VICROADS SPECIFICATION

# TCS 016 – A – 2014

# The Supply and Installation

# Of

# Traffic Signal Controllers

| | |
|---|---|
| Revision: | A |
| Revision Date : | May 2014 |

# Foreword

This specification has been developed by VicRoads. It is one of a number of technical specifications, and associated standard drawings, which set out the requirements for roadside ITS devices, traffic signal equipment and other electrical equipment and associated devices and control systems.

This specification is intended for use in all relevant works undertaken by or on behalf of VicRoads.

VicRoads Standard Drawings, Specifications and Guidelines are available for downloading from the VicRoads website at http://www.vicroads.vic.gov.au



**Specification updates.** VicRoads specifications and associated standard drawings are subject to periodic review. To keep the specifications up to date, amendments or new editions are issued as necessary. It is therefore important for users of VicRoads specifications to ensure that they have the latest version and associated amendments.

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**Revision History**

| Revision | Date | Prepared by | Approved by |
|---|---|---|---|
| A (original) | May 2014 | E Lee | W Harvey |
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| | | | |

# PREFACE

## A APPROVED PRODUCTS

A.1 All equipment supplied under this specification shall conform to a sample previously supplied to, and formally accepted, or separately exempted, by the Department. Such acceptance shall be subject to the issue of a Certificate of Type Approval or Notification of Acceptance by the Department.

A.2 References to "approved" within this specification shall mean individual components or methods that have been previously accepted by the Department.

A.3 All equipment supplied under this specification shall be manufactured and supplied by an approved manufacturer under a VicRoads approved Quality Assurance System and shall be subject to all requirements of audit therein.

## B TELECOMMUNICATIONS EQUIPMENT

B.1 All telecommunications equipment shall comply with relevant requirements of the Australian Communications and Media Authority (ACMA). Such equipment shall be labelled with a Compliant RCM mark.

## C CHANGES TO THIS SPECIFICATION

C.1 The main changes to this specification are listed below.

- Additional information to Section 5 Communications;
- Updated the SCATS Network Diagram in Section 5.4;
- Additional information for connection for CCTV camera.

The following table details version to this specification:

| Revision | Date | Revision Owner | Purpose of Revision |
|---|---|---|---|
| C | Dec 2013 | VicRoads ITS | • Removal of clauses regarding the presence of nominated VR representative to witness the controller test;<br>• Removal of clauses to have the label signed by nominated VR representative;<br>• Addition of 'Operational Test' in Section 8. |

| | | | |
|---|---|---|---|
| B | July 2011 | VicRoads ITS | • Additional references to Australian Standards and VR Standard Drawings;<br>• Addition of Top Hat requirements. |
| Original | Jan 2011 | VicRoads ITS | New specification |

# Contents

# SECTION 1 SCOPE AND GENERAL

## 1.1 SCOPE

1.1.1 This specification covers the mechanical, electrical and functional requirements for the control equipment used for the operation of road traffic signals in the State of Victoria.

## 1.2 GENERAL

1.2.1 The traffic signal controller processes information from vehicle detectors, pedestrian push-buttons, internal time clocks, remote master equipment and other external inputs (such as railway signalling equipment) to control the sequence and duration of signal aspects for the control of road traffic.

1.2.2 Traffic signal controllers shall conform to the requirements of AS 2578, together with the requirements detailed in this specification.

## 1.3 TYPE APPROVAL

1.3.1 All equipment to be supplied under this specification shall hold current VicRoads 'Type Approval' certification. To obtain VicRoads 'Type Approval' the supplier must submit evidence of compliance in accordance with Appendix C of this specification and the requirements of individual tender documents.

1.3.2 Compliance with this version of this specification (and subsequent VicRoads Approval) does not constitute automatic approval against future versions of this specification. Where it is considered necessary, VicRoads may withdraw current Type Approval and request that the affected product be re-submitted for evaluation against future versions of this specification.

## 1.4 RELATED SPECIFICATIONS AND DRAWINGS

1.4.1 The fabrication and supply of all components for traffic signal controllers shall conform with the current version of all relevant Australian Standards.

