Call Delay and Hold Periods have elapsed and the controller has resumed normal operations.

The controller shall be capable of providing at least two Hurry Call facilities which may be allocated to any of the controller stages. Hurry Calls shall be ordered on a priority structure. The presence of a request for the lower priority Hurry Call shall be ignored during the Delay and Hold periods of the higher priority Hurry Call.

5.7 Urban Traffic Control (UTC)

5.7.1 General

In the UTC method of control, the controller is controlled either by a remote computer, via a data transmission system, or by a MOVA unit, which may be either integral to the controller or installed as an ancillary item. More details on UTC, including SCOOT (Split, Cycle and Offset Optimisation

Technique) can be found in MCE 0360. MCH 1542 provides more details on MOVA (Microprocessor Optimised Vehicle Actuation).

This section details the operation and facilities of the controller to be compatible with existing UTC systems under remote computer control and with existing MOVA equipment under local control.

The facilities described in this section shall be available in any combination, as required by the Works Specification. The controller shall operate as indicated by this section when used in a UTC system to MCE 0360.

Controllers may become part of a UTC system and shall comply with one of the following options.

- a) *Option 1* permits force signals to behave as though simultaneous demand bits were transmitted.
- b) *Option 2* allows a measure of vehicle actuated operation during the UTC cycle.

When operating under Urban Traffic Control, the Controller shall operate in a stage based manner, as specified in clause 4.2, whereby it is necessary to allocate phases to stages, such allocations being conditioned by the traffic requirements and safety constraints.

Designations of control/reply signals (see clauses 5.7.4 and 5.7.5) are those commonly used. Others may be used where a need is identified.

Integral MOVA may be used as a fall-back mode for UTC.

5.7.2 OTU/Controller Interface – Ancillary

The Controller shall be linked to the transmission system by an OTU designed to MCE 0312 or MCE 0361, normally housed within the Controller cabinet.

Control and reply information between an OTU and the signal controller shall be presented at the OTU/Controller interface.

5.7.2.1 Interface Signal Conditions

The logical conditions are defined as follows:

Method 1

- a) a logical condition '0' represents the inactive state and, where relevant, will be the closed circuit condition across the controller input terminals and the closed circuit condition across the controller output terminals of the OTU/Controller interface;
- b) a logical condition '1' represents the active state and, where relevant, will be the open circuit condition across the controller input terminals, and the open circuit condition across the controller output terminals of the OTU/Controller interface.

This may present a compatibility problem with some existing ancillary equipment. As an option it may therefore be possible to configure the logical conditions as per method 2.

Method 2

- a) A logical '0' condition represents the active state and, where relevant, will be the closed circuit condition across the controller input terminals and the open circuit condition across the controller output terminals of the OTU/Controller interface.
- b) A logical '1' condition represents the idle state and, where relevant, will be the open circuit condition across the controller input terminals, and the closed circuit condition across the controller output terminals of the OTU/Controller interface.

A change of the control signal condition presented at the OTU/controller interface shall not be accepted by the controller until the signal condition has persisted for two successful controller scans to ensure valid data. The time between scans shall not exceed 400 milliseconds. The controller shall not accept any control signals shorter than 10 milliseconds. The controller reply signals presented at the OTU/controller interface shall be updated simultaneously at least once per controller scan.

5.7.3 OTU/Controller Interface – Integral

It may be possible for a manufacturer to supply

equipment with the OTU function integrated into the controller logic. Such an integrated system will interface to the transmission lines subject to the relevant Clauses of MCE 0361 or of MCE 0312 in particular chapter 4 (except for clause 4.12), and chapter 5. Such a system need not necessarily interface to all the variants of data transmission formats in current use.

When the integrated OTU facility is used, a manufacturer shall be able to provide facilities for switched signs and/or remote pelican controllers or any other item of equipment controlled via the interface.

Note: With a separate OTU such signals would be derived directly from the OTU input/output interface in accordance with the Standard Interface requirements defined in clauses 3.2.2 and 3.2.4.

It shall be possible to configure control and reply bits between the OTU and the controller. This may be via a handset.

A change of the control signal condition presented through the OTU/Controller interface shall not be accepted, by the controller, until the controller has ensured the data is valid. Data shall be validated within 400 milliseconds. The controller reply signals presented at the controller/OTU interface shall be updated simultaneously at least once every 400 milliseconds.

5.7.4 Control Signals (Originating externally to the controller)

It shall not be possible for any single control signal or for any combination of control signals in any sequence, to modify the duration of any minimum green period or fixed intergreen period.

Table 5.3 refers to junction control functions, Table 5.4 refers to stand-alone functions and Table 5.2 details functions that are common to both.

5.7.4.1 Stage Demand Bits DX and D1, D2 etc.

Common Demand Bit (DX). Condition '1' on the DX control bit shall simulate the operation of detector inputs to the controller from detector equipment on vehicle actuated stages and, where specified, on pedestrian stages by simulating demands or demands/extensions for selected phases associated with each of the stages. Exceptionally,

(where specified), certain stages may be excluded from this common demand. DX shall not inhibit the operation of the pedestrian push buttons and/or vehicle or pedestrian detectors.

DX Bit and Other Methods of Control. The DX function shall be fitted to all controllers equipped for the UTC method of control and may operate in any mode.

DX and Option 1 Strategy. For controllers operating the UTC method of control to OPTION 1 strategy, DX shall simulate the operation of all detectors. Under other methods of traffic control DX will simulate the operation of detectors on all vehicle actuated stages and, (where specified), of pedestrian demands.

DX and Option 2 Strategy. For controllers operating to OPTION 2 strategy, DX will simulate the operation of detectors on all vehicle actuated stages and (where specified), of pedestrian demands under either remote computer control or local operation. Means shall be provided of allocating phase detectors to stages.

DX Operation and VA Operation. The Common Demand bit (DX) shall cause each of the stages called by DX to run for its fixed maximum. The continuous presence of DX shall cause the controller to serve the demanded stages in cyclic order.

DX Operation with F Bits (optional). With this option some stages will be declared demand dependent. Such demand dependent stages will only respond to an F bit either when a local demand exists or when a DX bit is sent with the F bit. (Thus a particular DX bit is allocated to a stage and will not insert demands for any other stage). e.g. F1 = go to stage 1 if a local demand for stage 1 exists; F1.DX = forces controller to stage 1.

Demand Bits and the Detector Fault Monitor. The Common Demand bit (DX) and the individual stage demand bits D1, D2 etc shall not influence the Detector Fault Monitor.

Individual Computer Stage Demand Bits (D1, D2 etc). Where specified in the Works Specification certain stages may be demand dependent each with its own demand bit.

Logical Conditions for Stage Demand Bits.

Condition '1' on a stage demand bit (D1, D2 etc.) shall simulate the operation of a detector by simulating the demands and extensions for selected phase(s) associated with the stage.

Insertion of Stage Demands. Stage demands may be derived from:

- a) Common Demand Bit (DX);
- b) Individual Stage Demand Bits (D1, D2 etc.);
- c) Pedestrian Push Buttons (with pedestrian detection in the case of Puffins);
- d) Vehicle Detectors.

Non-Demand Dependent Stage. In the UTC method of control the non-demand dependent stages (i.e. stages not covered by DX, or D1, D2 etc) will behave as though a demand signal has been received simultaneously with the corresponding force signal. (This is to cater for Option 1 strategy.)

Latching and Non-Latching Demands.

Computer stage demands (DX, D1, D2, etc) may be latched or not latched, as specified in the Works Specification and will simulate street detection as in clauses 7.2.1, 7.2.2 and 7.2.3 with the following exceptions:

- a) timing delays associated with the delayed call/cancel facilities are not applicable to computer demands, (i.e. the presence of a computer demand associated with the call/cancel facility shall cause an immediate demand for the associated phase to be registered). Removal of the computer demand shall remove the associated phase demand unless this is also generated by street detection;
- b) the condition where a turning phase demand is active only if another selected phase demand is present, shall not be overridden by a UTC computer calling for the stage which runs the turning phase. If the turning phase is demand dependent when operating under Urban Traffic Control mode a demand

for the conditional phase must be detected from one of the sources specified in clause 7.2.3 paragraph 1, before the turning stage is actioned.

Servicing of Stage Demands. The servicing of demands shall be subject to traffic movement constraints specified in clause 4.2.3 and to the presence of force bits.

When there are no force bits present, the controller will revert to the fall-back method of control as required by clause 5.7.4.3.

A demand for a stage may either extend that stage or request the stage to run according to the following provisions:

- a) a VA stage already having right-of-way:
 - i) if an extendable stage already has right-of-way, a demand shall hold the vehicle extension timer reset and, on release of the demand, the vehicle extension timer associated with the stage shall become operative;
 - ii) if at any time the maximum timers for the relevant phases in the stage expire then the required stage change away from this stage shall occur and the demand shall then be treated as a demand for a stage not having right-of-way. Only the maximum timers for those phases which do not run in the next stage are regarded as relevant.
- b) Stages not having right-of-way:

If a stage does not have right-of-way, a demand for the stage shall request the stage.

5.7.4.2 Force Bits (F1, F2 etc.)

The controller shall assume the UTC method of traffic control within 400 milliseconds of a force bit being accepted or, conversely, in the absence of force bits, the controller shall revert to the fall-back method of traffic control within 400 milliseconds. This time may be additional to the time required to ensure valid data, as detailed by clauses 5.7.2 and 5.7.3.

The forced change to the selected stage shall not contravene any restrictions upon stage to stage movements which may be imposed by the requirements of clause 4.2.3.

Condition '1' shall force the controller to make an immediate change to the selected stage or shall hold a selected stage subject to the following conditions:

- a) if the selected stage does not have right-of-way then condition '1' on the force bit for that stage, and no other, shall cause a forced change to that stage provided that a demand exists or is assumed to exist for the stage;
- b) if the controller is in an intergreen or a minimum green period, the change to the selected stage shall be deferred until the expiry of the minimum green period, provided that the force condition still exists;
- c) if the selected stage has already appeared, condition '1' on the force bit for that stage shall reset the phase maximum timers and hold that stage for so long as the condition '1' is received, provided that gap changes to another demanded stage are prevented by vehicle extensions (e.g. either by control demand signals or from local detectors).

Where called for in the Works Specification, it shall be possible for a stage to behave as though a control demand signal (D1, D2, etc) has been received simultaneously with the corresponding force signal, even though no such demand signal has been transmitted.

A facility shall be provided to time-out force bits such that if an F bit(s) is unchanged for longer than a predetermined time the controller shall revert to the fall-back method of control. This time shall be preset at a value in the range between 120 and 300 seconds, and adjustable in incremental steps no less than 10 seconds. If no time is specified then a default of 200 seconds shall be set.

This facility shall not be provided if the MOVA Take Over (TO) but set to '1'.

If condition '1' is received on the force bits for

more than one stage simultaneously then the controller shall respond as in table 5.1.

5.7.4.3 Switch Facility (SF1, SF2, etc.)

Condition '1' shall switch a specified miscellaneous facility, (e.g. a regulatory traffic sign). This facility may be provided by interfacing directly to the specified OTU output terminal or via the controller.

If required by the Works Specification this facility may be associated with a nominated stage or phase so that a sign will only switch 'ON' at the start of the nominated stage and shall only be extinguished at the start of a nominated stage or phase green.

If required by the Works Specification the command to switch the facility shall remain in the '1' or the '0' states for a period of between 7 and 10 seconds before the facility is switched on or off. Where the switching action is associated with a stage the time period shall have expired before the start of the stage for the switching action to take place.

The condition '1' shall be the fall back condition and where relevant should be associated with the safe state of the sign as defined in the Works Specification.

Where this facility is used to control a sign, a phase lamp drive equipment may be used for this purpose.

5.7.4.4 Hold Vehicle (PV)

Condition '1' shall prevent the appearance of the pedestrian stage by the imposition of a 'hold' condition on the vehicle stage. All pedestrian demands which have not been served, or which occur during the 'hold' period, shall be stored and allowed to mature in a normal manner when the PV signal ceases.

5.7.4.5 Pedestrian Demand (PX)

Condition '1' shall simulate a pedestrian push button operation. Where the Puffin facility is provided, this shall also simulate an output from the kerb side detector.

5.7.4.6 Solar Switch Override (SO)

Condition '1' shall switch the traffic signals to the non-dimmed condition, overriding the Solar Switch.

Condition '0' shall not override the solar switch.

5.7.4.7 CLF Group Timer Synchronisation Signal (SG)

Receipt of an external signal, having the series message format '1, 0, 1' (received over three consecutive transmission message cycles), shall cause the CLF to commence the relevant plan cycle timing from the start of the first group within 1 second $\pm 5\%$ of the '0' to '1' transition of the synchronising message. The Group Timer synchronising signal shall take effect at the receipt of the second '1' providing the Group Timer synchronising signal has been correctly received.

The synchronisation shall not respond to the message format if the duration of each '1, 0, 1' bit lasts for less than 1 second.

Note: This is intended to prevent the operation of a time switch affecting synchronisation.

<i>Current Stage</i>	<i>Condition</i>	<i>Option 2</i>	<i>Option 1</i>
Controller already on one of stages for which a force bit is being received	1. No demands.	Hold current stage indefinitely.	Hold current stage indefinitely.
	2. Demand (Ext) for current stage.		
	3. No demand for current stage, demand for other forced stage(s).	Change to next forced stage in cyclic order.	
	4. Demands for stage(s) other than forced stage(s).	Change(s) to demanded stage(s).	
Controller <u>not</u> already on one of the stages for which a force bit is being received.	1. No demands.	Hold current stage.	If both forced stages are demand dependent – hold current stage. If either of the forced stages is not demand dependent then demands are assumed and a move to the next forced (and demanded) stage in cyclic order is made, and is then held indefinitely.
	2. Demand for one of the forced stages.	Move to demanded stage and hold.	Move to next forced (and demanded) stage in cyclic order and hold.
	3. Demand for two or more forced stages.	Move to next of the forced stages in cyclic order and hold.	Move to next of the forced stages in cyclic order and hold.
	4. Demands for stages other than forced stages.	Move to demanded stages in cyclic order. (Dependent on traffic movement constraints.)	If both forced stages are demand dependent, hold current stage. If either of the forced stages is not demand dependent then move to the next forced (and demanded) stage in cyclic order and hold.

Table 5.1 – Simultaneous Force Bits

5.7.4.8 Lamps On/Off (LO)

Where a condition '1' exists for a minimum of 10 seconds, the signals shall switch on in accordance with the Start Up Sequence specified in clause 4.5. Where a condition '0' is present for a minimum of 10 seconds, the signals shall switch off during a nominated stage, provided that all minimum running periods have expired.

5.7.4.9 Local Linking Inhibit (LL)

Condition '1' shall inhibit local linking between parallel stage streams, or other local links as specified in the Works Specification.

5.7.4.10 Time Synchronisation Signal (TS)

Receipt of an external signal, having the series message format '1, 0, 1' (received over three consecutive transmission message cycles), shall cause the controller clock to reset to 00:00 hours. The controller synchronising signal shall take effect at the receipt of the second '1' providing the Group Timer synchronising signal has been correctly received.

The synchronisation shall not respond to the message format if the duration of each '1, 0, 1' bit lasts for less than one second.

Note: This is intended to prevent the operation of a time switch affecting synchronisation.

5.7.4.11 Fall Back Selection (FM)

When it is not in the UTC mode, condition '1' shall inhibit CLF mode and cause the controller to revert to the next lowest priority method of traffic control. Condition '0' shall have no effect.

5.7.4.12 Take Over (TO)

This facility shall change control to be accepted from a remote source.

Where an ancillary MOVA unit is specified, i.e. control is via the UTC interface, control shall only be operational when the Take Over bit (logic condition '1') is present.

5.7.4.13 Hurry Call Inhibit (HI)

Logic condition '1' shall inhibit Hurry Call Requests.

5.7.4.14 Transmission Confirm (TC)

The TC bit shall be set to logic condition '1' when a validated control message has been received by the OTU. When the TC bit is set to logic '0' (inactive condition) the controller shall ignore all control data from the OTU.

5.7.4.15 Close Car Park (CP)

Logic condition '1' shall close the car park.

5.7.5 Reply Signals

The signal controller shall return reply signals via the OTU to indicate any of the functions specified below. The appropriate reply signals shall be present in all methods of traffic control. Condition '1' indicates the active facility in all cases.

Table 5.3 refers to junction control functions, Table 5.4 refers to stand-alone functions and Table 5.2 details functions that are common to both.

5.7.5.1 Stage Confirmation (Gn)

Condition '1' confirms that a particular stage, or phase if specified is running.

G1 and G2 shall normally be returned simultaneously to indicate that one of the following has occurred:

- a) the mains supply to the signal lamps is off;
- b) manual method of traffic control is either in operation or requested.

Note: All the reply bits may be condition '0' under certain controller/OTU fault states.

5.7.5.2 Vehicle Stage Green Confirmation (GX)

Condition '1' confirms that a green signal is displayed to vehicles on a stand-alone controller. When the signals are not on stage green, or when the controller or signals are switched off, the indication returned shall be condition '0'.

5.7.5.3 Detector Fault Monitor (DF)

Condition '1' confirms that the detector fault monitor system indicates a detector failure (clause 7.6).

5.7.5.4 Fall Back Selection Confirmation (FC)

Condition '1' confirms that the Fall Back selection facility has been introduced.

5.7.5.5 Switch Facility Confirmation (SCn)

Condition '1' confirms that a particular Switch Facility has been introduced.

5.7.5.6 Hurry Call Confirmation or Request (HC)

Condition '1' confirms that a Hurry Call request is being actioned, or that a Hurry Call is requested.

5.7.5.7 Wait Indicator Confirm (WI)

Condition '1' confirms that the WAIT indicator (Pelican) is energised. Condition '0' shall be given when the wait indicator, controller or signals are switched off.

5.7.5.8 Pedestrian Stage Green Confirm (PC)

Condition '1' confirms that the pedestrian green signal is energised. Condition '0' shall be given when the controller or signals are switched off. This can apply to junction or stand-alone facilities.

5.7.5.9 Puffin Pedestrian Clearance Period (PR)

Condition '1' confirms that the pedestrian clearance period (reference 6.4.4, period 6) is operative. Condition '0' shall be given when the controller or signals are switched off.

5.7.5.10 CLF Group Timer Synchronisation Confirm (CG)

A signal shall be returned to the OTU/controller interface when the synchronising signal has been correctly received and actioned. This reply signal (condition '1') shall be normally maintained for a period of 3 seconds \pm 1 second or as specified in the Works Specification.

As an option the CG bit may confirm the time of day and day of week in the controller clock. The CG bit may be set to condition '1' (active) at a predetermined period after the controller synchronisation time. The length of time the signal is held active shall indicate the day of the week as follows:

Sunday	3 seconds
Monday	5 seconds
Tuesday	7 seconds
Wednesday	9 seconds
Thursday	11 seconds
Friday	13 seconds
Saturday	15 seconds

5.7.5.11 Group 1 Indication (GR1)

That CLF is in the first group. This reply signal (condition '1') shall be maintained for a period of three seconds \pm 1 second.

5.7.5.12 Stage Demands (SDn)

Condition '1' confirms that a demand exists for a stage.

5.7.5.13 Manual Control (MC)

Condition '1' confirms that Manual Control is either in operation or requested.

5.7.5.14 Controller Fault Indication (CF)

Condition '1' confirms that an entry is in the system fault log.

5.7.5.15 Lamps Extinguished Indication (LE)

That the mains supply to the signal lamps has been interrupted by:

- operation of the lamp switch, or;
- the lamp fuse being blown, or;
- the controller mains supply being off (only in the case of a separately powered OTU).

This may include part time signal operation.

5.7.5.16 Remote Reconnect (RR)

As an optional facility, the controller may be released from remote control due to manual intervention. Condition '1' shall request release and condition '0' shall be returned to request re-establishment of remote control (see clause 5.7.5.13).

5.7.5.17 Lamp Failure (LFn)

Condition '1' confirms that one or more traffic signal lamps have failed, where these are monitored.

5.7.5.18 Vehicle Red Lamp Failure (RF1)

Condition '1' confirms that at least one vehicle red lamp has been accepted as failed where these are monitored for Part Time or Pedestrian Audible/Tactile Control.

5.7.5.19 Vehicle Red Lamp Failure (RF2)

Condition '1' confirms that a second vehicle red lamp has been accepted as failed on an approach, or a vehicle red lamp feed has failed where these are monitored for Part Time or Pedestrian/Audible Tactile Control or the Red Lamp monitor has failed.

5.7.5.20 Emergency Vehicle (EV)

Condition '1' confirms that the controller is servicing a priority call, other than a hurry call.

5.7.5.21 Vehicle Count (VC)

A count of the number of vehicle pulses scaled by a predetermined scale factor.

5.7.5.22 Queue Detector (VQ)

Condition '1' confirms that the Vehicle Queue Detector indicates a queue state.

5.7.5.23 Car Park Occupancy Threshold Exceeded (CA)

Condition '1' confirms that the car park occupancy threshold is exceeded.

5.7.5.24 Queue at Car Park Reservoir (CR)

Condition '1' confirms that a queue state exists at the car park entry reservoir.

5.7.5.25 Car Park Closed (CL)

Condition '1' confirms that the car park is closed.

5.7.5.26 Car Park Information (CSn)

Condition '1' indicates the state of specified signs associated with the car park.

5.7.5.27 Handset Connected (TF)

Condition '1' confirms that the handset equipment is connected to the Terminal interface.

5.7.5.28 SCOOT Detector Output Presence (VS_n)

Condition '1' is the active output state on a SCOOT detector.

Note: These are four sample bits/second/ detector.

5.7.5.29 Cabinet Door Open (CO)

Condition '1' confirms that the cabinet door is open.

5.7.6 UTC Control of Stage Streams

Stage streams shall be controlled by UTC according to one of the following 3 options, any of which it shall be possible to specify.

5.7.6.1 Option A, Master–Master Linking

Control shall be achieved by separate forces to each stream. For the computer method of traffic control to operate on any stream, force bits are required to be present for all streams. If force bits for any of the streams are absent, the controller will revert to the standby method of traffic control except when control bit, LL, is present.

5.7.6.2 Option B, Master–Slave Linking

Only the master stream is required to be computer controlled. The slave streams shall either be computer controlled or under the control of master–slave cross–linking. Under this option the computer method of traffic control does not operate if force bits for the master stage stream are absent, except when control bit, LL, is present.

5.7.6.3 Option C, Unlinked

Streams with no cross–linking constraints shall have completely independent computer control for each stream. The method of traffic control of one stream shall have no effect on the method of control of any other stream.

Control		Description	Reply	
Designation	Clause		Clause	Designation
SFn	5.7.4.4	Switch Facility	5.7.5.5	SCn
SO	5.7.4.7	Solar Override		
SG	5.7.4.8	CLF Group Timer Synchronisation	5.7.5.10	CG
LO	5.7.4.9	Lamps On/Off	5.7.5.15	LE
LL	5.7.4.10	Local Link Inhibit		
TS	5.7.4.11	Time Switch Synchronisation to Stored Value (or Nearest ½ Min)		
TO	5.7.4.13	Take Over		
TC	5.7.4.15	Transmission Confirm		
CP	5.7.4.16	Close Car Park	5.7.5.25	CL
		Detector Fault Monitor	5.7.5.3	DF
		CLF Group Timer in First Group	5.7.5.11	GR1
		Remote Reconnect	5.7.5.16	RR
		Entry in Controller Fault Log	5.7.5.14	CF
		Handset Connected	5.7.5.27	TF
		Lamp Fault	5.7.5.17	LFn
		Car Park Occupancy Threshold Exceeded	5.7.5.23	CA
		Pedestrian Green Confirm	5.7.5.8	PC
		Queue Detector Presence	5.7.5.22	VQ
		Detector Vehicle Count	5.7.5.21	VC
		Car Park Information	5.7.5.26	CSn
		Queue at Car Park Entry Reservoir	5.7.5.24	CR
		SCOOT Detector Presence	5.7.5.28	Vsn
		Cabinet Door Open	5.7.5.29	CO

Table 5.2 – Control and Reply Bits for either Junction or Stand-alone Facilities

Control		Description	Reply	
Designation	Clause		Clause	Designation
Dn (or Dx)	5.7.4.2	Demand Individual Stage (or Common Stages)	5.7.5.12	SDn (or SDx)
Fn	5.7.4.3	Force Stage		
FM	5.7.4.12	Fall Back Mode	5.7.5.4	FC
HI	5.7.4.14	Hurry Call Inhibit		
		Stage Confirmation, Stage n	5.7.5.1	Gn
		Hurry Call Confirmation or Request	5.7.5.6	HC
		Manual Control	5.7.5.13	MC
		Emergency Vehicle	5.7.5.20	EV
		Vehicle Red Lamp Failure Indication 1	5.7.5.18	RF1
		Vehicle Red Lamp Failure Indication 2	5.7.5.19	RF2

Table 5.3 – Control and Reply Bits for Junction Facilities

Control		Description	Reply	
Designation	Clause		Clause	Designation
PV	5.7.4.5	Hold Vehicle Stage		
PX	5.7.4.6	Demand Pedestrian Stage		
		Puffin Clearance Period	5.7.5.9	PR
		Vehicle Green Confirm	5.7.5.2	GX
		Wait Indicator Confirm	5.7.5.7	WI

Table 5.4 – Control and Reply Bits for Stand-alone Facilities

5.7.6.4 Stage Stream Routining

Where stage streams are cross-linked to an extent which would inhibit the normal UTC night-time routining, it shall be possible (subject to safety considerations) to arrange for specific cross-linking to be disabled. This shall be achieved by the use of a specific local linking inhibit bit (LL) sent by the computer. It shall also be possible for the receipt of LL with force bits for one stage stream to modify other cross-linking constraints if specified.

5.8 Manual Control

5.8.1 General

The controller shall incorporate facilities, where specified in the Works Specification, to enable manual operation of the traffic signal stage sequence. Facilities may be provided to call stages and indicate

which stage is currently running.

Under the Manual method of control the normal influence of the detectors shall be suspended and any existing demands ignored, except when associated with the extended red period as specified in clause 4.3.2.3. Stages shall be served as requested by the operator. Any detector whose operation would normally prevent the appearance of a stage shall be inhibited under the Manual method of traffic control.

5.8.2 Manual Control Facilities

5.8.2.1 General

A manual panel shall be incorporated in the controller to provide access to one of three sets of facilities as required by the Works Specification.

The manual control facilities sets 1, 2 and 3 shall,

unless stated, be operationally latched (including under power failure conditions) until the status of that facility is changed by an alternative command.

The facilities of clauses 5.8.2.3 (c) and (d) shall be rendered inoperative if a higher priority method of control is selected.

5.8.2.2 Set No. 1

A switch shall be provided to immediately remove the signal lamps supply and audible/tactile supplies without interfering with the supply to the controller operating circuits. When the lamps are switched on again the controller shall operate in the startup sequence described in clause 4.5.

5.8.2.3 Set No. 2

The following facilities shall be provided:

- a) a switch as specified in clause 5.8.2.2;
- b) switches to select the following individual methods of traffic control:
 - i) normal;
 - ii) fixed time; and
 - iii) manual;
- c) a facility consisting of switches to switch from stage to stage in sequence, called during manual conditions, but having regard to any restrictions specified in clause 4.2.6 Stage switching shall be achieved without interference to any preset clearance periods. Stage requests shall not be stored;
- d) a facility to call an All-Red condition shall be provided. When this condition is called, the controller shall switch to All-Red immediately subject to outstanding minimum green and intergreen periods and shall be terminated by the selection of another stage to which it shall switch via the red/yellow period for the new stage and subject to intergreen timings. All-Red condition requests shall not be stored. It shall be possible to select and hold the All-Red condition indefinitely.

The functions of the switches in clause 5.8.2.3(c)

and (d) shall not be latched.

5.8.2.4 Set No. 3 (Part Time Signals Only)

The following facilities shall be provided:

- a) a switch as specified in clause 5.8.2.2;
- b) switches as specified in clause 5.8.2.3 (b);
- c) stage call switches as specified in clause 5.8.2.3(c);
- e) the facility to call an All-Red condition as specified in clause 5.8.2.3(d);
- e) switches to override normal part time operation as follows:
 - i) switch signal lamps permanently on when normally off under part time operation. Once the signals have been switched on, further operation of this switch shall have no effect until the controller has been restored to normal part time operation by the switch back facility described in (ii) below; and
 - ii) switch back to normal operation where the signal lamps follow the requests for part time operation.

5.8.3 Manual Control of Parallel Stage Streams

5.8.3.1 General

Where manual control is provided, it shall be possible to operate all stage streams by a single manual control panel to provide 'manual conditions' plus an All-Red condition. The 'manual conditions' shall constitute combinations of specified phases provided within the controller.

5.8.3.2 Change to Manual Method of Traffic Control

On a change to the manual method of control from any other method, if the stages in current operation correspond with one of the manual conditions, a direct change of method of traffic control is made. If a direct transition cannot be made immediately, it shall be possible to specify that the request for the Manual method of traffic control imposes a

particular set of demands on all stage streams which will cause one of the manual conditions to be met. The controller shall then move to this condition by the most direct route, if necessary via alternative moves in accordance with clause 4.2.6. Vehicle demands and extensions shall be ignored. Alternative means of effecting the change may be accepted.

On controllers where VA has been specified for standby, it shall be possible to specify that a request for manual control in the absence of computer force bits, inhibits all detector inputs and imposes false demands and extensions, as necessary.

5.8.4 Automatic Reversion from the Manual Method of Control to Normal Working

Closure of the manual panel door shall cause the controller to revert back to normal working, (i.e. as if the selection switch had been returned to the Normal position).

Closure of the manual panel door under conditions of power failure shall cause the controller to start up in the normal working mode when power is restored. (See clause 4.5.)

5.8.5 Indicators

A 'Lamp Test' facility shall be provided for the operator to manually verify the satisfactory operation of all manual facility indicators and the FM indicator.

In manual control facilities sets 1 and 2, indicators shall be provided to show the current operational status of each control facility (with the exception of the lamps on/off switch) that can be accessed.

Upon selection of the manual method of traffic control, indication shall be given that the controller is ready to accept commands from the manual control facility (where applicable).

The indication shall be removed when either:

- a) the controller is executing a valid request; or
- b) a higher priority method of traffic control is requested.

The indication shall not be given when the 'stage switch' facility is not available.

An indication shall be given when a request for a prohibited stage-to-stage movement is made. The indication shall continue to be given until either:

- a) a request for a permitted stage-to-stage movement is requested; or
- b) a higher priority method of control is requested.

An indication shall be given to show that the stage switch facilities are not available.

Manual conditions in clause 5.8.2.3(c) and 5.8.2.4(c) may either be separately indicated or displayed on a common numerical indicator. Under all methods of traffic control except manual, stage indication may be switched off.

All visual indicators shall be located in a position on the manual control facility (where applicable) such that they are readily visible with the access door open. The visual indicators shall have a high brightness light source applicable the application.

The inclusion of an indicator in the controller housing shall not degrade the environmental or EMC requirements required by this Specification (see chapter 14).

5.8.6 Safety Conditions

It shall not be possible for a stage to be terminated under manual control until the minimum times of all currently running phases have expired. It shall not be possible to override the prohibited stage movements specified for the Manual method of traffic control (see clause 4.2.3).

In the event of a prohibited move being requested, an indication that the selection is prohibited shall be given and the movement shall not take place. The operator may accomplish this move via permitted stage routes which may include the All-Red stage. (See clause 5.8.5)

5.8.7 Engineer's Control Facilities

Control facilities located inside the controller case shall be incorporated as manual switches and/or as part of the user terminal interface, described in clause 3.2.1.3, for use by engineering personnel.

A signal lamps ON/OFF facility shall be provided to

switch all signals and Pedestrian confirm indicators on and off. This facility shall only be available via Level 3 access of the User Interface and may only be enabled with the signals switched off from the police panel. During the accessing of this facility all signal lamps shall be off.

A facility shall be provided which will inhibit the selection of manual facilities set no 2 with the exception of the lamps on/off switch and optionally the All-Red call switch as defined in the Works Specification. An indicator shall be provided to show that the stage switch facilities are not available when this facility is active.

5.9 Warden Control

A push-button or biased key-operated switch may be specified which, when operated, shall cause an intergreen period to be extended for school crossing patrol use. The push-button or switch shall be mounted within or on a remote box, the design of which shall be agreed, prior to manufacture, with the Approval Authority.

The voltage applied to the device(s), specified in clause 5.9.1, shall not exceed 50 V ac RMS.

When the switch device is not operated, the extension to the intergreen shall be terminated or cancelled. The extended intergreen shall appear after a nominated stage, and shall provide an extended red period. The facility may be provided by introducing an All-Red stage.

Where a remote box is used it shall incorporate:

- a) either a push button; or a biased key-operated switch;
- b) a white indicator lamp, which may be integral with item (a) and shall be illuminated when a demand for the extended intergreen period has been registered; and
- c) a green indicator lamp, which shall be illuminated for the duration of the All-Red period. The white lamp shall extinguish at the start of this period.

Either:

- a) The push button together with the white and

green indicator lamps shall be mounted behind a locked door in the remote box; or

- b) The key operated switch together with the white and green indicator lamps shall be mounted on the outside of the box.

The green indicator lamp shall be subject to the monitoring requirements of clause 9.2.

It shall not be possible for the green indicator lamp to be illuminated if either the:

- a) lamps supply has been turned off;
- b) lamps supply fuse has blown; or
- c) controller has shut down due to a fault.

5.10 Public Service Vehicle Priority

This clause specifies the facility to enable controllers to provide priority facilities for Public Service Vehicles (PSV).

5.10.1 General

Under no circumstances shall the introduction or cancellation of priority facilities override the minimum green period, intergreen periods (including pedestrian blackout periods), or any enforced stage sequences specified for safety or other reasons. A priority demand shall result in each phase of such a sequence running for its minimum period.

An operation of the priority vehicle detection equipment whilst the priority phase does not have right of way shall, in addition to registering as a priority demand, register as a normal demand. For a phase normally called via a call/cancel facility, a latching demand shall be registered if so required by the Works Specification.

Provision shall be made for the full range of priority facilities. It shall be possible to include or exclude facilities and adjust timings via the operator interface.

The minimum facilities are priority extensions and priority maximum running period. To this may be added a priority change, an inhibit period and a compensation period(s).

Priority facilities will need to be provided on a minimum of eight phases.

5.10.2 Servicing of Priority Facilities

The presence of an output from a priority vehicle detector shall, while the priority phase is running, hold the green signal. The cessation of the output shall initiate a priority extension period. A priority demand, for a phase other than those which are running, which is received whilst a priority extension and/or priority maximum period is running, shall be stored and serviced when the priority extension or priority maximum period expires, when no inhibit period is operational.

Should two or more priority demands be stored at the termination of a minimum running period, then the priority demands shall be serviced in the normal cyclic order, and not necessarily in order of receipt.

When a priority extension runs a phase beyond its normal maximum running period then a normal demand shall be entered when the phase loses right-of-way during, or at the end of, the priority maximum running period. An extended intergreen shall also be introduced in this case if specified for the intergreen period following the priority phase green (for high speed roads). This demand and extended intergreen may be omitted only if, by monitoring the normal detectors, it is established that no vehicles or vehicle extensions are present.

If a phase green is terminated with an unexpired priority extension present, then a revertive priority demand may be automatically entered, if the priority demand facility is operational. Optionally, a facility may be specified to enable this reversion to be included or excluded.

When the inhibit period is not operational, then irrespective of the normal cyclic stage sequence, priority demands which are received after the commencement of a priority change, shall be serviced immediately (subject to normal safety periods) after the initial priority demand and after any priority extensions (subject to the priority maximum running period) are satisfied.

An inhibit period shall only be introduced when a priority change has led to a phase green being

prematurely terminated or a demanded phase not being run and will commence from the termination of the phase green or the point where the phase demand would otherwise have been actioned.

The inhibit period shall be terminated either after a preselected period has elapsed, or by right-of-way being granted to the phase to which the original priority change was made, whichever occurs first.

A priority demand stored during the inhibit period shall be cancelled if the demanded phase is served at the normal VA level during the inhibit period (this may also cancel the inhibit period).

A preselected extension (the compensation period) to the normal maximum running period shall, when specified, be given to nominated phases the first time they gain right-of-way following a priority change, if their running periods were curtailed or they were caused not to run by the priority change. The compensation period shall be selected individually for each phase for which compensation is specified. Different phases may be compensated as a result of priority changes to each priority phase.

If a compensation period is curtailed by a priority change, the compensation period shall be reapplied on the next cycle, if required in the Works Specification.

If compensation periods are required for a phase as a result of two separate priority changes, these compensation periods should run concurrently.

Note: This may limit the compensation periods to VA mode of operation only.

Each phase caused not to run or whose running period was curtailed by a priority change shall always be serviced in the normal cyclic order following a priority change.

The receipt of a priority extension request, during an inhibit period, for a running priority phase shall result in a priority extension and priority maximum running period being introduced.

A compensation period shall only be introduced on a particular running phase if there is an outstanding vehicle extension present at the expiry of the normal maximum period for that phase. Gap changes may occur during a compensation period.

When a priority change results in a VA extension being curtailed, then:

- a) for high speed roads, an extended intergreen period shall be introduced if specified for that stage change; and
- b) a revertive demand shall be entered for the phase losing right-of-way.

In the event of a PSV detector either:

- a) having a fault indication occasioned by disconnection of the loop; or
- b) giving a permanent output for a time adjustable in the range 0–600 seconds in 30 second steps;

then until reset, the output of the detector shall, have no further effect on the operation of the controller, and the external FM indicator shall be illuminated.

The detector output may be either manually or automatically reset. Automatic reset shall only occur after at least 15 operations of the detector output.

It shall be possible to introduce or delete each priority change facility and adjust each priority maximum, inhibit and compensation period by means of timetable entries.

5.10.3 Changes from VA to PSV Level

The priority structure for methods of control are defined in clause 5.1.1.

5.10.4 Other Change of Level

Following the selection of manual operation, no signal changes shall be commenced until demanded by the manual push buttons.

If a controller is 'taken over' by UTC force signal(s) while a priority level is running, the force signal(s) shall have no effect until all vehicle extensions at the priority level have been satisfied. Subsequently, response to force signals shall comply with clause 5.6, unless further priority demands and/or extensions are received, and unless compensation periods are specified.

5.10.5 Visual Indications

A suitable means shall be provided to display the status of all:

- a) priority vehicle detection inputs;
- b) inhibit periods; and
- c) compensation period(s).

It shall be possible to observe all detection inputs of one priority level simultaneously. These shall preferably be indicated by either:

- a) a suitable indicator behind the police facility door of the controller, or
- b) an indication on an engineer's plug in terminal via the RS232 port

6 PEDESTRIAN/CYCLIST FACILITIES

6.1 General

In addition to all relevant parts of this Specification, the following section applies to Toucan, Pelican, Puffin and Pedestrian facilities.

A bicycle is defined as a vehicle and should be treated as such. Chapter 4 enables cyclists to be signalled either as per other road users or where dedicated facilities for cyclists are employed.

Any one or a combination of the junction, pedestrian and Toucan facilities in clauses 6.2 to 6.6 may be provided, as called for in the Works Specification. If more than one facility is provided then each facility shall be provided with concurrently accessible manual facilities (see clause 5.8.2) and shall have separate safety monitoring facilities, see chapter 9.

The facilities described in this section are referenced in the Pedestrian Crossing Regulations 1997 and Local Transport Notes (LTN) 1/95 and 2/95. References to periods relate to the sequences detailed in LTN 2/95.

Where Puffin, Toucan or Pedestrian stand-alone facilities are used within UTC schemes it may be possible, subject to the Works Specification, to operate the crossing without on-crossing detection. In each case the variable All-Red or black out periods 6 and vi respectively, may be pre-set at a value within the range of time allocated to the same period.

Note: Where a crossing uses near-sided indicators and has a central refuge which has pushbuttons and indicators mounted on it, the indicators mounted on the central refuge shall display a blackout period after pedestrian green as for far-sided signals. This does not apply to staggered crossings which are treated as two different crossings.