1.4.2 The following specifications, standards, documents and standard drawings are referred to in this specification:

- AS 2578 Traffic Signal Controllers
- AS 2703 Vehicle Loop Detector Sensors
- AS/NZS 3000, Wiring Rules
- AS 60529, Degrees of protection provided by enclosures (IP Code)
- TCS 038-4.1-2010 VicRoads Specification for the Supply of Traffic Signal Lanterns
- TC-1203 Controller Foundation Details
- TC-2100 Standard Cabinet Label

## 1.5 LANTERN TECHNOLOGY

### 1.5.1 General

1.5.1.1 Controllers, as specifically ordered, shall be capable of switching, operating and monitoring lanterns of different technologies. These shall include:

- Incandescent (tungsten filament). See clause 1.5.2
- Quartz halogen. See clause 1.5.3
- Mixed incandescent and quartz halogen. See clause 1.5.4
- LED. See clause 1.5.5

1.5.1.2 All controllers shall:

- enable full conflict detection;
- monitor "last red" for all vehicle displays, including arrows, B, and T displays;
- detect any inoperative display, vehicle and/or pedestrian, and the replacement of same; and
- enable display flashing.

1.5.1.3 Controllers may incorporate alternative Lamp Control cards when operating with different lantern technologies. Cards shall be clearly marked to identify the card for the specific lamp technology.

### 1.5.2 Incandescent (Tungsten Filament) Lanterns

1.5.2.1 Controllers shall be capable of switching, operating and monitoring 70 watt and 100 watt incandescent vehicle and pedestrian lanterns.

### 1.5.3 Quartz Halogen Lanterns

1.5.3.1 Controllers shall be capable of switching, operating and monitoring 50 watt quartz halogen vehicle and pedestrian lanterns.

### 1.5.4 Mixed Incandescent and Quartz Halogen

1.5.4.1 Controllers shall be capable of switching, operating and monitoring a mix of 70 watt and 100 watt incandescent and 50 watt quartz halogen vehicle and pedestrian lanterns.

### 1.5.5 LED Lanterns

1.5.5.1 Controllers shall be capable of switching, operating and monitoring VicRoads approved LED vehicle and pedestrian lanterns.

1.5.5.2 When operating with LED traffic signal lanterns the controllers shall:

- enable dimming of the LED displays;
- enable full conflict detection as per conventional lamp technologies;
- monitor "last red" for all vehicle displays, including arrows, B, and T displays, for which a minimum load of not less than 5 watts (undimmed) will be set for any such display aspect;

- ° detect any fully inoperative display, vehicle and/or pedestrian, and the replacement of same.
- ° enable display flashing.

1.5.5.3 The wattage load represented by LED lantern aspects varies with colour and luminosity requirements of AS/NZS 2144, as well as the type of display (Roundel, Arrow, Green Walking Man, Red Stationary Man, Red Flashing Man, etc), representing some 9 different wattage combinations. Further, LED aspects may be driven by step-down transformer or switched mode power supply.

1.5.5.4 The controller shall therefore operate with LED lanterns with the following characteristics:

| | |
|---|---|
| Maximum Load of LED lamp aspect | **20 W** |
| Minimum Load of LED lamp aspect – no dimming | **5 W** |
| Maximum Wattage in the "LED failed state" | **0.5 W** |

1.5.5.5 The controller shall have a minimum sensing threshold of **3 Watts.**

1.5.5.6 The controller shall be fully compatible with VicRoads' approved lantern aspects as specified in Section 4.5.3, AS/NZS 2144 and VicRoads Specification TCS 038-3-2004.

1.5.5.7 Controllers shall be fully compatible with LED aspects which may be driven by step-down transformer or switched mode power supply.

## 1.6 SWITCHING VOLTAGE

### 1.6.1 240 volt operation

1.6.1.1 Where specified in individual orders, controllers shall provide and switch a 240 volt supply to field circuits.

1.6.1.2 Controllers operating with 240 volt field circuits may be required to control sites with incandescent, quartz halogen or LED lanterns, or a mixture of these lanterns.

### 1.6.2 42 volt operation

1.6.2.1 Where specified in individual orders, controllers shall provide and switch a 42 volt supply to field circuits.

1.6.2.2 For 42 volt controllers, push button and call record lights shall operate at 30 volts in accordance with AS 2578.

1.6.2.3 Controllers operating with 42 volt field circuits shall only be required to control sites with LED lanterns.

1.6.2.4 Transformers installed to provide the 42 volt supply to field circuits shall be located such that access to other components is not impeded.

## 1.7 UNINTERRUPTIBLE POWER SUPPLY

1.7.1 Where specified in individual orders, controllers shall be supplied with a VicRoads approved uninterruptible power supply to enable a controller driving a 12 group site to provide normal operation of the site for a period of not less than six hours whilst the mains supply is unavailable.

# SECTION 2 CONTROLLER HOUSING

## 2.1 GENERAL

2.1.1 The controller housing is to conform to the requirements of AS 2578.

## 2.2 COMMUNICATION CONDUIT

2.2.1 The entry position for the communications conduit is to be in accordance with VicRoads Standard Drawing TC 1203 Controller Foundation Details.