6.2 Manual Facilities

The following control facilities shall be provided in a stand-alone controller, access to all of which shall normally be gained by means of a single Yale key Type 900 without opening the controller door:

- a) a facility by means of which the signal lamps, pedestrian or pedestrian/cyclist indicators and audible alarms can be switched off;
- b) a facility by means of which the following can be applied to the pedestrian or pedestrian/cyclist stage:
 - i) a continuous artificial pedestrian or pedestrian/cyclist demand for a facility with far-sided crossing signals;
 - ii) a continuous artificial pedestrian or pedestrian/cyclist demand and clearance extensions for a facility with near sided crossing signals;
- c) a facility by means of which the controller may be switched to operate in the fixed vehicle period or vehicle actuated method of control. When set to the fixed vehicle period method of control the controller shall operate as specified in clauses 6.3.1.1, 6.4.1.1 and 6.5.1.1 and clause 6.6.1.1. Where vehicle detection equipment is not fitted, the controller shall operate in the fixed vehicle period method of traffic control regardless of the state of this facility;
- d) a facility by means of which a continuous extension can be applied to the vehicle stage. The timers controlling the 'Maximum Vehicle Period' shall continue to time out and shall not be held or reset whilst this facility is operated.

Facilities (b), (c) and (d) are optional on the manual panel. Where more than one facility is required e.g. a duplicate crossing, then the extra manual facilities must be catered for within the manual panel.

6.3 Pelican

This facility is a stand-alone pedestrian crossing which shall have far-sided crossing signals but shall not have pedestrian demand cancelling or on-crossing pedestrian detection. Pedestrian demands shall be in accordance with the requirements of clause 7.3.2. The method of control of the facility shall be selectable to be fixed vehicle period, vehicle actuated or linked.

Figure 6a provides an overview of the Pelican signal sequence and facilities.

6.3.1 Vehicle Phase – *Period A*

This period is the quiescent state in which the signals shall normally display vehicle green and pedestrian red, but may reside on All-Red, if called for in the Works Specification. In each operating mode the period shall function in accordance with the following requirements.

6.3.1.1 Fixed Vehicle Period Method of Control

The vehicle phase green shall terminate on expiry of the vehicle maximum green time, with a pedestrian demand present. This time shall be preset at a value in the range between 20 and 60 seconds, and adjustable in incremental steps no greater than four seconds.

Following the expiry of the vehicle maximum green time, any subsequent pedestrian demand shall be served after a configurable delay period of either 1, 2 or 3 seconds before period 'B' commences.

6.3.1.2 Vehicle Actuated Method of Control

The vehicle phase green shall be terminated by either a forced change, with a pedestrian demand present, or a gap change.

The minimum green time shall be preset at a value in the range between 6 and 15 seconds, and adjustable in incremental steps no greater than 1 second. This period will be timed from the start of the vehicle green.

The maximum green time shall be preset at a value in the range between 10 and 60 seconds, and adjustable in incremental steps of a maximum of 10 seconds. This period will be timed from either:

- a) the receipt of a demand i.e. to extend; or
- b) with the start of the minimum green i.e. pre-timed maximum.

The extension timer shall be preset at a value in the range between 0.2 and 5 seconds, and adjustable in incremental steps no greater than 0.2 seconds.

Following the expiry of the pre-timed maximum green period, any subsequent pedestrian demand shall be served after a configurable delay period of either 1, 2 or 3 seconds, before period B commences

6.3.1.3 Linked Method of Control

The vehicle phase green shall be prevented from terminating if a hold vehicle (PV) signal is present. On removal of this signal the vehicle period shall terminate immediately provided the minimum vehicle, or fixed, green period has terminated and a pedestrian demand is present.

6.3.1.4 All-Red quiescent state

In absence of vehicle and pedestrian demands the signals may be held on a pedestrian and vehicle All Red state i.e. period C. On receipt of one of the following demands the signals shall:

- a) for a vehicle demand only, respond as in clause 6.3.1 (period A) via period G (clause 6.3.4); or
- b) for a pedestrian demand only, the signals shall respond as in clause 6.3.3 (period D) after a configurable delay of 0, 1 or 2 seconds, as required in the Works Specification.

6.3.2 Vehicle to Pedestrian Phase Intergreen – *Periods B and C*

These periods immediately follow the vehicle phase green and shall comprise:

Period B – A fixed period of three seconds during which the signals shall display vehicle yellow and pedestrian red.

Period C – A period during which the signals shall display vehicle red and pedestrian red. The duration shall be dependent upon the highest of the following criteria applying at the time:

- a) fixed at 1, 2 or 3 seconds for a gap change in vehicle actuated operation;
- b) preset at either 1, 2 or 3 seconds for fixed vehicle period operation, linked operation, a forced change in vehicle actuated operation or if the FM indicator specified in clause 9.11.4.4 is active;
- c) fixed at 3 seconds when speed measuring equipment as specified in 7.5.4 is fitted.

6.3.3 Invitation to Cross Period – *Period D*

This period during which the signals shall display vehicle red and pedestrian green shall immediately follow the vehicle to pedestrian phase intergreen clause 6.3.2, and shall be preset at a value in the range between 4 and 9 seconds, and adjustable in incremental steps no greater than one second.

Note: The full pedestrian stage is comprised of periods D, E and F.

If audible and/or tactile signals are provided they may be activated during this period in accordance with the requirements of clause 6.13.

6.3.4 Pedestrian to Vehicle Phase Intergreen – *Periods E, F and G*

These periods shall immediately follow the 'Invitation to Cross' period and shall comprise the following:

Period E – Operation with either the inclusion or exclusion of a period of 2 seconds during which the signals shall display vehicle red and flashing pedestrian green.

Period F – A period during which the signals shall display flashing vehicle yellow and flashing pedestrian green. This period shall be preset at a value in the range between 6 and 18 seconds, and adjustable in incremental steps no greater than 1 second.

Period G – A period during which the signals shall display flashing vehicle yellow and pedestrian red. If this period follows period F then this period shall be preset at a value of either 1 or 2 seconds. If this period follows period C then this period will be preset at a value of 3, 4 or 5 seconds. Upon termination the signals shall immediately go to the vehicle phase green (period A).

6.3.5 Vehicle Yellow and Pedestrian Green Flash Rate

The flashing rate of the flashing vehicle yellow and the flashing pedestrian green signals shall be not less than 70 nor more than 90 flashes per minute. The on/off period of both signals shall be equal and synchronous.

Phase

Vehicle	GREEN	AMBER	RED	FLASHING AMBER
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Pedestrian	RED	GREEN	FLASHING GREEN	RED
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References

LTN 2/95	Period A	Period B	Period C	Period D	Period E	Period F	Period G
TR 2210A	6.3.1	6.3.2	6.3.2	6.3.3	6.3.4	6.3.4	6.3.4

Facilities

- Far Side Signals
- No Call Cancel
- No Crossing Extension
- Latching Push Button Demand Ref. Clause 7.3.2
- Audible and Tactile Ref. Clause 6.13

Figure 6a – Pelican Sequence and Facilities

6.4 Puffin

This facility is a stand-alone pedestrian crossing which shall have near-sided crossing signals with call/cancel crossing demand and on crossing pedestrian detection. Pedestrian demands shall be in accordance with the requirements of clause 7.3.3.

Figure 6b provides an overview of the Puffin signal sequence and facilities.

6.4.1 Vehicle Phase – Period 1

This period is the quiescent state in which the signals shall normally display vehicle green and pedestrian red, but may reside on All-Red, if called for in the Works Specification. In each operating mode the period shall function in accordance with the following requirements.

6.4.1.1 Fixed Vehicle Period Method of Control

The vehicle phase green shall terminate on expiry of

the vehicle maximum green time, with a pedestrian demand present. This time shall be preset at a value in the range between 20 and 60 seconds, and adjustable in incremental steps no greater than 4 seconds.

Following the expiry of the vehicle maximum green time, any subsequent pedestrian demand shall be served after a configurable delay period of either 1, 2 or 3 seconds before period 2 commences.

6.4.1.2 Vehicle Actuated Method of Control

The vehicle phase green shall be terminated by either a force change with a pedestrian demand present, or a gap change.

The minimum green time shall be preset at a value in the range between 6 and 15 seconds, and adjustable in incremental steps no greater than 1 second. This period will be timed from the start of the vehicle green.

The maximum green time shall be preset at a value in

the range between 10 and 60 seconds, and adjustable in incremental steps of 10 seconds. This period will be timed from either:

- a) the receipt of a demand; or
- b) with the start of the minimum green i.e. Pre-timed maximum.

The extension timer shall be preset at a value in the range between 0.2 and 5 seconds, and adjustable in incremental steps no greater than 0.2 seconds.

Following the expiry of the pre-timed maximum green period, any subsequent pedestrian demand shall be served after a configurable delay period of either 1, 2 or 3 seconds before period 2 commences.

6.4.1.3 Linked Method of Control

The vehicle phase green shall be prevented from terminating if a hold vehicle (PV) signal is present. On removal of this signal the vehicle period shall be terminated provided the minimum vehicle green period has terminated and a pedestrian demand is present.

6.4.1.4 All-Red quiescent state

In the absence of vehicle and pedestrian demands the signals may be held on a pedestrian and vehicle All Red state i.e. period 3. On receipt of one of the following demands the signals shall:

- a) for a vehicle demand only, respond as in clause 6.4.1 (period 1) via period 9 (clause 6.4.4 b); or
- b) for a pedestrian demand only, the signals shall respond as in clause 6.4.3 (period 4) after a configurable delay of 0, 1 or 2 seconds, as required in the Works Specification.

6.4.2 Vehicle to Pedestrian Phase Intergreen – Periods 2 and 3

These periods shall immediately follow the vehicle phase green and shall comprise:

Period 2 – A fixed period of 3 seconds during which the signals shall display vehicle yellow and pedestrian red.

Period 3 – A period during which the signals shall display vehicle red and pedestrian red. The duration shall be dependent upon the highest of the following criteria applying at the time:

- a) fixed at 1, 2 or 3 seconds for a gap change in vehicle actuated operation;
- b) preset at either 1, 2 or 3 seconds for fixed vehicle period operation, linked operation, a forced change in vehicle actuated operation or if the FM indicator specified in clause 9.11.4.4 is active;
- c) fixed at 3 seconds when speed measuring equipment as specified in 7.5.4 is fitted.

6.4.3 Invitation to Cross Period – Period 4

This period during which the signals shall display vehicle red and pedestrian green shall immediately follow the vehicle to pedestrian phase intergreen, clause 6.4.2, and shall be preset at a value in the range between 4 and 9 seconds, and adjustable in incremental steps no greater than 1 second.

Note: The full Pedestrian Stage is comprised of periods 4, 5 and 6.

If audible and/or tactile signals are provided they may be activated during this period in accordance with the requirements of clause 6.13.

6.4.4 Pedestrian to Vehicle Phase Intergreen – Periods 5 to 9

This period shall immediately follow the 'Invitation to Cross' (period 4), and shall comprise the following periods.

- a) Periods 5 to 8 which shall display vehicle and pedestrian red signals.

Period 5 – The minimum All-Red time shall be preset at a value in the range between 1 and 5 seconds, and adjustable in incremental steps no greater than 1 second.

Period 6 – This period shall be extended by pedestrian detection, similar to the principle of vehicle actuation, and shall be terminated by either a gap or forced change.

The extendable All-Red time shall be preset at a maximum value in the range between 0 and 30 seconds, and adjustable in incremental steps no greater than 1 second. The extendable All-Red timer shall start at the end of the minimum red period.

The extension timer shall be preset at a value in the range between 0.4 and 5 seconds, and adjustable in incremental steps no greater than 0.2 seconds.

If an associated on-crossing detector has not given a demand during the period defined in clause 7.6.2, then an artificial demand will extend this period to the maximum red time followed by the forced change period defined at period 7.

Note: The maximum All-Red time is the sum of periods 5, 6, 7 or 8.

Note: Following period 6 will be periods 7 or 8, not 7 and 8.

Period 7 This period only appears if period 6 runs to a maximum, if a pedestrian is still being detected. This time shall be preset at a value in the range between 0 and 3 seconds, and adjustable in incremental steps no greater than one second.

Period 8 – If preceded by a gap change, this time shall be preset at a value in the range between 0 and 3 seconds, and adjustable in incremental steps no greater than one second.

- b) **Period 9** – A fixed period of 2 seconds during which the signals shall display vehicle red and yellow and pedestrian red. Upon termination the signals shall immediately go the Vehicle Phase green (period 1).

Phase

Vehicle	GREEN	AMBER	RED				RED
							AMBER

Pedestrian	RED		GREEN	RED	EXT RED	RED		
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References

LTN 2/95	Period 1	Period 2	Period 3	Period 4	Period 5	Period 6	Period 7	Period 8	Period 9
TR 2210A	6.4.1	6.4.2	6.4.2	6.4.3	6.4.4(a)	6.4.4(a)	6.4.4(a)	6.4.4(a)	6.4.4(b)

Facilities

- Crossing Extension Ref. Clause 7.3.4
- Audible and Tactile Ref. Clause 6.13
- Call Cancel Ref. Clause 7.3.3
- Near Sided Signals

Figure 6b – Puffin Sequence and Facilities

6.5 Toucan Stand-alone Far-sided Crossing Signals

This facility is a stand-alone combined pedestrian and cyclist crossing which shall have far-sided pedestrian/cyclist crossing signals with on-crossing pedestrian/cyclist detection, but with no call/cancel crossing demand.

Figure 6c provides an overview of the Toucan sequence and facilities (far sided signals).

6.5.1 Vehicle Phase – *Period i*

This period is the quiescent state in which the signals shall normally display vehicle green and pedestrian red, but may reside on All-Red, if called for in the Works Specification. In each operating mode the period shall function in accordance with the following requirements.

6.5.1.1 Fixed Vehicle Period Method of Control

The vehicle phase green shall terminate on expiry of the vehicle maximum green time, with a pedestrian and/or cyclist demand present. This time shall be preset at a value in the range between 20 and 60 seconds, and adjustable in incremental steps no greater than 4 seconds.

Following the expiry of the vehicle maximum green time, any subsequent pedestrian demand shall be served after a configurable delay period of 1, 2 or 3 seconds before period ii commences.

6.5.1.2 Vehicle Actuated Method of Control

The vehicle phase green shall be terminated by either a forced change, with a pedestrian and/or cyclist demand present, or a gap change.

The minimum green time shall be preset at a value in the range between 6 and 15 seconds, and adjustable in incremental steps no greater than 1 second. This period will be timed from the start of the vehicle green.

The maximum green time shall be preset at a value in the range between 10 and 60 seconds, and adjustable in incremental steps of 10 seconds. This period will be timed from either:

- a) the receipt of a demand i.e. to extend; or

- a) with the start of the minimum green i.e. pre-timed maximum.

The extension timer shall be preset at a value in the range between 0.2 and 5 seconds, and adjustable in incremental steps no greater than 0.2 seconds.

Following the expiry of the pre-timed maximum green period, any subsequent pedestrian/cyclist demand shall be served after a configurable delay period of either 1, 2 or 3 seconds, before period ii commences.

6.5.1.3 Linked Method of Control

The vehicle phase green shall be prevented from terminating if a hold vehicle (PV) signal is present. On removal of this signal the vehicle period shall terminate provided the minimum vehicle, or fixed, green period has terminated and a pedestrian demand is present.

6.5.1.4 All-Red Quiescent State

In the absence of vehicle and pedestrians/cyclists demands the signals may be held on pedestrian/cyclist and vehicle All Red state i.e. period iii. On receipt of one of the following demands the signals shall:

- a) for a vehicle demand only, respond as in clause 6.5.1 (period i) via period ix (clause 6.5.4); or
- b) for a pedestrian demand only, the signals shall respond as in clause 6.5.3 (period iv) after a configurable delay of 0, 1 or 2 seconds, as required in the Works Specification;

6.5.2 Vehicle to Pedestrian/Cyclist Phase Intergreen – *Periods ii and iii*

This period shall immediately follow the vehicle phase green and shall comprise:

Period ii – A fixed period of 3 seconds during which the signals shall display vehicle yellow and pedestrian/cyclist red;

Period iii – A period during which the signals shall display vehicle red and pedestrian/cyclist red. The duration shall be dependent upon the highest of the following criteria applying at the time:

- a) fixed at 1, 2 or 3 seconds for a gap change in vehicle actuated operation;
- b) preset at either 1, 2 or 3 seconds for fixed vehicle period operation, linked operation, a forced change in vehicle actuated operation or if the FM indicator specified in clause 9.11.4.4 is active;
- c) fixed at 3 seconds when speed measuring equipment as specified in 7.5.4 is fitted.

The extendable blackout timer shall start at the end of the minimum blackout period.

The extension timer shall be preset at a value in the range between 0.4 and 5 seconds, and adjustable in incremental steps no greater than 0.2 seconds.

If an associated on-crossing detector has not given a demand during the period defined in clause 7.6, then an artificial demand will extend this period to the maximum blackout time followed by the forced change period defined at period vii.

6.5.3 Invitation to Cross Period – *Period iv*

This period during which the signals shall display vehicle red and pedestrian/cyclist green shall immediately follow the vehicle to pedestrian/ cyclist phase intergreen (clause 6.5.2), and shall be preset at a value in the range between 4 and 9 seconds, and adjustable in incremental steps no greater than 1 second.

Note: The full pedestrian stage is comprised of periods iv, v and vi.

If audible and/or tactile signals are provided they may be activated during this period in accordance with the requirements of clause 6.13.

6.5.4 Pedestrian/Cyclist to Vehicle Phase Intergreen – *Periods v to ix*

This period shall immediately follow the 'Invitation to Cross' period iv and shall comprise the following periods:

- a) periods v and vi shall display vehicle red and pedestrian/cyclist blackout signals;

period v – the minimum blackout time shall be preset at a value in the range between 1 and 5 seconds, and adjustable in incremental steps no greater than 1 second;

period vi – this period may be extended by pedestrian/cyclist detection, similar to the principal of vehicle actuation, and shall be terminated by either a gap or forced change.

The extendable blackout time shall be preset at a maximum value in the range between 0 and 30 seconds, and adjustable in incremental steps no greater than 1 second.

Period vii – This period only appears if period vi runs to a maximum, if a pedestrian and/or cyclist is still being detected. This time shall be preset at a value in the range between 1 and 3 seconds, and adjustable in incremental steps no greater than 1 second.

Period viii – which shall display red vehicle and pedestrian/cyclist red signals. This time shall be preset at a value in the range between 1 and 3 seconds, and adjustable in incremental steps no greater than 1 second.

Period ix – A fixed period of 2 seconds during which shall display vehicle red and yellow and pedestrian/cyclist red signals. Upon termination the signals shall immediately to the Vehicle Phase green (period i).

Phase

Vehicle	Green	Amber	Red				Red	Amber
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Pedestrian	Red		Green	Blackout	Variable Blackout	Blackout	Red	
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References

LTN 2/95	Period i	Period ii	Period iii	Period iv	Period v	Period vi	Period vii	Period viii	Period ix
TR2210A	6.5.1	6.5.2	6.5.2	6.5.3	6.5.4	6.5.4	6.5.4	6.5.4	6.5.4

Facilities

Far Side Signals

No Call Cancel Ref. Clause 7.3.2

Crossing Extension Ref. Clause 7.3.4

Audible and Tactile Ref. Clause 6.13

Figure 6c – Toucan Sequence and Facilities Far-Side Signals

6.6 Toucan Stand-alone Near-sided Crossing Signals

This facility is a stand-alone combined pedestrian and cyclist crossing which shall have near-sided pedestrian/cyclist crossing signals, call/cancel crossing demand and on-crossing pedestrian and cyclist detection.

6.6.1 Vehicle Phase – Period I

This period is the quiescent state in which the signals shall normally display vehicle green and pedestrian/cyclist red, but may reside on All-Red, if called for in the Works Specification. In each operating mode the period shall function in accordance with the following requirements.

6.6.1.1 Fixed Vehicle Period Method of Control

The vehicle phase green shall terminate on expiry of the vehicle maximum green time, with a pedestrian and/or cyclist demand present. This time shall be preset at a value in the range between 20 and 60 seconds, and adjustable in incremental steps no greater than 4 seconds.

Following the expiry of the vehicle maximum green time, any subsequent pedestrian demand shall be served after a configurable delay period of 1, 2 or 3 seconds before period II commences.

6.6.1.2 Vehicle Actuated Method of Control

The vehicle phase green shall be terminated by either a forced change, with a pedestrian and/or cyclist demand present, or a gap change.

The minimum green time shall be preset at a value in the range between 6 and 15 seconds, and adjustable in incremental steps no greater than 1 second. This period will be timed from the start of the vehicle green.

The maximum green time shall be preset at a value in the range between 10 and 60 seconds, and adjustable in incremental steps of 10 seconds. This period will be timed from either:

- a) the receipt of a demand i.e. to extend; or
- b) with the start of the minimum green i.e. pre-timed maximum.

The extension timer shall be preset at a value in the range between 0.2 and 5 seconds, and adjustable in incremental steps no greater than 0.2 seconds.

Following the expiry of the pre-timed maximum green period, any subsequent pedestrian/cyclist demand shall be served after a configurable delay period of 1, 2 or 3 seconds before period II commences.

6.6.1.3 Linked Method of Control

The vehicle phase green shall be prevented from terminating if a hold vehicle (PV) signal is present. On removal of this signal the vehicle period shall terminate provided the minimum vehicle, or fixed, green period has terminated and a pedestrian demand is present.

6.6.1.4 All-Red Quiescent State

In the absence of vehicle and pedestrian/cyclist demands the signals may be held on a pedestrian/cyclist and vehicle All Red stage i.e. period III. On receipt of one of the following demands the signals shall:

- a) for a vehicle demand only, respond as in clause 6.5.1 (period I) via period IX (clause 6.5.4)); or

for a pedestrian demand only, the signals shall respond as in clause 6.5.3 (period IV) after a configurable delay of 0, 1 or 2 seconds, as required in the Works Specification.

6.6.2 Vehicle to Pedestrian/Cyclist Phase Intergreen – Periods II and III

These periods shall immediately follow the vehicle phase green and shall comprise:

period II – a fixed period of 3 seconds during which the signals shall display vehicle yellow and pedestrian/cyclist red;

period III – a period during which the signals shall display vehicle red and pedestrian/cyclist red. The duration shall be dependent upon the highest of the following criteria applying at the time:

- a) fixed at 1, 2 or 3 seconds for a gap change in vehicle actuated operation;
- b) preset at 1, 2 or 3 seconds for fixed vehicle period operation, linked operation, a forced change in vehicle actuated operation or if the FM indicator specified in clause 9.11.4 is active;
- c) fixed at 3 seconds when speed measuring equipment as specified in 7.5.4 is fitted.

6.6.3 Invitation to Cross Period – Period IV

This period during which the signals shall display vehicle red and pedestrian/cyclist green shall immediately follow the vehicle to pedestrian/cyclist phase intergreen clause 6.6.2, and shall be preset at a value in the range between 4 and 9 seconds, and adjustable in incremental steps no greater than 1 second.

Note: The full pedestrian stage is comprised of periods IV, V and VI.

If audible and/or tactile signals are provided they may be activated during this period in accordance with the requirements in clause 6.13.

6.6.4 Pedestrian/Cyclist to Vehicle Phase Intergreen – Periods V to IX

This period shall immediately follow the 'Invitation to Cross' Period IV and shall comprise the following periods:

- a) periods V to VIII which shall display vehicle and pedestrian red signals;

period V – the minimum All-Red time shall be preset at a value in the range between 1 and 5 seconds, and adjustable in incremental steps no greater than 1 second.

period VI – this period shall be extended by pedestrian/cyclist detection, similar to the principal of vehicle actuation, and shall be terminated by either a gap or forced change.

The maximum extendable All-Red time shall

be preset at a value in the range between 0 and 30 seconds, and adjustable in incremental steps no greater than 1 second. The extendable All-Red timer shall start at the end of the minimum red period.

The extension timer shall be preset at a value in the range between 0.4 and 5 seconds, and adjustable in incremental steps no greater than 0.2 seconds.

If an associated on-crossing detector has not given a demand during the period defined at clause 7.6, then an artificial demand will extend this period to the maximum red time followed by the forced change period defined at period VII.

Note: Following period VI will be period VII or VIII, not period VII and VIII.

Period VII – This period only appears if period VI runs to a maximum, if a pedestrian and/or cyclist is still being detected. This time shall be preset at a value in the range between 0 and 3 seconds, and adjustable in incremental steps no greater than 1 second.

Period VIII – If preceded by a gap change, this time shall be preset at a value in the range between 0 and 3 seconds, and adjustable in incremental steps no greater than 1 second.

Note: The maximum All-Red time is the sum of the periods V, VI and VII or VIII.

- b) **Period IX** – A fixed period of 2 seconds during which the signals shall display vehicle red and yellow and pedestrian red. Upon termination the signals shall immediately go to the Vehicle Phase green (period I).

Phase

Vehicle	Green	Amber	Red					Red	
							Amber		
Pedestrian	Red		Green	Red	Ext. Red	Red			

References

LTN 2/95	Period I	Period II	Period III	Period IV	Period V	Period VI	Period VII	Period VIII	Period IX
TR 2210A	6.6.1	6.6.2	6.6.2	6.6.3	6.6.4	6.6.4	6.6.4	6.6.4	6.6.4

Facilities

- Far Side Signals
- No Call Cancel Ref. Clause 7.3.2
- Crossing Extension Ref. Clause 7.3.4
- Audible and Tactile Ref. Clause 6.13

Figure 6d – Toucan Sequence and Facilities Near-Side Signals

6.7 Intersection Pedestrian (Far-Sided Crossing Signals)

This facility is a pedestrian crossing used at or closely linked to junctions which shall have far-sided crossing signals but shall not have call/cancel crossing demand but may have on-crossing pedestrian detection. Pedestrian demands shall be in accordance with the requirements of clause 7.3.2.

A pedestrian phase may run more than once within a stage.

In the case of a shared stage, it shall not be possible to violate the minimum green, extensions or intergreens for a vehicular phase, or the pedestrian ‘invitation to cross’ or pedestrian to vehicle phase intergreen for the pedestrian phase.

Figure 6e provides an overview of the pedestrian signal sequence and facilities.

6.7.1 Vehicle Phase – Period i

This period is the quiescent state in which the signals shall normally display vehicle green and pedestrian red, but may reside on All-Red, if called for in the Works Specification. In each operating mode the period shall function in accordance with the following requirements.

6.7.1.1 Fixed Vehicle Period Method of Control

The vehicle phase green shall terminate on expiry of the vehicle maximum green time, with a pedestrian demand present. This time shall be preset at a value in the range between 20 and 60 seconds, and adjustable in incremental steps no greater than 4 seconds.

Following the expiry of the vehicle maximum green time, any subsequent pedestrian demand shall be served after a configurable delay period of 1, 2 or 3 seconds before period ii commences.

6.7.1.2 Vehicle Actuated Method of Control

The vehicle phase green shall be terminated by either a forced change, with a pedestrian present, or a gap change.

The minimum green time shall be preset at a value in the range between 3 and 15 seconds, and adjustable in incremental steps no greater than one second. This period will be timed from the start of the vehicle green.

The maximum green time shall be preset at a value in the range between 10 and 60 seconds, and adjustable in incremental steps of 10 seconds. This period will be timed from either:

- a) the receipt of a demand, or
- b) with the start of the minimum green i.e. Pre-timed maximum.

The extension timer shall be preset at a value in the range between 0.2 and 5 seconds, and adjustable in incremental steps no greater than 0.2 seconds.

Following the expiry of the pre-timed maximum green period, any subsequent pedestrian demand shall be served after a configurable delay period of 1, 2 or 3 seconds, before period ii commences.

6.7.1.3 Linked Method of Control

The vehicle phase green shall be prevented from terminating if a hold vehicle (PV) signal is present. On removal of this signal the vehicle period shall terminate provided the minimum vehicle green period has terminated and a pedestrian demand is present.

6.7.1.4 All-Red Quiescent State

In the absence of vehicle and pedestrian demands the signals may be held on a pedestrian and vehicle All Red state i.e. period iii. On receipt of one of the following demands the signals shall:

- a) for a vehicle demand only, respond as in clause 6.7.1 (period i) via period ix (clause 6.7.4 b); or
- b) for a pedestrian demand only, the signals

shall respond as in clause 6.4.3 (period iv) after a configurable delay of 0, 1 or 2 seconds, as required in the Works Specification.

6.7.2 Vehicle to Pedestrian Phase Intergreen Periods ii and iii

This period shall immediately follow the vehicle phase green and shall comprise:

Period ii a fixed period of 3 seconds during which the signals shall display vehicle yellow and pedestrian red;

Period iii a period during which the signals shall display vehicle red and pedestrian red. The duration shall be dependent upon the highest of the following criteria applying at the time:

- a) fixed at 1, 2 or 3 seconds for a gap change in vehicle actuated operation;
- b) preset at 1, 2 or 3 seconds for fixed vehicle period operation, linked operation, a forced change in vehicle actuated operation or if the FM indicator specified in clause 9.11.4.4 is active;
- c) fixed at 3 seconds when speed measuring equipment as specified in 7.5.4 is fitted.

6.7.3 Invitation to Cross – Period iv

This period during which the signals shall display vehicle red and pedestrian green shall immediately follow the vehicle to pedestrian phase intergreen in clause 6.7.2, and shall be preset at a value in the range between 4 and 9 seconds for stand-alone and 4–99 for junctions, both adjustable in incremental steps no greater than one second.

Note: The full Pedestrian Stage is comprised of periods iv, v and vi.

If audible and/or tactile signals are provided they may be activated during this period in accordance with the requirements of clause 6.13.

6.7.4 Pedestrian to Vehicle Phase Intergreen Periods v to ix

This period shall immediately follow the 'Invitation to Cross' period iv and shall comprise the following periods:

- a) periods v and vi shall display vehicle red and pedestrian blackout signal.

period v – the minimum black-out time shall be preset at a value in the range between 3 and 15 seconds, and adjustable in incremental steps no greater than 1 second.

Period vi – this period may be extended by pedestrian detection, similar to the principal of vehicle actuation, and shall be terminated by either a gap or forced change.

The extendable blackout time shall be preset at a maximum value in the range between 0 and 30 seconds, and adjustable in incremental steps no greater than 1 second. The extendable black-out timer shall start at the end of the minimum blackout period.

The extension timer shall be preset at a value in the range between 0.4 and 5 seconds, and adjustable in incremental steps no greater than 0.2 seconds.

If an associated on-crossing detector has not given a demand during the period defined in clause 7.6.2, then an artificial demand will extend this period to the maximum black-out time followed by the forced change period defined at period vii.

Where on-crossing detection is not provided, the blackout period shall be preset at a value within the same range as that defined for the extendable blackout time.

Period vii – This period only appears if period vi runs to a maximum, if a pedestrian is still being detected. This time shall be preset at a value in the range between 1 and 3 seconds, and adjustable in incremental steps no greater than 1 second.

Period viii – which shall display red vehicle and pedestrian red signals. This time shall be preset at a value in the range between 1 and 3 seconds, and adjustable in incremental steps no greater than 1 second, and

- b) **Period ix** – A fixed period of 2 seconds during which shall display vehicle red and yellow and pedestrian red signals. Upon termination the signals shall immediately to the Vehicle Phase green (period i).

Phase

Vehicle	Green	Amber	Red				Red
							Amber

Pedestrian	Red		Green	Blackout	Variable Blackout	Blackout	Red
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References

LTN 2/95	Period i	Period ii	Period iii	Period iv	Period v	Period vi	Period vii	Period viii	Period ix
TR 2210A	6.7.1	6.7.2	6.7.2	6.7.3	6.7.4(a)	6..4(a)	6.7.4(a)	6.7.4(a)	6.7.4(b)

Facilities

Far Side Signals

No Call Cancel Ref. Clause 7.3.2

Crossing Extension Ref. Clause 7.3.4

Audible and Tactile Ref. Clause 6.13

Figure 6e – Pedestrian Sequence and Facilities

6.8 Intersection Puffin

The signal sequence and requirements for an intersection Puffin shall be as per a stand-alone Puffin, as detailed at clause 6.4.

As with clause 6.4, the on-crossing detection shall control the All-Red period of the intergreen.

Exceptionally, kerb side call/cancel and/or on-crossing pedestrian detection is optional, as required in the Works Specification.

Where on-crossing detection is not provided, the All-Red period 6 shall be pre-set at a value within the range between 0–30 seconds, adjustable in 1 second steps.

A pedestrian phase may run more than once within a stage.

In the case of a shared stage, it shall not be possible to violate the minimum green, extensions or intergreens for a vehicular phase, or the pedestrian

‘invitation to cross’ or pedestrian to vehicle phase intergreen for the pedestrian phase.

6.9 Intersection Toucan (Far-sided Crossing Signals)

The signal sequence and requirements shall be as for a stand-alone Toucan, as detailed in clause 6.5.

As with clause 6.5, the on-crossing detection shall control the black-out period of the intergreen.

Exceptionally, kerb-side call/cancel and/or on-crossing pedestrian/cyclist detection is optional, as required in the Works Specification.

A Toucan phase may run more than once within a stage.

In the case of a shared stage, it shall not be possible to violate the minimum green, extensions or intergreens for a vehicular phase, or the ‘invitation to cross’ in clause 6.5.3 or the pedestrian/cyclist to vehicle phase black-out periods in clause 6.5.4.

Where on-crossing detection is not provided, the All-Red period vi, shall be pre-set at a value within the range between 0–30 seconds, adjustable in 1 second steps.

6.10 Intersection Toucan (Near-sided Crossing Signals)

The signal sequence and requirements shall be as per a stand-alone Toucan, as detailed in clause 6.6.

As with clause 6.6, the on-crossing detection shall control the All-Red period of the intergreen.

Exceptionally, kerb side call/cancel and/or on-crossing pedestrian/cyclist detection is optional, as required in the Works Specification.

A Toucan phase may run more than once within a stage.

In the case of a shared stage, it shall not be possible to violate the minimum green, extensions or intergreens for a vehicular phase, or the 'invitation to cross' in clause 6.5.3 or the pedestrian/cyclist to vehicle phase All-Red periods in clause 6.5.4.

Where on-crossing detection is not provided, the All-Red period VI, shall be preset at a value within the range between 0–30 seconds, adjustable in 1 second steps.

6.11 Toucan Push Button Demand, Kerb Side Cancel and Cyclist Demand

A demand shall be registered either when both a push button box and kerb side detector demand exists or when both a cyclist demand and kerb side detector demand exists.

The push button box demand shall have an extension which shall be preset at a value in the range between 1 and 5 seconds, and adjustable in incremental steps of no more than 0.2 seconds.

Each kerb side detector demand shall have an extension which shall be preset at a value in the range between 1 and 5 seconds, and adjustable in incremental steps of no more than 0.2 Seconds.

Each cyclist demand shall have an extension which

shall be preset at a value in the Range between 1 and 5 seconds, and adjustable in incremental steps of no more than 0.2 seconds.

Each registered demand shall have an extension which shall be preset at a value in the range between 1 and 5 seconds, and adjustable in incremental steps of no more than 0.2 seconds.

The push button box, kerb side, cyclist and registered demands shall be non-latching.

The registered demand shall be removed either upon expiry of the registered demand extension or on commencement of the pedestrian/ cyclist phase green.

6.12 Pedestrian or Pedestrian/Cyclist Indicator

The Pedestrian (Wait [Pelican], Demand Accepted [Puffin]) or Pedestrian/Cyclist indicator shall be illuminated to indicate that a demand exists for the pedestrian (pedestrian/cyclist) phase. All indicators associated with the same phase shall be displayed concurrently. Demands for the pedestrian (pedestrian/cyclist) phase shall be in accordance with the requirements of clause 7.3.

6.13 Audible/Tactile Signals

6.13.1 General

Audible and/or tactile signals may be provided to indicate the steady green man period. Audible signals shall not be used unless the red signal displayed to motorists is such that all vehicular movements are signalled to stop. Tactile signals may be used where the red signal displayed to motorists is such that all conflicting vehicular movements are signalled to stop.

Where required by the Works Specification the audible and/or tactile signals may operate for a reduced period at the start of the steady green man period.

Where required by the Works Specification the audible signals shall be operative for only part of the day or switched to a lower audible level. The tactile signals in this case shall be fully operative.

6.13.2 Types of Audible Signals

Only audible signals approved to TR 0157 may be used.

6.13.3 Types of Tactile Signals

Only tactile signals approved to TR 0157 may be used.

6.13.4 Safety Requirements

Audible and tactile devices shall meet the requirements of clause 9.17

6.14 Standalone Controller Linking (Option)

6.14.1 General

This section details the operation and facilities provided to interface via a cabled link to a stand-alone pedestrian or Toucan controller. When the PV bit is not generated by an OTU the junction controller may, itself, generate a control bit to prevent a stand-alone pedestrian controller moving away from its vehicle phase green except at a specified time in the junction controller cycle.

Note: This ensures that traffic moving along the road connecting the junction and the stand-alone pedestrian controller is not unduly halted, and during the remainder of the junction controller cycle, when the control bit is removed, the stand-alone pedestrian controller can service its pedestrian phase if demanded.

6.14.2 Operational Requirements to Hold a Vehicle Phase

It shall be possible to prevent the stand-alone controller from moving to the pedestrian phase green during the time when the control bit (PV) is present.

6.14.3 Operational Requirements to Release a Vehicle Phase

The control bit, logic condition '1' (the inhibit release period) shall commence either at the start of a specified junction controller stage (following the interstage period) or at the end of a specified stage (at the start of the interstage period). The inhibit release period timing is defined in Chapter 11. The appearance of the control bit may be delayed with respect to the stage start or end. If the signals are switched off, or manual control is selected, the control bit shall remain at logic condition '1'.

6.14.4 Interface Requirements

The linking equipment shall be compatible with the interface requirements of the stand-alone pedestrian controller. The output interface to the stand-alone pedestrian controller shall conform to the Parallel Output Interface (from the Controller) as specified in clause 3.2.4. The inhibit release shall be active with the specified condition '1' (open contact) across the appropriate controller output terminals of the link to the stand-alone pedestrian or Toucan controller.

7 DEMANDS

7.1 General

Provision shall be made for the controller to receive inputs from vehicle and pedestrian detectors to influence the operation of the controller.

Note: Detector systems are defined in TR 0100 and Volume 8 of the Design Manual for Roads and Bridges (DMRB).

7.1.1 Demand sources

Demands for right-of-way shall be received by the controller from:

- a) on-street detection equipment, including pedestrian push buttons;
- b) the UTC computer;
- c) the Cableless Linking Facility;
- d) manual inputs;
- e) special requests, (e.g. hurry calls) (subject to protection of the safety timings reference 9.16);
- f) priority inputs, (e.g. LRT);
- g) linking from adjacent controllers; and
- h) MOVA.

The controller shall order the appearance of stages in accordance with the controller strategy, the currently running mode of control and the demand requests for right-of-way.

7.1.2 Inputs

Inputs shall be associated with phases and may:

- a) demand a phase;
- b) extend a phase green;
- c) terminate a phase green;

- d) cancel a demand;
- e) curtail an interstage period (subject to protection of the safety timings reference 9.16);
- f) demand and extend a phase green;
- g) introduce a hurry call facility;
- h) be associated with an All-Red condition;
- i) introduce another specified event; and
- j) influence special logic, as specified for the individual site.

Note: Where special logic is employed, if it modifies or affects the way in which the controller performs to this Specification, then the logic must be approved by the approval authority.

7.1.3 Detector functions

Detector functions may be:

- a) latching demands;
- b) non-latching demands;
- c) call-cancel demands;
- d) unidirectional demands;
- e) maximum reversions;
- f) arterial reversions;
- g) conditional demands.

7.2 Vehicle Demands

7.2.1 Latching Demands

Demands shall be latching or non-latching according to the Works Specification. Typically demands will be latching with the exception of Call/Cancel demands.

Demands for right-of-way for a phase showing red

may be accepted from any detector input. Once right-of-way is achieved, the demand shall be cancelled.

7.2.2 Call–Cancel Demands

It shall be possible to arrange that turning traffic movements can be initiated by Call/Cancel vehicle detectors. In this case, the demand shall not be stored but shall only persist whilst the detector remains operational. In addition, it shall be possible to arrange that the demand from the detector does not take effect until it has persisted for a preset period – the Call Delay, and/or to prolong the effect when it ceases for a preset period – the Cancel Delay. The Call Delay shall be within the range of 0–60 seconds and adjustable in 1 second steps. Similarly, the Cancel Delay shall be within the range of 0–60 seconds and adjustable in 1 second steps. (See table 11.1.)

7.2.3 Conditional Demands

It shall be possible to arrange that:

- a) the demand for a turning phase is only active if there is a demand for another specified phase, (i.e. the stage selection logic will only action the turning demand if the other phase demand is present);
- b) a request for right-of-way from a nominated detector input(s) shall be ignored until a single specified stage has been reached;
- c) demands are conditional subject to other internally generated parameters, including demands, phase or stage conditions, the state of timers and the condition of external inputs.

7.2.4 Revertive Demands

If a phase green is terminated with the extension timer running, a demand, known as a revertive demand, for a return to that phase shall normally be inserted. Where required the demand may alternatively be inserted for another specified phase.