## 2.3 DOOR LOCK

2.3.1 The controller door shall be fitted with two identical locks installed not less than 250mm from the top and bottom of the door. The lock(s) shall be VicRoads' **Bi-Lock System B9-67, AM 1-5**.

## 2.4 TERMINAL BLOCKS

2.4.1 Terminal blocks in accordance with clause 2.6.1 of AS 2578 are to be provided.

## 2.5 NEUTRAL TERMINALS

2.5.1 The lamp active and neutral terminals specified in clause 2.6.3 of AS 2578, shall capable of accepting cables of area $10mm^{2.}$

## 2.6 MISCELLANEOUS RELAYS AND CONTACTORS

2.6.1 The requirements for miscellaneous relays will be as detailed in individual controller orders.

## 2.7 GAS SENSOR

2.7.1 A gas sensor shall not be required unless specified in an individual controller order.

## 2.8 SERVICE LIGHT

2.8.1 A service light is to be provided in accordance with clause 2.18 of AS 2578.

## 2.9 STANDBY GENERATOR CONNECTION

2.9.1 The manufacturer shall provide facilities for connection of an external generator to the controller in accordance with clause 2.23 of AS 2578. The generator connection shall be a 3-pin male plug rated at 15 amps.

## 2.10 HOUSING TOP EXTENSION

2.10.1 The supplier shall ensure that a housing top extension (“top hat”) as clause 2.3.16 of AS 2578, is available if called for in the individual controller order.

2.10.2 The construction of the extension shall conform to the relevant requirements specified herein for the controller cabinet.

2.10.3 The extension shall be designed to exactly fit the top of the controller cabinet with no gap and provide an internal height clearance of at least 450mm.

2.10.4 The controller cabinet with an extension fitted shall provide a degree of protection of not less than IP45 as detailed in AS 60529.

2.10.5 The extension shall have a full width door, hinged on the same side as the controller cabinet using two similar hinges.

2.10.6 The extension door shall be provided with a single lock keyed as specified in individual tender documents.

2.10.7 A removable full width panel shall be mounted on the back of the extension for mounting hardware.

# SECTION 3 CONTROLLER LOGIC MODULE

## 3.1 PEDESTRIAN WAIT INDICATOR OUTPUTS

3.1.1 The manufacturer shall provide pedestrian Wait Indicator outputs in accordance with clause 3.4.5 of AS 2578. The number of outputs to be provided shall be as detailed in the individual controller order.

## 3.2 SPECIAL FACILITY INPUTS AND OUTPUTS

3.2.1 The manufacturer shall provide interface circuits for Special Facility inputs and outputs as detailed in the individual controller order.

# SECTION 4 SOFTWARE AND FUNCTIONAL REQUIREMENTS

## 4.1 GENERAL

4.1.1 The manufacturer is to provide the appropriate communication protocol for the controller to operate in the SCATS system.

## 4.2 PROVISION FOR PUBLIC TRANSPORT PRIORITY MEASURES

### 4.2.1 Requirements

Traffic signal controllers supplied under this Specification shall provide public transport priority measures specified below under all modes of operation and any number of the measures may be selected and introduced by special flags or specified inputs. These special flags and inputs may be set or reset by the operating mode, current plan, special tram detectors or time of day.

### 4.2.2 Extend Priority Movement (Late Extension)

4.2.2.1 Strategy - Provision of an extension to the priority movement beyond the normal termination point.

4.2.2.2 Operation - A specific phase called by the public transport vehicle provides time beyond that normally allocated. Other phases scheduled to run are delayed for the duration of the late extension.

4.2.2.3 Detection -

Advance: to call the extension phase if the priority vehicle will not be impeded during the extension.

Stop Line: to call the extension phase; when vacated: to cancel unwanted priority time and signal the vehicle's departure.

### 4.2.3 Early Start Priority Movement

4.2.3.1 Strategy - the controller allows the early introduction of the priority movement.

4.2.3.2 Operation - A specific phase used by the public transport vehicle is introduced at a point in the cycle in advance of its normal introduction point. The running is terminated early.

4.2.3.3 Detection –

Advance: to call the phase where traffic queues would otherwise delay the arrival of the public transport vehicle at the signals.

Stop Line to call the phase where traffic queues are not expected to be a problem (e.g. at safety zones) upon completion of the passenger loading.

### 4.2.4 Special Priority Phase

4.2.4.1 Strategy - the introduction of a phase into the normal sequence to cater for priority vehicles only.

4.2.4.2 Operation - A phase is provided in the normal operating sequence to cater for public transport vehicles only. Such phases may provide exclusive turning opportunities for priority vehicles. Such a phase may be introduced more than once in a cycle, between other non-public transport phases.