An arterial reversion facility shall be available such that it shall be possible, in the absence of demands, to revert to a selected stage which may be an ‘All–Red’ stage.

7.2.5 Artificial Demands/ Extensions

The operator facility shall provide a means by which continuous artificial demand and/or extensions may be applied to any phase or phases and a means by which the effect of a detector may be inhibited.

7.3 Pedestrian Demands

7.3.1 General

Appropriate means shall be provided so that the pedestrian phase can be demanded. Demands shall be registered at any time other than during the pedestrian phase green and shall be removed on commencement of the pedestrian phase green. A registered demand from detection equipment shall be in accordance with the following requirements as applicable.

7.3.2 Push Button only Demand

The registered demand shall be latching and shall be removed on commencement of the pedestrian phase green.

7.3.3 Push Button Demand and Kerb Side Cancel (Puffin)

A demand shall be registered when both a push button box and kerb side detector demand exists simultaneously. Once registered, the demand shall remain registered while a kerb side demand persists, irrespective of the state of the push– button demand.

The push button box demand shall have an extension which shall be preset at a value in the range between 1 and 5 seconds, and adjustable in incremental steps of no more that 0.2 seconds.

A kerb side detector demand shall have an extension which shall be preset at a value in the range between 1 and 5 seconds, and adjustable in incremental steps of no more that 0.2 seconds. Each registered demand shall have an extension which shall be preset at a value in the range between 1 and 5 seconds, and adjustable in incremental steps of no more than 0.2 seconds. The registered demand shall be removed either upon expiry of the registered demand extension or on commencement of the pedestrian phase green.

The push button box, kerb side and registered demands shall be non–latching.

The performance requirements of Puffin kerb side detection systems is defined in specification TR 2182.

7.3.4 On-crossing Pedestrian Extension Demands (Puffin)

This is required by the Puffin facility as detailed in clauses 6.3 and 6.5.

The controller shall receive inputs from the on-crossing detection system and provide the variable All-Red period of the pedestrian to vehicle phase intergreen as defined in clause 6.3.4. The performance requirements of Puffin on-crossing detection systems are specified in TR 2179.

7.4 Cyclist Demands

Appropriate means shall be provided so that a cyclist phase can be demanded.

Demands shall be latching and registered at any time other than during the cyclist phase green and shall be removed on commencement of the cyclist phase green.

Toucan demands are specified in section 6.

7.5 Detectors

7.5.1 Detector Unit Location

Detector equipment shall either be provided as a separate unit which may be mounted in the controller housing, or alternatively mounted in its own housing, as detailed in the Works Specification.

7.5.2 Standard Interface

A Standard Interface as specified in clause 3.2 shall be provided.

For both the On-crossing and kerb side detectors, at least four detector input channels for each stand-alone crossing, and at least two detector input channels for each junction crossing shall be provided.

7.5.3 Unidirectional Detector

Optionally, a combination of detectors may be connected to have the effect of a unidirectional

detector. The logic for this may be incorporated within the controller.

7.5.4 Speed Measuring Detectors

The use of Speed Discrimination and Speed Assessment requires detectors installed in pairs. The speed is measured from the time interval between the operation of the two detectors as a vehicle passes. The logic for this may be incorporated within the controller.

The strategy for the implementation of speed measuring detectors is described in Annex C.

7.5.4.1 Speed Discrimination

Where Speed Discrimination (Double Vehicle Extension) is required, if a difference in signal between the inputs from the speed measuring loops of 275 milliseconds or less exists, the phase green shall be extended for a fixed period of 3.0 seconds, subject to the maximum running period.

Where Speed Discrimination (Triple Vehicle Extension) is required, if a difference in signal between the inputs from the speed measuring loops of 183 milliseconds or less exists, or from the inner speed measuring loops of 235 ms or less exists, the phase green shall be extended for a fixed period of 3.5 seconds, subject to the maximum running period.

7.5.4.2 Speed Assessment

Where Speed Assessment (Double Vehicle Extension) is used, if a difference in signal between the inputs from the speed measuring loops indicates a speed of 45 km/h (28 mph) or more, the phase green shall be extended by a fixed period of 5.0 seconds following a delay period given by the formula:

$$\text{Delay} = \frac{140 - 5v}{v} \text{ Seconds}$$

where v is the measured vehicle speed in metres/second. Above 100 km/h (62 mph), where the above expression is negative, the delay shall be zero.

Other algorithms may be used with the prior approval of the Approval Authority;

A gap change shall be permitted during the speed dependent delay period;

The overall period comprising the fixed extension and the speed dependent delay period shall be subject to the maximum running period.

7.5.4.3 Extra Clearance Period

A two second extension to the 'All-Red' period shall be automatically added following the running of any phase which is provided with speed assessment or speed discrimination equipments if any one of the following circumstances occur:

- a) any speed extension is curtailed;
- b) a speed discrimination or speed assessment extension occurs during the yellow signal;
- c) during the phase green period, any vehicle detector connected to speed measurement equipment associated with that phase is not operated.

7.5.4.4 Speed Discrimination/Assessment Test Facility

A means of testing the SDE/SA facility on site shall be provided. The test method shall be capable of access via the handset or another appropriate test facility. Access shall be level 3 i.e. access only available on-site.

When in the test mode the controller shall:

- a) disconnect the links between the detector outputs and the corresponding discriminator/ assessor inputs;
- a) introduce an extra clearance period (see clause 7.5.4) following any phases that may be affected by this test.

Exiting the test mode shall generate an extension to cover any high speed vehicles which may not have been detected. Typical values are approximately 4 seconds for SDE or 10 seconds for speed assessment.

7.5.5 Variable Maximum (option)

The strategy for the use of the variable maximum facility is described in Annex C.

7.5.5.1 Selection of Additional Period

The additional period selected is that period which is added to the phase maximum when the traffic flow is twice the selected threshold. The additional period given shall not exceed four times the additional period selected for twice threshold flow. (See figure 9a.)

7.5.5.2 Access to Threshold Values

The additional period and the threshold shall be capable of being selected via the user interface.

7.5.5.3 Disabling of Variable Maximum

The variable maximum facility may be disabled by selecting an additional period of zero seconds.

The variable maximum facility may be switched by the master time clock to operate under the control of the X or X and Y* detectors on all or any approach associated with any phase as required to allow threshold limits as low as 450 vph. In addition, it shall be possible for the threshold and additional period to be changed to a different value by the master time clock.

7.6 Detector Monitoring

The input signals from the detector equipment shall be monitored by the controller. Pedestrian push buttons may, when required, be treated as vehicle detectors for fault monitoring purposes.

Puffin detector monitoring referenced in clauses 7.6.1 and 7.6.2 is optional for junction facilities, as required in the Works Specification.

7.6.1 Kerb Side Detector Test

For surface mounted kerb side pedestrian detectors only, a separate test circuit shall be provided as follows:

- a) during those periods when no demand exists for a pedestrian crossing, a trigger pulse shall be generated. The interval between pulses shall be between 1 and 3 minutes. The pulse shall be of 3.5–27 volts amplitude and of 500 millisecond \pm 100 milliseconds duration. The minimum source current available shall be 10 mA \pm 0.5 mA. The line potential in the absence of the pulse shall be zero volts \pm 0.75 V;

- b) the response from the detector system, to the trigger pulse, shall be the declared detect condition, dependent on the detector design, to indicate a correctly functioning detector (see TR 2182). This may be either:
- i) a low resistance condition (logic '0') or;
 - ii) a high resistance condition (logic '1').

A correct reply response, from the detector system, shall commence 50 milliseconds after the start of the trigger pulse and shall cease between 350 and 500 milliseconds after the end of the trigger pulse.

7.6.2 Detector Failure Conditions

Each detector input shall be individually monitored. A detector failure shall be registered under any of the following conditions:

- a) for an on-crossing pedestrian detector, if a signal has not been received in the period between the end of the preceding pedestrian phase green (period 6 or vi), and the end of the current pedestrian 'invitation to cross' period (period 4 or iv);
- b) for a surface mounted kerb side detector, if the correct response has not been received from the detector system, as specified in clause 7.6.1;
- c) for all detectors, the output shall be timed against timeout values for both a permanent detect state and for a permanent non-detect state.

The permanent detect state timeout value shall be pre-settable to a maximum of at least 60 minutes with a maximum incremental step of 1 minute.

The permanent non-detect state timeout value shall be pre-settable to a maximum of at least 72 hours with a maximum incremental step of one hour.

It shall be possible to allocate detectors timeout values to at least two different groups. Each group shall be capable of having a different fault reporting time.

It shall be possible to designate a group as being non-monitoring, thereby providing for unmonitored detectors. The timeout values of each group should be switchable to a minimum of one alternative set by time switch.

7.6.3 Detector Failure Action

If a detector failure occurs:

- a) it shall be possible, where specified, to set an artificial demand as follows:
 - i) for an on-crossing detector, a temporary artificial pedestrian demand shall be inserted, being reset at the end of each pedestrian to vehicle phase intergreen gap or forced change;
 - ii) for a surface mounted kerb side detector, the artificial pedestrian demand shall be permanent and shall only be reset if further five consecutive trigger pulses are correctly answered;
 - iii) for all other detectors, the artificial demand shall be permanent and shall be removed only when the detector fault is cleared.

and b) the FM indicator shall be lit.

Once the FM indicator has been lit, it shall be extinguished only by operator intervention and an indication of which detector has failed shall be stored in the fault log.

8 MASTER TIME CLOCK SYSTEM

8.1 General

The system shall be based on a precision real time clock and calendar from which timing information is derived.

The Master Time Clock System provide the facilities necessary for the controller to be integrated into a cableless link system or to allow the controller to be operated in a fall back mode of operation in an Urban Traffic Control Scheme.

The Master Time Clock System may additionally be used to achieve time controlled switch facilities, such as alternative timings, or stage structure, or the control of secret signs.

The Master Time Clock System is used to change to and from British Summer Time.

8.2 Main Elements of System

The timing of the Master Time Clock System shall be generated by two main elements:

- a) the clock; and
- b) the group timer.

The user interface shall comply with BS EN 28601:1992 ISO 8601:1988.

In normal operation both elements shall be synchronised to the mains supply frequency.

8.3 The Clock

The clock shall generate time information on at least a 24 hour, seven day week, 52 week (annual) basis with a basic resolution of 1 second. The clock transition shall occur within ± 0.1 second of the 1 second crossover.

A facility shall be provided to allow the clock to be manually set up/reset via the operator interface. To assist the operator in this operation provision shall be made to enable a time value to be set up and then by the operation of a specified

switch, or push button, this time value shall be inserted into the clock.

As an option, an automatic means of initialisation/synchronisation may be provided, e.g. by means of a separate plug-in unit or via the 'Rugby Time' signal.

A facility shall be provided to allow the clock's current time value to be displayed. The following parameters are to be available for display:

- a) week number or date;
- b) day of week;
- c) hours;
- d) minutes; and
- e) seconds.

A facility shall be provided to allow an operator, up to at least a year preceding the required change, to set automatic advance or retard of the clock. This facility, if set, shall advance or retard the clock by 1 hour on Sunday morning at 02.00 hours. No timing error in the clock shall occur when this facility is used.

8.4 Power Supply Failure

In the event of a mains power failure of a total or transitory nature which prevents timing information being obtained from the mains supply frequency, the necessary timing signals to maintain the timing system in synchronisation with 'system time' shall be provided by a standby crystal oscillator.

The crystal oscillator shall maintain the clock, during standby, with an error of less than one second in 12 hours.

During mains power failure the timing system and crystal oscillator shall derive their power from a suitable standby source. The duration of the available standby period is specified in clause 3.4.12.

8.5 The Group Timer

The Group Timer shall be linked in real time to the clock and shall be used to generate the timing periods for the individual groups within a specified plan. A facility shall be provided to allow the Group Timer to be set to its starting point of the active plan (i.e. start of the first group). The Group Timer shall be synchronised to the plan starting time to within ± 0.1 second. This may be achieved via the operator interface and/or a signal received from the remote UTC control centre if the cableless link facility is used to achieve a standby capability in a UTC scheme.

8.6 Timetable

8.6.1 Time Settings

Functions which have to be changed at particular times of day shall be related to the clock by means of a 'Timetable'. The timetable shall comprise a 'list' which can be programmed to hold time settings and relevant data.

Time settings shall be based upon the following defined periods:

- a) type of day
 - i) individual day of week (i.e. Monday–Sunday as required);
 - ii) weekday (i.e. Monday–Friday inclusive);
 - iii) every day except Sunday (i.e. Monday–Saturday inclusive); and
 - iv) every day of week;
 - v) user defined groups of days;
- b) time
 - i) hours (0–23);
 - ii) minutes (0–59); and
 - iii) seconds (0–59).

8.6.2 Timetable Entries

The individual entries in the timetable shall be used to determine the particular time at which a change is

to be made to the controller's operation.

By means of examples, the timetable shall determine the time of the following (where the relevant facilities are included):

- a) introduction of cableless linking method of traffic control operation;
- b) introduction of vehicle actuated method of traffic control operation;
- c) introduction or cancellation of a specific stage or phase green;
- d) introduction or cancellation of alternative maximum timings;
- e) switching on or off of a secret sign;
- f) introduction of specific plans in the cableless linking method of control;
- g) introduction or deletion of specific detectors;
- h) change of variable maximum threshold and/or additional period;
- i) switching on or off of part-time signals.

When timetable entries are actioned they shall cancel previous related conflicting entries.

Note: Different Types of timetable entry may interact, (e.g. introduction of a stage will require a plan change if the controller is operating the CLF method of traffic control).

8.7 Operator Facilities

It shall be possible to view all plan and timetable settings via the operator interface. It shall be possible to view any specific setting prior to entering it into the system and cancel it if so required.

It shall be possible to exercise any plan and then reintroduce the previous running plan without losing that plan's synchronisation to the linked system.

It shall be possible to give an indication of the current state of the group timer via the operator interface, (i.e. the group influence and running stage number).

8.8 Capacity of Master Time Clock System

The master time clock system shall be capable of providing at least the following facilities:

- a) timetable entries – 32 off;
- b) plans – 8 off;
- a) groups within a cycle for each plan – 16 off;
- d) 4 sets of alternative maximum green timings.
- e) an annual calendar.

9 SAFETY MONITORING

9.1 General

This section details the facilities which shall be incorporated to verify the functional integrity of the controller. Such facilities are concerned primarily with the microprocessor system but may be considered in the following categories:

- a) facilities provided to ensure the functional integrity of the microprocessor system; and
- b) facilities provided to ensure the functional integrity of equipment peripheral to the microprocessor system.

9.2 Green/Green Conflict

9.2.1 General

During normal operation and under fault conditions or with permitted operator intervention, the controller shall not allow the illumination of conflicting green aspect signal lamps.

All controllers shall be equipped with facilities to prevent the persistent display of simultaneous green signals on any conflicting phases.

The conflict monitor method shall ensure that no conflict persists for more than 512 milliseconds.

9.2.2 Conflict Monitor

The conflict monitor shall comprise the following:

- a) two voltage level sensors which shall be installed on the output side of each green phase switching device and shall monitor the green signal leads. The associated sensor circuitry shall detect if an ac voltage or either half cycle component in excess of a threshold value, in the range 24–48 volts RMS (with a nominal 230 V ac supply) is present on conflicting phase green signal leads. Any in–line fusing of the green aspect shall be placed between the level sensors and the phase switch device (see clause 3.1.4.);
- b) a means which will check for

correspondence between the two voltage level sensors for each green phase switching device;

- c) a method which shall ensure that the phase green signal status as detected by the monitor system is equivalent to that requested by the control processor;
- d) a green conflict monitor which shall be independent of the control processor. The conflict pattern for a junction facility shall be configurable via access level 4. The conflict pattern for all stand–alone facilities shall be fixed in a defined configuration with level 4 access.

9.2.3 Validation of Independent Green Conflict Monitor

The control processor shall during normal operation, continuously validate the performance of the independent green conflict monitor up to the input terminals of the contactor. The technique should:

- a) not involve injecting test voltages on the signal leads; and
- b) ensure that all individual phase green to phase green conflicts are tested. All validity tests shall be completed within 120 seconds. Conflicts for phases not requested during the running period (i.e. demand dependent) need not be validated.

9.2.4 Removal of Lamp Power Supply

The supply to the lamp circuits shall be removed in the event of a correspondence failure (see clause 9.2.2b), an equivalence failure (see clause 9.2.2c) a conflict detected by the monitor (see clause 9.2.2d) or non–validation of the independent green conflict monitor (see clause 9.2.3).

The method of removing the feed to the signal lamp circuits shall be by use of a contactor. Two contactors shall be installed in accordance with one of the following methods:

- a) one primarily controlled by the main control

processor and one primarily controlled by the independent conflict monitor. Each contactor shall be normally operated and shall release in the event of a conflict. If either the main control processor or the conflict monitor initiates the process of releasing its contactor and this fails, a facility shall exist which enables the other contactor to be released; or

- b) the main processor and the independent conflict monitor shall each release both contactors.

9.2.5 Restoration of Facilities

Facilities shall not be restored until the fault has been rectified. The controller will need to be manually reset.

9.3 Other Signal Group Conflicts (unwanted signals)

9.3.1 The simultaneous display of other conflicting signal groups shall have an effect according to one or more of the classes of BS EN 12675 specified in Annex B, Section 2.

9.4 Signal Group green / absent red conflict.

9.4.1 In the event that configured signal group red signals are not displayed with a signal group green signal, it shall have an effect according to one or more of the classes of BS EN 12675 specified in Annex B, Section 2.

9.5 National Signal regulations (unwanted signals)

9.5.1 Unwanted signals on the same signal group which infringe the national signal regulations shall have an effect according to one or more of the classes of BSEN 12675 specified in Annex B, Section 2.

9.6 Absent signals

9.6.1 Absent signal group red signals.

Absent signal group red signals which are required by the traffic signal controller to be displayed shall

have an effect in accordance with one or more of the classes of BS EN 12675 specified in Annex B, Section 2.

9.7 Compliance checking

9.7.1 There is no requirement to check for compliance.

9.8 Safety timings

9.8.1 The traffic signal controller shall check that the values of safety timings are in accordance with national requirements for the BS EN12675 classes specified in Annex B, Section 2.

9.9 National Signal Sequences.

9.9.1 National signal sequences (infringement).

There is no requirement to check for National signal sequences.

9.9.2 Specified signal group green to signal group green movements.

There is no requirement to check for signal group green movements.

9.9.3 Specified signal start-up sequence signal group movements.

There is no requirement to check for signal start-up sequence group movements not being correct.

9.10 Faults of external inputs.

Class HA1 – In the event of a configured input indicating a fault of the external equipment the traffic signal controller shall register a fault.

9.11 Red Lamp Monitor (for Part Time and Pedestrian Facilities at Junctions)

9.11.1 Use of Red Lamp Monitoring

Red lamp monitoring shall be provided at junctions with pedestrian facilities employing audible/tactile

signals or under Part Time control, and may be provided at other junctions where considered necessary.

Red lamp monitoring will monitor for red lamp and red lamp supply failure.

For new installations, separate monitoring shall be employed:

- a) for pedestrian facilities employing audible/tactile signals, on each conflicting vehicle approach;
- b) for part time control, on each vehicle approach which has natural priority.

For existing installations which are not separately cabled for each vehicle approach, it will be necessary to monitor a phase. This will give rise to unnecessary failure action where one lamp has failed on each of two approaches.

Where both junction (where red lamp monitoring is required) and stand-alone facilities or multiple stand-alone facilities are provided in a common controller, red lamp monitoring failures shall not cause a common controller failure.

Note: It is normal that primary signals shall always be monitored but that secondary signals may be un-monitored, but site conditions may require other monitoring arrangements.

9.11.2 Single Vehicle Red Lamp Failure

In the event of a single vehicle red lamp failure, within one signal cycle of the failure, the following action shall be possible if called for in the Works Specification:

- a) the All-Red period of the relevant intergreens may be extended up to a value of 5 seconds, unless it is already 5 seconds or greater when no action will be taken (see Speed Assessment clause 7.5.4).

9.11.3 Second or Total Vehicle Red Lamp Failure

Upon the event of a second vehicle red lamp failure on the same phase, vehicle red lamp feed failure or failure of the vehicle red lamp monitor, the following actions shall be taken:

9.11.4 Pedestrian Facilities at Junctions

If the failure occurs during the pedestrian stage, the stage shall terminate in accordance with clause 9.11.3.4 unless it is within the minimum green period when it shall terminate at the end of the minimum green period.

If the failure occurs during the pedestrian blackout period, the blackout shall terminate at the end of its period.

If the failure occurs at any other time, the following actions shall be taken:

- a) for exclusive pedestrian stages, subsequent pedestrian stages shall be omitted. All pedestrian demands shall be disabled and all pedestrian red signals and indicators shall be illuminated;
- b) for other parallel pedestrian stages, subsequent pedestrian stages shall run normally but without the green pedestrian and audible/tactile signals. All pedestrian red signals and indicators shall be permanently illuminated;
- c) selected stand-alone streams shall be extinguished in accordance with clause 9.11.4.3.

9.11.4.1 Part Time Facilities

All signals shall be extinguished in accordance with clause 9.11.4.3.

9.11.4.2 Full Time Signals

Full time signals may react as part time facilities.

9.11.4.3 Response Time

Action required by clause 9.11.2 and 9.11.3 shall occur within 500 milliseconds of the failure unless the failure occurs before or within 500 milliseconds of the start of the monitored vehicle red. In this circumstance action shall be taken within 1 second of the start of the red.

9.11.4.4 FM Indicator

The FM indicator shall operate whilst the conditions in clauses 9.11.2 or 9.11.3 apply, and shall flash at a rate between 60 and 90 flashes per minute with a 50% duty cycle. The requirement to flash the FM

indicator shall override any requirement to illuminate it continuously.

9.11.5 Restoration of Facilities

Following the shut down of a facility (see clause 9.11.3), the facility shall not be restored until the fault has been rectified and the controller reset. This may be achieved either manually or by automatic reset, as called for in the Works Specification.

Where action has been taken that affects pedestrian facilities, either at junctions or stand-alone, then the controller will have to be manually reset. If there are no pedestrian facilities then automatic reset is allowed.

In either case the controller shall go through a controlled start-up sequence (see clause 4.5).

9.11.6 Red Lamp Monitor Interface

Where the red lamp monitoring facility is provided within either a UTC or remote monitoring system, vehicle red lamp failure RF1 and vehicle red lamp failure RF2 interfaces shall be available (see clause 5.7).

9.12 Red Lamp Monitor (for Stand-alone Pedestrian Facilities)

9.12.1 Monitor

A stand-alone controller shall have the facility for both monitored and unmonitored vehicle red lamps. The red lamp monitor shall function with a minimum of one and a maximum of four red vehicle lamps. A red lamp monitor shall be provided for each vehicular approach. The controller shall be capable of being equipped with at least four red lamp monitors.

Note: It is normal that primary signals shall always be monitored but that secondary signals may be unmonitored, but site conditions may require other monitoring arrangements.

9.12.2 Operation of Red Lamp Monitor

On the event of all monitored red vehicle lamps failing, two vehicle lamps on the same phase failing or a failure of the red lamp monitor being detected then all signals and pedestrian indicators shall switch off within 500 milliseconds, unless the failure occurs before or within 500 milliseconds of the start of the monitored vehicle red. In this circumstance the above action shall take place within 1 second of the

start of the red.

9.12.3 Restoration of Facilities

Facilities shall not be restored until the fault has been rectified. The controller will need to be manually reset.

9.13 Program Monitor

9.13.1 Monitoring Requirements

The site configuration data held in the non-volatile store shall be repeatedly monitored.

Each of the individual memory components used to store the program and the fixed data for the controller shall be tested by the sum check or other equipment validation techniques. Each such component shall incorporate its own unique check value set according to the information contained within the component.

The check error detection system may employ a technique which requires a check error to be present for a minimum of 2 consecutive trials before an error is considered to be detected. If a check error is found then that section of program or fixed data shall be re-tested as soon as possible.

Each of the individual memory components used to store the program and the fixed data for the controller shall be individually monitored:

- a) during the start-up procedure and prior to the illumination of any signal lamps;
- b) and whilst the controller is powered up and during the spare processing time. This checking shall occur at intervals of not more than 10 seconds.

9.13.2 Action on Detection of an Error

If a check error is detected in either of the above checking operations an indication shall be provided which is visible on opening the main door(s), subject to the error not inhibiting this indication.

Following the detection of a check error either:

- a) the supply to the signal lamps shall be switched off within 500 milliseconds. The lamp supply shall remain switched off until manually reset; or

- b) alternatively, at the manufacturer's discretion, the controller may reset automatically to lower priority mode of automatic control provided that functional integrity can be maintained.

9.14 Read/Write Memory Monitor

Note: There are two applications for read/write memory:

- a) storage of timing data, (e.g. phase timings and cableless link data that may be changed by an operator); and
- b) work space, (i.e. data areas used by the program during processing).

9.14.1 Monitoring Requirements

The controller shall be equipped with a facility such that the complete set of timing parameter data contained in the non-volatile store can be transferred into read/write memory. During normal operation the controller will operate with timing parameters taken from the read/write memory.

The timing data in the read/write memory area shall be protected by the use of a checksum. Each of the individual memory components used to store the timing data for the controller shall be tested as specified in clause 9.13.1.

9.14.2 Action On Detection of an Error

In the event of corruption of the timing data contained in the read/write memory being detected by either system described above, then the data contained in the read/write memory shall be ignored and only the data held in non-volatile store shall be used for the operation of the controller. An appropriate entry shall also be made in the fault log.

9.15 Watchdog Monitor

9.15.1 General

There shall be at least one watchdog fitted to the controller.

The watchdog shall employ an independent timer, external to the microprocessor, that must be reset at frequent intervals by the microprocessor program. If this timer expires (e.g. because the microprocessor has stopped running), then the

equipment shall be prevented from entering an unsafe condition by holding the processor in a quiescent state with the signal lamps switched off.

Following the operation of all the routines which have to be executed at fixed time intervals the watchdog timer shall be reset.

If a watchdog timer expires an indication shall be given which is visible on opening the main door(s).

9.15.2 Monitoring for Microprocessor Becoming Trapped in Loop

A means shall also be provided to ensure that under fault conditions the microprocessor system does not become trapped in a loop and hence prevented from servicing the lower priority program areas.

This facility shall be provided by either a second watchdog, or by a software check, (at the manufacturer's discretion), which if it fails shall cause the watchdog not to be reset.

9.16 Adjustment of Safety Timings

It shall be possible, without recourse to changes in data held in non-volatile storage, only to adjust controller parameters subject to the following constraints:

- a) a phase minimum running period shall not be set below the minimum green limit value;
- b) a phase intergreen shall not be set below the intergreen limit value;
- c) the stand-alone vehicle minimum running period shall not be set below six seconds;
- d) the stand-alone vehicle red/green walking man shall not be set below four seconds; and
- e) the stand-alone vehicle red/red standing man shall not be set below one second.

Items (c), (d) and (e) may be held in separate storage to items (a) and (b).

It shall not be possible to adjust the minimum green and the intergreen limit values without recourse to changes in non-volatile store.

If an attempt is made to modify any timing to a value

that conflicts with the timing constraints specified in this clause, no change shall be made to the timing.

9.17 Safety of Audible and Tactile Signals

The operation of audible/tactile signals shall be subject to the following requirements:

- a) the output, to audible/tactile drives, shall either be configurable, as in clause 9.2 (green conflict), or driven direct from the appropriate green pedestrian signal;
- b) the red lamp monitoring requirements:
 - in accordance with clause 9.11 for an intersection facility;
 - in accordance with clause 9.12 for a stand-alone facility.

Outputs to drive audible and/or tactile signals shall only be provided during the steady pedestrian green signal periods.

During normal operation, under fault conditions, or with permitted operator intervention, the controller shall only present an output to an audible and/or tactile signal if all vehicle phases conflicting with the pedestrian phase are at red.

10 FAULT LOG

10.1 Accepting Faults

Unless the operator has instructed the controller that the detector faults present have been 'accepted' (i.e. are known to exist and should be ignored by the FM), it shall not be possible to extinguish the FM indicator if the fault condition still persists (i.e. if the detector equipment output still has not changed state between alarm and manual reset). If the operator has accepted the faults it shall be possible for the operator to clear the fault.

10.2 Fault Log Entry

A fault 'log' in read/write memory shall be used to store information for all faults detected during the operation of the controller. This area of store shall be supported by the standby power supply source in the event of mains failure.

Note: Certain fault conditions, for example, failure of the microprocessor may prevent the operation of the fault log.

The log shall contain information relating to the following:

- a) the identity of the faulty detector input(s);
- b) information from the green conflict monitor system(s) allowing the identity of conflicting phases to be determined;
- c) an indication that corruption has occurred to timing data held in non-volatile store or volatile store; and
- d) an indication that the standby power supply source has failed.

The fault log shall operate as follows:

- a) there shall be two fault log functions:
 - i) a current fault log containing at least 64 entries which holds uncleared faults; and
 - ii) an historical fault log containing at least

255 entries which keeps a record of all fault occurrences, clearances and events;

- b) the historical fault log shall be a rolling log i.e. when a log becomes full, the next entry overwrites the oldest entry;
- c) the current log shall not be a rolling log;
- d) faults shall only be cleared from the current log when they are:
 - i) safety related (e.g. conflict, sum check, violation of clause 11.8) in which case they shall only be cleared manually on-site;
 - ii) non-safety related, in which case they may be cleared automatically;
- e) faults shall be entered into both logs when they occur. When a fault is cleared it shall only be deleted from the current log with a 'clear' entered into the historical log;
- f) entries from the historical log shall not be deleted except when they are overwritten by new entries when the log is full. Provision may be incorporated to delete historical log entries due to commissioning tests. This will not be accessible to the user;
- g) every entry into a log shall be stamped with the time and date to a resolution of 2 seconds;
- h) it shall be possible to record certain events which are not faults and which do not require to be cleared. Events shall be recorded into the historical log and not into the current log.

The information held in the fault log shall be accessible via the user interface.

11 TIMING PARAMETERS

Note: This section details all the controller timing parameters both fixed and variable. It relates variable timings to operator access levels.

11.1 Range and Step Size

The range and step size quoted in the timing tables 11.1, 11.2 and 11.3, represent the minimum facilities which are acceptable. A manufacturer at his discretion, and subject to the approval of the Approval Authority, may provide more comprehensive facilities.

11.2 Timing Tolerance

The total timing tolerance of the controller can be considered in various categories, these categories are related to the various parameters by means of the timing charts.

Category

- A – Tolerance ± 250 milliseconds
- B – Tolerance \pm one second
- C – Tolerance ± 1 minute
- D – Mains Sync \pm one second in 30 days or
Crystal Clock \pm one second in 24 hours
- E – Tolerance ± 10 minutes

For the parameters in Table 11.1 the timing tolerance shall be as specified in that table. All parameters in Table 11.2 and 11.3 shall have tolerance category A.

11.3 Derivation of Timings

All timings may be derived from the mains frequency and hence subject to any variations present upon the mains frequency.

11.4 Fixed and Alterable Parameters

The parameters marked 'FIXED', in Tables 11.1, 11.2 and 11.3, shall be held in non-volatile store and shall not be alterable via the operator interface.

It shall be possible to change the parameters marked 'ALT', (i.e. alterable, via the operator interface).

11.5 Speed Measurement Accuracy

The following refer to accuracy of controller equipment only, and do not take account of inaccuracies introduced by vehicle detector equipment.

The accuracy of speed discrimination equipment shall be within $\pm 3.5\%$ of nominal at nominal mains frequency.

The accuracy of equipment for speed assessment shall be within $\pm 4\%$ of the measured speed. The delay period given shall not vary from the nominal value given by the formula defined by more than ± 250 milliseconds.

11.6 Timing Data Security

The operator facilities shall allow the timing data contained in read/write memory to be changed. This enables 'on site' changes to be made to any of the alterable timing parameters. Such changes may subsequently require to be incorporated into the non-volatile store, using level 4 facilities.

When the operator makes changes to the timing data, held in read/write memory, data shall initially enter the work space area. On completion of the change(s) the new data shall be written into the read/write memory together with an updated sum check value.

Parameter	Range	Maximum Step Size	Tolerance	Access Level	Fixed / Alterable
Mandatory Signal Timings					
Red/yellow	2 sec	–	A	4	Fixed
Yellow	3 sec	–	A	4	Fixed
Signal Timings - Working Values					
Phase Min Green	3–30 sec	1 sec	A	3	ALT
Vehicle extension	0.2–5 sec	0.2 sec	A	3	ALT
Phase green Extension	0–25 sec	0.5 sec	A	2	ALT
Phase green Maximum	0–99 sec	1 sec	A	2	ALT
Phase Intergreen	0–30 sec	1 sec	A	3	ALT
Extra Clearance	0–30 sec	1 sec	A	2	ALT
Phase Losing Delay	0–60 sec	1 sec	A	3	ALT
Phase Gaining Delay	0–60 sec	1 sec	A	3	ALT
All-Red Extension	0–25 sec	0.5 sec	A	2	ALT
Max Extended All-Red	0–99 sec	1 sec	A	2	ALT
Pedestrian Blackout (preset)	3–30 sec	1 sec	A	3	ALT
Pedestrian Inhibit Release	0–30 sec	1 sec	A	2	ALT
Pedestrian Inhibit Delay	0–99 sec	1 sec	B	2/4	ALT/FIX
Variable Maximum (V Max)					
V Max Threshold	900–3000 VPH	50 VPH	–	2	ALT
V Max Additional Period	0–100 sec	1 sec	A	2	ALT
Detector Function					
Call Delay	0–60 sec	1 sec	A	2	ALT
Cancel Delay	0–60 sec	1 sec	A	2	ALT

Table 11.1 – Timing Parameter Chart

Parameter	Range	Maximum Step Size	Tolerance	Access Level	Fixed / Alterable
Detector Fault Monitoring					
Permanent detect state timeout	0–60 min	1 min	C	2	ALT
Permanent non–detect state timeout	0–72 hrs	1 hr	E	2	ALT
Start up timings					
‘All Off’ period following power up	7–10 sec	–	N/A	4	Fixed
‘All Off’ period following manual switch on	0 sec	–	N/A	4	Fixed
Starting intergreen	0–30 sec	1 sec	A	3/4	ALT/Fixed
Push button demand with kerb side cancel					
Push button demand extension	1 – 5 secs	0.2	A	2	ALT
Kerb side detection demand extension	1 – 5 secs	0.2	A	2	ALT
Registered demand extension	1 – 5 secs	0.2	A	2	ALT

Table 11.1 – Timing Parameter Chart (continued)

Parameter	Range	Maximum Step Size	Tolerance	Access Level	Fixed / Alterable	
Master time clock						
Clock	Days	1–7 days	1 day	D	2	ALT
	Hours	0–23 hrs	1 hr	D	2	ALT
	Minutes	0–59 mins	1 min	D	2	ALT
	Seconds	0–59 secs	1 sec	D	2	ALT
Plans	Cycle Time ¹	0–200 sec	1 sec	D	2	ALT
	Offset ²	0–200 sec	1 sec	D	2	ALT
	Group	0–100 sec	1 sec	D	2	ALT
Timetable	Day Type	7 types	–	–	2	ALT
	Hours	0–23 hrs	1 hr	D	2	ALT
	Minutes	0–59 mins	1 min	D	2	ALT
	Seconds	0–59 secs	1 sec	D	2	ALT
Speed measurement SA/SDE						
SDE						
Double extension	3 sec	–	A	4	Fixed	
Triple extension	3.5 sec	–	A	4	Fixed	
SA	5 sec + delay period	–	A	4	Fixed	
Vehicle priority						
Priority Extension	0–15 sec	1 sec	B	2	ALT	
Priority Maximum	0–31 sec	1 sec	B	2	ALT	
Compensation Period	0–30 sec	2 sec	B	2	ALT	
Inhibit Period	0–150 sec	10 sec	B	2	ALT	
Hurry Call						
Hurry Call Delay	0-99 sec	1 sec	B	2	ALT	
Hurry Call Hold	0-99 sec	1 sec	B	2	ALT	
Hurry Call Prevent	0-199 sec	1 sec	B	2	ALT	

Table 11.1 – Timing Parameter Chart (continued)

¹Cycle time is the summation of group times²Offset times may not physically be specified

Parameter	Facility Type	Range	Maximum Step Size	Access Level	Fixed/ Alterable
Vehicle phase Pelican, Puffin, and Ped/Junction					
Fixed vehicle period	ALL	20 – 60	4	3	ALT
VA vehicle minimum	Pe, Pu	6 – 15	1	3	ALT
VA vehicle minimum	Ped	3 – 15	1	3	ALT
VA vehicle maximum	ALL	10 – 60	10	2	ALT
Vehicle extension	ALL	0.2 – 5	0.2	3	ALT
11.6.1.1 Vehicle to pedestrian phase					
Intergreen	ALL	3	–	4	Fixed
Vehicle yellow/ped red					
Red/red	ALL	1 – 3	1	3	ALT
- gap change	ALL	1 – 3	1	3	ALT
- forced change					
Pedestrian phase					
Vehicle red/ped green					
Stand-alone (Period D)	Pe)				
(Period 4)	Pu)—	4 – 9	1	3	ALT
(Period iv)	Pd)				
Junction		4 – 99	1	3	ALT

Table 11.2 – Timing Parameter Chart for Pedestrian Facilities

Parameter	Facility Type	Range	Maximum Step Size	Access Level	Fixed/Alterable
Pedestrian to vehicle phase intergreen					
<u>Pelican</u>					
Veh red/FGM (Period E)	Pe	0 or 2	2	3	ALT
FA/FGM (Period F)	Pe	6 – 18	1	3	ALT
FA/ped red (Period G)	Pe	1 – 2	1	3	ALT
<u>Puffin</u>					
Red/Red					
Minimum (Period 5)	Pu	1 – 5	1	3	ALT
Maximum (Period 6)	Pu	0 – 30	1	3	ALT
Force Change (Period 7)	Pu	0 – 3	1	3	ALT
Gap Change (Period 8)	Pu	0 – 3	1	3	ALT
<u>Pedestrian</u>					
Red/Blackout					
Minimum (Period v)	Pd	3 – 15	1	3	ALT
Maximum (Period vi)	Pd	0 – 30	1	3	ALT
Force Change (Period vii)	Pd	1 – 3	1	3	ALT
Period viii	Pd	1 – 3	1	3	ALT
Red or Blackout Extension (Ref Period 6 or vi)	Pu Pd	0.4 – 5	0.2	3	ALT
Key: Pe Pelican					
Pd Pedestrian					
Pu Puffin					

Table 11.2 – Timing Parameter Chart for Pedestrian Facilities (continued)

Parameter	Range	Maximum Step Size	Access Level	Fixed/Alterable
Vehicle Phase (Period i or I)				
Fixed vehicle period	20–60	4	3	ALT
VA vehicle minimum	6–15	1	3	ALT
VA vehicle maximum	10–60	10	2	ALT
Vehicle extension	0.2–5	0.2	3	ALT
Vehicle to Pedestrian/Cyclist Phase Intergreen				
Vehicle yellow/pedestrian red (Period ii or II)	3	–	4	Fixed
Red/red (Period iii or III)				
– gap change	1–3	1	3	ALT
– forced change	1–3	1	3	ALT
Pedestrian/Cyclist Phase (Period iv or IV)				
Vehicle red/ped and cyclist green				
Stand-alone	4–9	1	3	ALT
Junction	4–99	1	3	ALT
Pedestrian/Cyclist to Vehicle Phase Intergreen				
Variable red/red or blackout				
minimum (Period v or V)	1 – 5	1	3	ALT
maximum (Period vi or VI)	0 – 30	1	3	ALT
ext	0.4 – 5	0.2	3	ALT
Forced Change (Period vii)	1 – 3	1	3	ALT
Forced Change (Period VII)	0 – 3	1	3	ALT
Period viii	1 – 3	1	3	ALT
Gap Change (Period VIII)	0 – 3	1	3	ALT
Red + yellow/red (period ix or IX)	2	-	4	Fixed
Notes				
Parameters:	Lower case Periods	see figure 7a		
	Upper case Periods	see figure 7b		

Table 11.3 – Timing Parameter Chart for Toucan Facilities

Parameter	Range	Maximum Step Size	Tolerance	Access Level	Fixed/ Alterable
Push Button Demand with Kerb Side Cancel					
Push button demand extension	1–5 secs	0.2	A	2	ALT
Kerb side detection demand extension	1–5 secs	0.2	A	2	ALT
Cyclist demand extension	1–5 secs	0.2	A	2	ALT
Registered demand extension	1–5 secs	0.2	A	2	ALT

Table 11.3 – Timing Parameter Chart for Toucan Facilities (continued)

12 ENVIRONMENTAL TESTING

12.1 Test Requirements

The controller, together with an equipment rack dissipating 90 Watts where ancillary equipment as specified in clause 3.3.2. is provided, shall be subjected to the test classes of BS 7987 (HD 638 SI) specified in Annex B, Section 2.

In addition, the controller shall be tested at its maximum rated load to an agreed test schedule. To facilitate such testing, resistive loads may be used.

12.2 Degrees of Protection Provided by Enclosures (IP Code)

The equipment housing shall be to Class V4 in BS 7987 (HD 638 SI) clause 5.1.1.3. This is defined as BS E 60529 IP55. When the manual panel is open, the protection provided shall be to IP43. When the housing is open the protection shall be to IP20.

The controller housing shall be manufactured from suitable material to provide mechanical protection to EN 50102, IK07. Surface cracks are allowed providing complete penetration does not occur i.e. the integrity of the seal is not broken. This test shall be conducted before the TR 2130 tests specified at 12.1.

No damage shall occur to the equipment contained within the housing and the equipment shall continue to operate to its specification. There shall be no degradation of the IP coding of the equipment.

12.3 Electromagnetic Compatibility (EMC)

EMC testing shall be carried out in accordance with EN 50293.

13 MARKING, LABELLING AND PACKAGING

13.1 Types of Module

It shall be a design aim to keep to a minimum the number of different types of module used.

13.2 Language/Symbols

All modules, units and main parts of the equipment shall be clearly marked or labelled in the English Language or Internationally agreed symbols in accordance with the requirements below.

13.3 Functional Code

Each unit shall carry its functional code or title, and type or part number.

13.4 Unit Marking/Labelling

The marking or labelling of main units shall be clearly visible without dismantling the unit. The marking or labelling of encased units or of modules shall be visible when the unit is removed from its normal position and covers, if fitted, taken off.

13.5 Component Marking

Components shall not be marked with circuit references (with the exception of certain semiconductor memories). The markings shall either be adjacent to the component or annotated in the diagram or photograph in the relevant handbook or manual.

13.6 Instruction Markings

Markings required for controls, maintenance or working shall be adjacent to the part concerned.

13.7 Life Expectancy of Markings

Markings shall maintain legibility throughout the life of the equipment in the specified environmental condition.

14 GLOSSARY

For the purpose of this specification the following definitions shall apply:

Address – A code which identifies a specific location within the microprocessor system memory.

All-Red Period – Period during the change from one phase green to the next when all phases show red. (BS 6100 241 7523).

All-Red Maximum Period – The maximum time that an All-Red period can be extended after a demand has been made by traffic on another phase.

Arterial Reversion – Reversion to a selected stage in the absence of demands.

ASCII – See ISO alphabet.

Binary Code – A system of expressing numbers to base 2.

Bit – A single digit in binary code.

Compensation Period – An extension of the normal maximum running period which, following a priority change, may be introduced in nominated phases associated with each Public Service Vehicle (PSV) priority phase, other than the phase to which the priority change was made.

Controller – Apparatus that controls and switches traffic signals. (BS 6100 241 7511).

Cycle – One complete sequence of the operation of traffic signals. (Signalling cycle, BS 6100 241 7510).

Cyclic Order – A control scheme in which the stages are given in fixed order.

Demand – Request for right-of-way for traffic passing a detector and approaching a red signal. (BS 6100 241 7528).

Demand-Latched – Demand locked after initialisation. Released only by controller sequence and safeguards.

Demand-Unlatched – Demand only retained while other import conditions exist or released by controller sequence and safeguards.

Demand Initiated Maximum – The commencement of maximum green upon insertion of a related demand, as opposed to pre-timed maximum.

Detector – Unit of the vehicular or pedestrian detecting equipment that initiates a demand or extension.

Detecting Equipment – The equipment provided at the installation which indicates the presence of traffic (vehicle or pedestrian) approaching or passing through the controlled area.

Dummy Phase – This is a software device, within the controller, which may be used to control traffic movements which are not, separately signalled. It does not have any associated traffic signals.

Early Cut-Off – A condition in which one or more traffic streams, that were running during the preceding stage, are stopped whilst one or more other traffic streams are allowed to continue moving. (BS 6100 241 7517).

Extension – Continuation of the green signal that results from a request made by a vehicle or pedestrian that has right of way. (BS 6100 241 7529) (may also be applied to a red signal).

Filter Green Arrow – Indicates that vehicles may proceed in the direction shown while the main signal is showing red.

Fixed Time Traffic Signals – Traffic signalling equipment in which the duration of the red and green signals and the time of the cycle is fixed.

Force – A UTC computer demand for a change to a selected stage or to hold a currently running stage.

Full Duplex – A data transmission channel in which simultaneous two-way transmission is available.

Gap Change – A signal change which occurs at the

end of a vehicle extension period. (BS 6100 241 7526).

Green – The green signal displayed by a phase to give right-of-way to the traffic stream(s) it controls. Its meaning is extended to cover other signals which are not green but give right-of-way to a traffic stream (such as the vertical white bar used in LRT signals).

Group – This is an influence or set of influences on the operation of the signal controller during CLF mode.

Group Time – This is the time period for which a specific group influence is exerted on the controller operation.

Hurry Call Change – A signal change to a selected stage, caused by a demand from a fire or ambulance station, or from a queue detector.

Indicative Green Arrow – This indicates that vehicles may proceed in the direction shown which is also covered by a full green signal. Opposing traffic has been stopped.

Inductive Loop Vehicle Detecting Equipment – The equipment provided at the installation by which the presence of vehicular traffic approaching or passing through the controlled area can be detected. This equipment would usually comprise loop(s), feeder(s) and detector(s).

Inductive Loop Vehicle Detector – Apparatus by which changes in loop parameters caused by a vehicle are detected.

Influence – Effect of an input, from an external source or an internal programmed control, on the sequence of signal indications.

Inhibit Period – A period following a priority change, during which priority changes to the same priority phase or up to at least three other specified priority phases shall not occur, but priority extensions may still be served. The inhibit period shall be considered to have started from the end of the priority phase which was called by a priority demand.

Input/Output (I/O) – Those parts of the microprocessor system which receive signals from and transmit signals to other parts of the controller or external devices.

Intergreen Period – Period between the end of the green signal giving right of way for one phase, and the beginning of the green signal giving right of way for the next phase. (BS 6100 241 7522).

Interstage Period – The period between the end of one stage and the start of the next stage.

ISO Alphabet – International Standards Organisation alpha-numeric data communications code used for data transmission.

Late Release – A condition in which one or more traffic streams are permitted to move before the release of other traffic streams which are permitted to run with them during the subsequent stage. (BS 6100 241 7518).

LMU – Lamp Monitoring Unit.

Loop – One or more turns of wire laid in or on the carriageway.

Loop Detector Feeder – The cable connecting the loop to the detector.

LRT – Light Rapid Transit e.g. a Tram.

Maximum Change – A signal change that occurs on the expiration of a maximum running period. (BS 6100 241 7527).

Maximum Running Period (also Maximum Green) – The time that a green signal to vehicles can continue after a demand has been made by traffic on another phase. (BS 6100 241 7516).

Memory – A means of storing information in a manner permitting its retrieval.

Memory Location – Synonymous with address.

Microprocessor – A semi-conductor device which carries out arithmetical and logical operations on information under the control of a program.

Microprocessor System – A system comprising a microprocessor with associated memory and I/O capabilities.

Minimum Change – A signal change that occurs on the expiration of a minimum running period. (BS 6100 241 7527).

Minimum Running Period (also Minimum Green)
– Duration of the green signal, following the extinction of a red–yellow signal, during which no change of signal lights can occur. (BS 6100 241 7514).

Mode – A particular method of operation for a hardware or software device.

MOVA – Microprocessor Optimised Vehicle Actuated strategy based on minimising stops and delays and maximises capacity at a single controlled junction.

Non–volatile memory – A memory device which does not lose its stored data either during processing, when the power supply is removed or when the controller is reset.

OMU – Outstation Monitoring Unit.

OMCU – Outstation Monitoring and Control Unit.

OTU – Outstation Transmission Unit.

Parallel Stage Streaming – A control scheme in which two or more separate stage streams run in parallel. The controller thus has the effect of two or more smaller controllers.

Pedestrian Demand – A request for right of way for pedestrians who, when the request is made, do not have right–of–way.

Pelican – A stand–alone pedestrian crossing that uses far–sided pedestrian signal heads and a flashing yellow/flashing green crossing period, of a fixed duration, which is demanded solely by push button.

Phase – Set of conditions that fixes the pattern of movement and waiting for one or more traffic streams during the signalling cycle. (BS 6100 241 7509).

Phase green Extension – An extension to a phase green which may either be configured or extended by its associated detection equipment.

Preset – The mechanism of specific timings, being adjustable within a specified range by user action but set at an initial defined value as called for in the Works Specification.

Pre–timed Maximum – The commencement of maximum green concurrently with minimum green, as opposed to demand initiated maximum.

Priority Vehicle Detection Equipment – Detection equipment designed to respond only to the appropriate type of vehicle.

Priority Phase – A phase which is equipped with PSV priority facilities.

Priority Extension – A continuation of a green signal requested by vehicle(s) equipped to operate the priority vehicle detection equipment.

Priority Maximum Running Period – A further maximum running period which increases the normal maximum running period (including any variable maximum) if a priority extension period is running or if a priority vehicle detector output is present.

Priority Demand – A demand for an immediate right of way originating from vehicle(s) equipped to operate the priority vehicle detection equipment.

Priority Change – A signal change which occurs as a result of a priority demand (the signal change being subject to the minimum safety periods and to the priority facilities specified on the phase which has right of way).

Program – A sequence of instructions to control the operations of a microprocessor.

PSTN – Public Switched Telephone Network.

PSV – Public Service Vehicle e.g. bus, LRT.

Puffin – A pedestrian crossing that uses near–side pedestrian signals heads and an extendable All–Red crossing period which is instigated by a push button request accompanied by a pedestrian detector demand.

Read/Write Memory – A device in which information at any desired address can be stored or changed and from which information can be retrieved.

Read Only Memory (ROM) – A device from which previously stored information at any desired address can be retrieved, but not overwritten in the

course of normal operation.

Revertive Priority Demand – A priority demand entered, at the termination of right of way of a priority phase, for the phase being left.

Right-of-way at Signals – Right of priority attached to traffic moving in a particular direction or a priority temporarily given to traffic by signals, signs pedestrian crossings or other means. (Right-of-way (2) BS 6100 41 7105).

Routine – A sequence of instructions comprised within a program and designed for the implementation of a specific function.

Run – A phase is said to be running when it is displaying a green signal. A stage is said to run a phase if that phase displays a green signal during that stage.

SCOOT – Split, Cycle, Offset Optimisation Technique which uses real time traffic data to minimise stops and delays for UTC controlled areas.

Software – Set of computer programs stored in memory.

Signal aspect – A single optical unit which, when illuminated, displays a single colour or symbol.

Signal display – The combination of illuminated aspects in a signal head which provides a control instruction to traffic.

Signal head – A combination of signal aspects which together provide all the signal displays required for the control of one or more traffic streams at the same stop line.

Speed Discrimination Speed Assessment

Equipment (SA/SDE) – The equipment provided at the installation which produces an output signal for a vehicle travelling faster than a specified speed.

Stage – A stage can primarily be considered as in BS 6100 241 7508 as “Indication by traffic signals during a period of the signalling cycle that gives right of way to one or more particular traffic movements”.

A stage may be considered as starting at the point at which all phases that will have right-of-way during the stage have been set to green, and all phases terminating have been set to red. The stage may be

considered to end at the point at which the first phase loses right-of-way. Therefore stages may be considered as being separated by interstage timing periods during which phases lose and gain right-of-way to establish a new stage. Provision is made for phases to receive right-of-way only when demanded e.g. left turn arrows. Such phases do not affect the definition of the stage.

Stage Minimum Period – The duration of the stage minimum green period shall be determined by the expiry of the minimum period(s) of the phases which will lose right-of-way upon a change to the next stage.

Stage Maximum Period – The maximum duration of a stage shall be determined by the expiry of the maximum running period of the last associated phase to be terminated by the stage change.

Stage Stream – A set of stages any one of which may run at a time.

Staggered Yellows – A condition where on a change of right-of-way the warning to traffic streams about to start commences during the warning to traffic streams called upon to stop. (BS 6100 241 7520)

Stand-alone – An independent controlled crossing between signalled junctions.

Starting Intergreen – Period between controller switch on and the commencement of vehicular green on the first run stage.

Startup Sequence – The controlled order through which signals progress from the off/standby mode to normal operation.

Store – Synonymous with memory.

Sum-Check – A check for the equality of the arithmetic sum of the binary coded information contained in a specified set of memory locations with a previously stored number in another set of memory locations.

Toucan – A stand-alone combined pedestrian/cyclist crossing.

Traffic – Vehicles, persons or animals, travelling on a highway. (BS 6100 241 7101).

Traffic Signals – System of different coloured lights, including arrow shaped lights for stopping traffic streams or permitting them to move. (BS 6100 241 7501).

Traffic Stream – (at Traffic Signals) Vehicles in one or more lanes on the same approach to the controlled area which, when they have the right-of-way, will move in the same direction. (cf BS 6100 241 7103).

Turning Traffic – Vehicles turning left or right after passing a stop line or primary signals. (BS 6100 241 7204).

UTC – Urban Traffic Control. A method of controlling and managing a number of traffic signals from one computer system.

Vehicle Actuated Traffic Signals – Traffic signalling equipment in which the duration of the red and green signals and the time of duration of the cycle vary in relation to the traffic flow into and through the controlled area. It is actuated by the traffic by means of vehicle detection. (BS 6100 241 7513).

Vehicle Extension Period – Additional duration of a green signal that can be secured by operation of a detector by vehicle that has right-of-way. (BS 6100 241 7515).

Vehicle Period (Pelican) – The timed period following the flashing yellow signal to vehicles during which no change of signals occurs.

Volatile Store – A memory device in which stored data is not retained in the absence of an electrical supply to the device (e.g. RAM).

Watchdog – a means of ensuring that the microprocessor system is executing its program.

Works Specification – A document provided by the purchaser of equipment, which details the purchasers specific requirements for the supply of equipment against this specification. See MCH 1827.

15 REFERENCES

This specification incorporates by dated or undated reference, provisions from other publications. These normative references are cited at appropriate places in the text and the publications listed hereafter. For dated references, subsequent amendments to or revisions of any of these publications apply to this standard only when incorporated in it by amendment or revision. For undated references the latest edition of the publication referred to applies.

15.1 British Standards

British Standards are published by the British Standards Institution, London.

BS 729	Specification for Hot Dip Galvanised Coatings on Iron and Steel Articles.
BS 1363	Specifications for 13 Amp Fused Plugs, Switched and Unswitched Socket-Outlets.
BS 1449	Steel Plate, Sheet and Strip.
BS 4072	Wood Preservation by means of Copper/Chromium/Arsenic Compositions.
BS 5378	Safety Signs and Colours.
BS 7671	Requirements for Electrical Installations.
BS 7987 (HD 638 SI)	Road Traffic Signal Systems.
BS EN ISO 9001	Quality Systems – Model for Quality Assurance in Design, Development, Production, Installation and Servicing.
BS EN 22063	Specification for Sprayed Metal Coatings.
BS EN 60529	Specification for degrees of protection provided by enclosures (IP Code).
BS EN 61008	Residual current operated circuit-breakers without

integral over current protection for household and similar uses (RCCBs).

BS EN 12675	Traffic signal controllers – Functional safety requirements.
BS EN 12368	Traffic control equipment – Signal heads and poles.
BS EN 50293	Electromagnetic Compatibility – Road traffic Signal Systems Product Standard.

15.2 Specifications and Instructions

Specifications and Instructions are available from The Highways Agency, Traffic Systems and Signing Division, Temple Quay House, 2 The Square, Bristol BS1 6HA.

TR 0100	Inductive Loop Vehicle Detection Equipment.
MCE 0312	Data Transmission System for use in Area Traffic Control.
MCE 0360	Urban Town Traffic Control - Functional Specification.
MCE 0361	High Capacity Data Transmission System for use in Urban Traffic Control Systems.
MCH 1398	Ventilated Plinths for Signal Controller Cabinets.
MCH 1542	Guidelines for the Implementation of MOVA using 'Add on' Equipment.
TR 0155	Audible Unit for use at Pelican Crossings.
TR 0157	Specification for Tactile Equipment.
TR 2130	Environmental Tests for Motorway Communications Equipment and Portable and Permanent Road Traffic Control Equipment.

- TR 2123 Specification for Above Ground
Detector Systems for use at
Permanent Traffic Signalled
Junctions.
- TR 2179 Above Ground Pedestrian Detectors
for Puffin Systems.
- TR 2181 Specification for Pedestrian
Nearside Signal Head for use at
Puffin Crossings.
- TR 2182 Puffin Kerbside Pedestrian
Detection.
- TRG 0500 Statutory Type Approval of
Equipment for the Control of
Vehicular and Pedestrian Traffic on
Roads.

15.3 Other Publications

The Safety Signs Regulations 1980, Statutory
Instrument 1980 No. 1471.

Construction Products Regulations 1991,
Statutory Instrument 1991 No. 1620
(Construction Products Directive 89/106/EEC).

EMC Regulations 1992, Statutory Instrument
1992 No. 2372 (EMC Directive 89/336/EEC).

The Traffic Signs Regulations and General
Directions.

The Zebra, Pelican and Puffin Pedestrian Crossings
Regulations and General Directions.

IEC 297 Dimensions of Mechanical Structures of the
482.6 mm (19") Series.

MIL HDBK 217 Reliability Prediction of
Electronic Equipment.

16 STATUTORY APPROVAL

16.1 Approval

Before any traffic control equipment may be used legally on public roads, it must be approved by the Approval Authority.

16.2 Procedures for Approval

Details of how this approval may be obtained are contained in Highways Agency specification TRG 0500. Any anomalies or interpretation of requirements of this specification must be agreed with the Approval Authority.

17 HISTORY

TR 0141A February 1991

TR 0141B August 1997

TR 0141C March 1998

TR 2210A July 2001



Team Manager:
Traffic Control Systems and Lighting Team

ANNEX A: STANDARD FACILITY REQUIREMENTS

Facility		Junction	Stand-alone
3.1	Common Requirements – General	Mandatory	Mandatory
3.2	Standard Interfaces	Mandatory	Mandatory
3.2.5.4	Test Equipment Interface	Optional	Optional
3.3.1	Housing	Mandatory	Mandatory
3.3.2	Accommodation of Ancillary Equipment	Standard	Standard
3.3.3	Cable Terminations	Mandatory	Mandatory
3.4.1	Mains Supply	Mandatory	Mandatory
3.4.2	Lamp Supply	Mandatory	Mandatory
3.4.3	Lamp Switching Circuits	Mandatory	Mandatory
3.4.4	Lamp Dimming	Mandatory	Mandatory
3.4.5	Ancillary Equipment Supply	Standard	Standard
3.4.6	Audible and Tactile Interlock	Standard	Mandatory
3.4.7	Detector Power Supply	Standard	Standard
3.4.8	Demand Accept Indicator Supply (Puffin)	Standard	Standard
3.4.9	Sign Power Supply	Standard	Standard
3.4.10	Solar Cell Power Supply	Standard	Standard
3.4.11	Maintenance Supply	Mandatory	Mandatory
3.4.12	Standby Power Supply	Mandatory	Mandatory
4.1	Phase Capability	Mandatory	N/A
4.1.5.7	Regulatory Signs	Standard	Standard
4.1.6	Dummy Phases/Stages	Standard	N/A
4.2.1	Stage Capacity (General)	Mandatory	N/A
4.2.2	Stage Selection	Mandatory	N/A
4.2.3	Stage to Stage Movement Constraints	Standard	N/A
4.2.6	Parallel Stage Streaming	Standard	Standard
4.3	All-Red Stages and Extended Red Period	Standard	Standard
4.4.1	Indicative Green Arrow	Standard	N/A
4.4.2	Filter Green Arrow	Standard	N/A
4.5	Controller Start Up Sequence	Mandatory	Mandatory
4.6	Traffic Signs	Standard	Standard
5.2	Fixed Time Operation	Mandatory	Mandatory
5.3	Vehicle Actuated Operation	Standard	Standard
5.4	Cableless Linking Facility	Standard	Standard
5.5	Part Time Operation	Standard	Standard
5.6	Hurry Call	Standard	Standard
5.7	Urban Traffic Control (UTC)	Standard	Standard
5.8	Manual Control	Mandatory	Mandatory
5.9	Warden Control	Optional	Optional
5.10	Public Service Vehicle Priority Facilities	Standard	Standard
6.1	Pedestrian Manual Facilities	Optional	Optional
6.2	Pelican	N/A	Optional
6.3	Puffin	Optional	Optional
6.4	Pedestrian	Optional	Optional
6.7	Audible/Tactile Signals	Standard	Standard
6.8	Controller Linking	Standard	Standard
7	Toucan Facilities	Optional	Optional

Facility		Junction	Stand-alone
7.	Demands	Standard	Standard
7.6	Detector Monitor	Standard	Standard
7.5.4	Speed Assessment/Discrimination	Standard	Standard
Annex C	Variable Maximum	Optional	Optional
8.	Master Time Clock System	Standard	Standard
9.	Safety Monitoring	Mandatory	Standard
9.2	Green/Green Conflict	Mandatory	Mandatory
9.11	Red Lamp Monitor for Part Time and Pedestrian Facilities at Junctions	Standard	N/A
9.11.4	FM Indicator	Standard	Standard
9.12	Red Lamp Monitor for Stand-alone Pedestrian Facilities	N/A	Mandatory
9.13	Program Monitor	Mandatory	Mandatory
9.14	Read/Write Memory Monitor	Mandatory	Mandatory
9.15	Watchdog Monitor	Mandatory	Mandatory
10	Fault Log	Mandatory	Mandatory
11.4	Fixed and Alterable Parameters	Mandatory	Mandatory
11.6	Timing Data Security	Mandatory	Mandatory

Key

Mandatory	–	Facility must always be provided.
Standard	–	Facility must always be available within design.
Optional	–	Manufacturer may or may not provide facility. If provided, the facility becomes standard.
N/A	–	Not applicable to application.

Note: This list is not exhaustive. The Approval Authority will advise on the facility requirements.

ANNEX B: HD 638 S1 and BS EN 12675

Section 1. HD 638 S1

1.1 ELECTRICAL SUPPLY AND LIMITS

1.1.1 Operating voltage Range

CLASS	ACTION
A1	Nominal Voltage $-13\% \dots +10\%$

1.1.2 Low Voltage

1.1.2.1 Switch off response voltage (V_{off})

CLASS	ACTION
B0	No Automatic switch off is required

1.1.2.2 Auxiliary state switch response voltage (V_{aux})

CLASS	ACTION
C0	No auxiliary state is required

1.1.3 Overvoltage

CLASS	ACTION
D0	No protective device is required

1.1.4 Voltage dip

CLASS	ACTION
E2	Period $t_1 < 20$ Period $t_2 > 800$

1.1.5 Mains frequency

CLASS	ACTION
F2	50Hz+4%

1.2 Safety

1.2.1 Criteria – leakage current

1.2.1.1 Road Traffic Signal Systems

CLASS	ACTION
T2	No requirement for leakage current protection facilities for the whole system

1.2.1.2 Maintenance equipment supply

CLASS	ACTION
U1	Earth leakage circuit breakers conforming to EN 61008 with nominal leakage currents ≤ 0.03 A shall be installed

1.2.2 Earthing

1.2.2.1 PE wiring of external equipment

CLASS	ACTION
L1	Accessible conductive parts shall be connected to the PE conductors incorporated in the cables or a separate PE cable. NOTE: Armouring of cables may also be used as PE conductors where the cable construction permits

1.2.2.2 Accepting methods of working

CLASS	ACTION
M1	Always earthed , no screw size is specified

1.2.3 Enclosure

CLASS	ACTION
V4	Enclosures shall provide protection to IP55. When the manual panel is open, the protection provided shall be to IP43. When the enclosure is open the protection shall be to IP20

1.2.4 Terminations

CLASS	ACTION
H0	No separate access to mains terminations

1.2.5 Controller enclosure doors

CLASS	ACTION
J2	No open locking device provided, but the purchaser may specify the device

1.2.6 Controller signal outputs

CLASS	ACTION
K1	0.1 A to 4 A

1.3 Requirements for signal states

CLASS	ACTION
AG5	500 ms NOTE: The time interval is the time from the dangerous signal occurs until this state has been removed
X1	Both a failure mode analysis and functional tests shall be carried out in accordance with signal states dangerous to traffic specified in EN 12675. Examples of failures to be considered are given in EN50129

1.3.1 Location of Monitoring Elements for signals

1.3.1.1 Location of monitoring elements for detection of absent signals

CLASS	ACTION
N0	No requirement for location is specified

1.3.1.2 Location of monitoring elements for detection of unwanted displays

CLASS	ACTION
P0	No requirement for location is specified

1.3.1.3 Requirements of Signalling Intensity for Safety

CLASS	ACTION
AF5	<p>For signals which for safety to be "ON" e.g Red, shall be considered to be switched ON if the voltage, on the output of the controller, is greater than 50% of the full rated output voltage, and if the current is greater than 10mA per signal head.</p> <p>For signals, which are required to be "OFF" e.g. Green, shall be considered to be OFF if the voltage, on the output of the controller, is less than 20% of the full rated output voltage</p>

1.4 Test of Impedance

1.4.1 Fault Loop Impedance test

CLASS	ACTION
AA1	<p>Fault loop impedance tests shall be performed to measure the fault path impedance at selected positions within an electrical installation both supply impedance and earth fault loop impedance. The fault path is comprised of the installation phase conductors, the Electricity Suppliers phase conductor, the distribution transformer winding, the Electricity Suppliers earthing conductor and either the neutral return or earth protective conductor routes. (A Phase conductor is a conductor of an AC-system for the transmission of electrical energy, other than a neutral conductor).</p> <p>The fault loop impedance test measures the fault loop impedance by connecting live to earth via a low resistance, causing the simulated fault current of approx. 25 A to flow for approximately 20 milliseconds from live to earth around the loop.</p> <p>Within a traffic signal installation, the nominal mains voltage is distributed from the Electricity Suppliers cut-out through overcurrent protection devices of descending values and where applicable, a dimming transformer, to terminal devices, e.g. box signs, aspects, wait indicators. Earth fault loop impedance measurements shall be made at enclosures and posts within the installation where terminal devices are installed. The maximum acceptable earth loop impedance is dependent upon the preceding fuse value. The acceptable loop impedance increases as the current carrying capacity of the fuse decreases.</p> <p>The maximum allowable earth loop resistance of an electrical installation following an in-line RCD where fitted shall be calculated by using the formula:</p> $Z = \frac{50 \times 1000}{I(mA)}$ <p>Where I(mA) is the operating current in milliamps for the RCD.</p>

1.4.2 Insulation of Live parts to earth

CLASS	ACTION
R1	IM?

1.4.3 RCD (Residual Current Detector / Earth leakage breaker)

CONFLICT	CLASS	ACTION
For the complete system	S2	An RCD tester.
For the maintenance socket	S2	An RCD tester when Test 1: The disconnection time at 30mA shall be less than 0.2 seconds. Test 2: The disconnection time at 150mA shall be less than 0.04 seconds.

1.5 Maintenance

1.5.1 Maintenance Testing Procedures

CLASS	ACTION
Y1	The actual procedures which are to be carried out under maintenance shall be specified by the customer who may request a subset of those recommended by the manufacturer and additions may be requested by the customer.

1.6 ENVIRONMENTAL

1.6.1 Environmental Test Parameters

Test	Class
Dry heat	AB3
Cold	AE2
Damp heat, cyclic	AK2
Solar radiation	AK0
Random vibration	AJ2

Section 2. BS EN 12675

2.1 Conflict Faults

2.1.1 Signal group conflicts (unwanted signals)

CONFLICT	CLASS	ACTION
Green – Green conflict	AA1	The occurrence of any signal group Green signals displayed simultaneously with any conflicting signal group Green signals shall register a fault
Green – Yellow conflict	AB0	There is no requirement to check for conflicting Green and Yellow signals
Yellow – Yellow conflict	AC0	There is no requirement to check for conflicting Yellow signals
Green – Red/Yellow conflict	AD0	There is no requirement to check for conflicting Green and Red/Yellow signals
Green – Green/Yellow conflict	AE0	There is no requirement to check for conflicting Green and Green/Yellow signals

2.1.2 Signal group Green/absent Red conflict

CONFLICT	CLASS	ACTION
Absence of any conflicting Red signal	AF0	There is no requirement to check for any signal Red
Absence for conflicting Red on specified signal heads	AG0	There is no requirement to check for any absent Red signal on specified signal heads
Absence of the last conflicting red signal	AH0	There is no requirement to check for the absence of the last Red signal

2.1.3 Absent Red/ absent Red conflicts

CONFLICT	CLASS	ACTION
	AJ0	There is no requirement to check absent Red/absent Red conflicts

2.1.4 National signal regulations (unwanted signals)

CONFLICT	CLASS	ACTION
National signal regulations (infringement)	BA0	There is no requirement to check for unwanted signals
Standby mode flashing signals	BB0	There is no requirement to check for unwanted signals
Failure mode flashing signals	BC0	There is no requirement to check for unwanted signals
Rate and duration of flashing signals during standby mode	BD0	There is no requirement to check flashing signals
Rate and duration of flashing signals during failure mode	BE0	There is no requirement to check flashing signals

2.1.5 Absent signals

2.1.5.1 Absent signal group Red signals

CONFLICT	CLASS	ACTION	NOTES
Absence of a Red signal on a specified signal group	CA0	There is no requirement to check for an absent Red signal on a specified signal group	Standard intersection without audible/tactile facilities and not part time
Absence of a Red signal on a specified signal group	CA1	The absence of a Red signal on specified signal groups shall register as a fault	First signal failure for a controller with audible/tactile facilities or part time
Absence of the last Red signal	CB0	There is no requirement to check for the absence of the last Red signal	Standard intersection without audible/tactile facilities and not part time.
Absence of the last Red signal	CB1	The absence of the last Red signal on any vehicular signal group shall register a fault	Feeder failure
Absence of a number of Red signals	CC0	There is no requirement to check for the absence of a number of red signals	Standard intersection without audible/tactile facilities and not part time
Absence of a number of Red signals	CC1	The absence of Red signals on a number of signal heads specified for each signal group shall register a fault	Second Red signal failure for a controller with audible/tactile facilities or part time
Absence of specified Red signals	CD0	There is no requirement to check for the absence of specified Red signals	

2.1.5.2 Absent signal groups, Yellow or Green signals

CONFLICT	CLASS	ACTION
	CE0	There is no requirement to check for the absence of Yellow or Green signals

2.1.6 Compliance checking

CONFLICT	CLASS	ACTION
	DA0	There is no requirement to check for compliance

2.1.7 Safety timings

CONFLICT	CLASS	ACTION
Stored values of timings	FA1	The stored values of timings shall be checked. The check shall ensure that the stored values are not corrupted. In the event of an error, the traffic signal controller shall register a fault
Time base frequency	FB0	There is no requirement to check the time base frequency
Minimum values of time settings	FC1	The values of time settings shall be checked to ensure that the minimum value is not less than a pre-defined value. In the event of an error, the traffic signal controller shall register a fault
Maximum settings of time settings	FD0	There is no requirement to check the maximum settings of time settings
Duration of timings	FE0	There is no requirement to check for the duration of timings

2.1.8 National signal sequences

CONFLICT	CLASS	ACTION
National signal sequences (infringement)	GA0	There is no requirement to check for the national signal sequence
Specified signal group Green to signal group Green movements	GB0	There is no requirement to check for signal group green movements
Specified signal start up sequence signal group movements	GC0	There is no requirement to check for signal start up sequence signal group movements not being correct

2.1.9 Faults of external inputs

CONFLICT	CLASS	ACTION
	HA1	In the event of a configured input indicating a fault of the external equipment the traffic signal controller shall register a fault

ANNEX C: SPEED AND FLOW STRATEGIES

General

The yellow signal at traffic signals requires drivers to stop if it is safe to do so. Drivers are not permitted to cross the stop line when the red signal is showing.

If the yellow appears when a vehicle is so close to the stop line that is possible to stop safely, the driver will be able clear the stop line before the red signal appears.

At further distances from the stop line there is an area (often referred to as the “dilemma zone”) where drivers confronted by a change to yellow have to choose between stopping at the stop line or, by continuing at the same speed, to cross the stop line before the onset of red. One of the purposes of System D detection is to extend green periods so that drivers are less likely to be confronted by a change to yellow while in the dilemma zone.

The location the dilemma zone depends on the speed of the vehicle. At speeds up to 30mph, the dilemma zone is within the area covered by System D detection: vehicles which have not reached the X detector before the change to yellow will be able to stop safely at the stop line. At higher speeds the dilemma zone is located further back from the stop line. Speed discrimination/speed assessment is designed to ensure as far as possible that signal changes for vehicles travelling in excess of 30mph do not occur within the dilemma zone.

Speed discrimination provides either one (double vehicle extension) or two (triple vehicle extension) additional detectors which operate only when a specific speed threshold is exceeded. These detectors provide sufficient extensions for a vehicle continuing at the same speed to reach the System D detection and prevent the green “gapping out” before the vehicle reaches the stop line.

Speed assessment works on a different principle. The speed assessment detector introduces a delay dependent on the vehicle speed after which a fixed extension is introduced. The delay is calculated to expire when the vehicle is just over 5 seconds travel time from the stop line. If yellow appears during the delay period the vehicle will still be able to stop safely at the stop line. The green signal is therefore permitted to “gap out” during the delay period. At the end of the delay period, if the signals have not

yet changed to yellow, a 5 second extension is introduced so that the green is prevented from gapping out until the vehicle is very close to the stop line, beyond the dilemma zone.

Speed Assessment/Speed Discrimination

The signal difference for speed measurement, is based on a speed measuring loop spacing of 3.66 metres (12 feet). The corresponding phase green extension period is governed by the distance of the speed loops relative to the standard vehicle loops spaced at 12, 25 and 39 metres from the stop line. Other configurations will modify the values.

Speed Discrimination Double Vehicle Extension

Where the 85th percentile approach speeds are greater than 56 km/h (35 mph) but do not exceed 72 km/h (45 mph), detector and extension equipment specified below may be provided:

- a) speed measuring equipment provided for each traffic lane and placed at 79 metres from the stop line. Each lane shall have 2 loop detector inputs, one from each speed measuring loop.
- b) Separate detectors and speed measuring equipment provided for each traffic lane at measuring point.

Speed Discrimination Triple Vehicle Extension

Where the 85th percentile approach speeds are greater than 72 km/h (45 mph) the extension equipment specified below may be provided:

- a) two sets of speed measuring equipment provided for each traffic lane. One set placed at 91 metres and the second placed at 159 metres from the stop line. Each lane shall have two loop detector inputs, one from each speed measuring loop for each of the inner and outer measuring points.
- b) Separate detectors and speed measuring equipments provided for each traffic lane at each measuring point.

Speed Assessment Double Vehicle Extension

Speed measuring equipment may be provided for each traffic lane and placed at 151 metres from the stop line. Each lane shall have two loop inputs, one for each speed measuring loop.

Extra Clearance Period

A two second extension to the 'All-Red' period shall be automatically added following any phase which is provided with speed assessment or speed discrimination equipments if any one of the following circumstances occur:

- a) any speed extension is curtailed;
- b) a speed discrimination or speed assessment extension occurs during the yellow signal;
- c) during the phase green period, any vehicle detector connected to speed measurement equipment associated with that phase is not operated.

Variable Maximum

Use of Variable Maximum

Following the pre-set maximum green running period it may be possible to provide an additional variable maximum period dependent upon the conditions stated below. When required in the Works Specification, the additional period shall not be added unless the traffic flow in vehicles/hour at the end of the preset maximum period exceeds a certain selected value (termed the threshold value), the traffic flow being measured as a 'moving average' continuously assessed during the phase green period. The duration of the additional period shall be reasonably proportional to the excess of the smoothed (with a time constant of 10 seconds) value of the actual traffic flow over the threshold traffic flow up to a value of actual traffic equal to 4 times threshold traffic flow at the time of termination. This requirement shall not prevent a gap change occurring at any time during the additional period.

Assessment of Traffic Flows

The assessment of traffic flows may be taken at the X or X and Y* detectors. Where the relevant approaches to the controlled intersection are essentially a single traffic lane, the X detector may consist of a single loop and detector. In all other

cases individual loops and detectors may be provided for each traffic lane. The dimensions and dispositions of the detector loops needs to be such as to achieve the highest accuracy of flow measurement without any significant risk of failing to detect the passage of any type of vehicle at the X detector point.

Loop/Lane Arrangement

- X and Y detector arrangement may be used on single lane approaches, or other approaches where a low threshold is required.

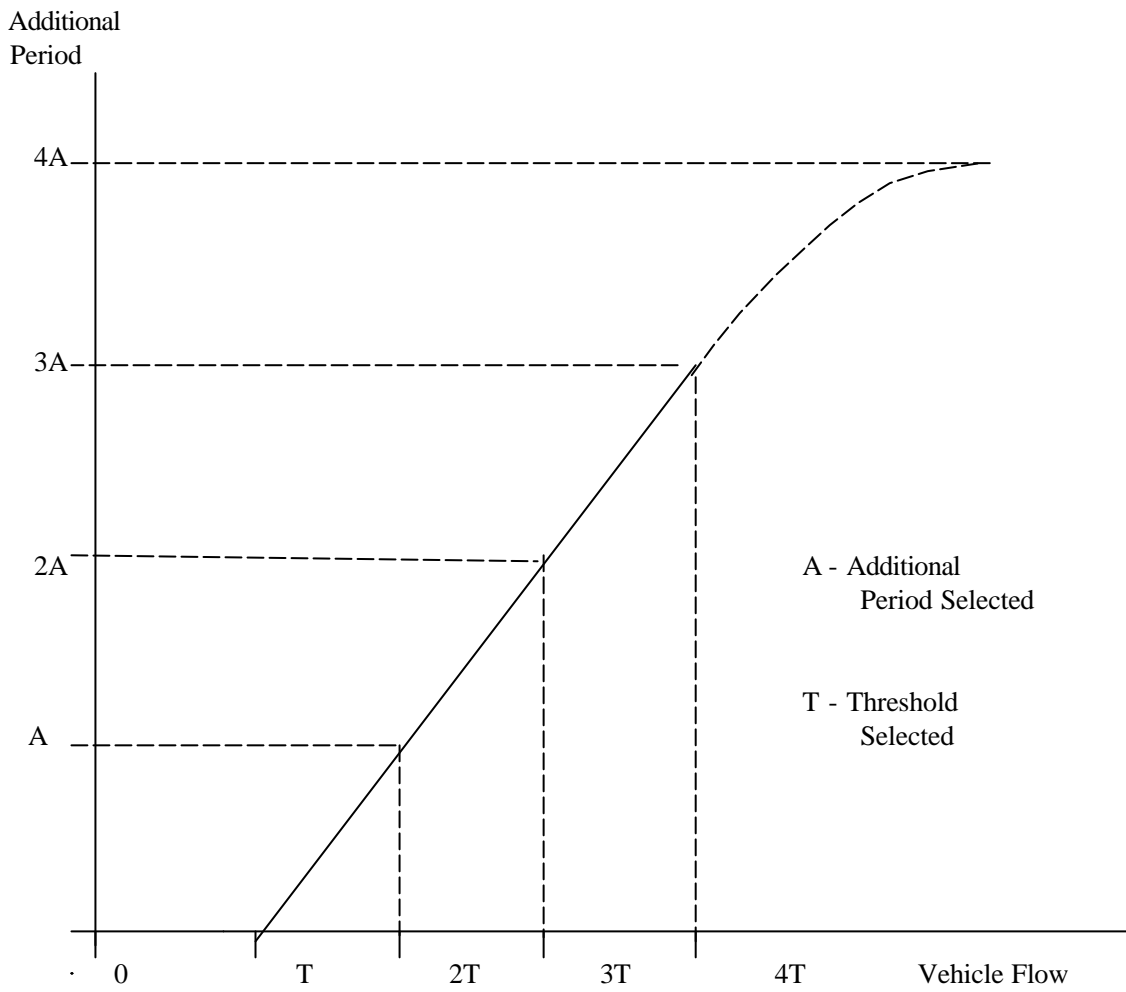


Figure 9a – Variable Maximum – Additional Period

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