4.2.4.3 Detection –

Stop Line: to call the phase upon completion of loading/unloading and extend for successive priority vehicles.

### 4.2.5 Clearance Phase

4.2.5.1 Strategy - A clearance phase is provided, or extended, to clear the approach of the priority vehicle to the stop line. This is normally a leading right turn phase.

4.2.5.2 Operation - A clearance phase, called by the priority vehicle, is provided to remove traffic from the path of the approaching vehicle and allow it access to the intersection stop line. It may be used in association with other options to guarantee the passage of the vehicle through the intersection.

4.2.5.3 Detection –

Advance: to call and provide a permanent extension to the clearance phase.

Stop Line: to terminate the clearance phase and initiate further priority options.

### 4.2.6 Omit Selected Phases from Standard Cycle

4.2.6.1 Strategy - the controller permits the skipping of nominated phases from the cycle to preferentially service priority vehicle calls.

4.2.6.2 Operation - the receipt of a priority vehicle call blocks the introduction of certain nominated phases, and permits the early introduction of the priority vehicle phase. A re-call is placed for the skipped phase.

4.2.6.3 Detection –

Advance OR Stop Line: to inhibit the nominated phase(s).

### 4.2.7 Initiate Special Sequence

4.2.7.1 Strategy - the priority vehicle call initiates a special sequence of phases to service the priority vehicle.

4.2.7.2 Operation - the call from the priority vehicle initiates a sequence, outside the normal cyclic order to service the priority vehicle. The local controller unlinks from the regional computer and starts a sequence of phase changes which may include a clearance phase and priority extension to immediately service the priority vehicle.

4.2.7.3 Detection –

Advance: to call the special sequence including clearance phase.

Stop Line: to call subsequent priority phases and/or hold phases during loading/unloading.

Release: to cancel priority once the vehicle has departed the intersection.

### 4.2.8 Variable Priority

4.2.8.1 Strategy - The local controller is able to decide, based on a number of priority inputs, which approach (or approaches) is to be serviced at highest priority.

4.2.8.2 Operation - the controller selects the priority phase (or phase sequence) from several alternative phases on the basis of:

- distribution of priority demands around the intersection

- strategic information supplied by the master

- time of day.

The priority phase(s) are selected on the basis of maximising expected benefit to public transport vehicles and so account needs to be taken of differences in importance attached to various priority movements.

This form of priority is particularly useful at nodes in the public transport network where several routes intersect and where importance is attached to several routes each with conflicting phasing requirements.

4.2.8.3 Detection –

Advance: to call priority and/or clearance phases.

Stop Line: to call and/or extend priority phases.
when vacated, to cancel priority requirements

### 4.2.9 Active Compensation

4.2.9.1 Additional compensatory phases may be scheduled as part of the local controller personality. These may only be called following priority phases and give additional time to disadvantaged movements.

# SECTION 5 COMMUNICATIONS

## 5.1 GENERAL

5.1.1 Controllers are to be linked to the SCATS regional computer by a SCATS compatible, approved modem. The purpose of this link is to convey co-ordination parameters from the SCATS regional computer, and to feed back to the regional computer confirmation of status of the controller, detector information and faults.

## 5.2 SCATS COMMUNICATIONS NETWORK

5.2.1 The communications link between the controller and the SCATS regional computer is managed by a SCATS compatible modem. This device functions as an integrated modem that actively manages the communication link between the SCATS regional computer and the controller. A VicRoads Type Approved SCATS compatible modem shall be provided and installed by the controller supplier in accordance with Clause 5.7.

5.2.2 This modem is connected to the SCATS regional computer over a TCP/IP network. This network is typically provided by a telecommunications company that includes the link to every traffic signal controller and to all the SCATS regional computers.

5.2.3 The SCATS compatible modem can use one of three communications medium to connect to the TCP/IP network. They are:

- Dial-up over the PSTN network
- ADSL over the PSTN network
- Wireless using the mobile 3G network

5.2.4 The protocol that is used is either PPP (point to point protocol) for dialup lines or 3G, or PPPoE (point to point protocol over Ethernet) for ADSL lines. The modem that manages this connection shall support these and other industry standards (V32, V34, HSDPA/UMTS).

## 5.3 SERIAL COMMUNICATION PORT (XM PORT)

5.3.1 The Controller's Control Module shall include an RS232C port for serial communications (commonly referred to as the XM port). This port is typically used to connect to a SCATS compatible modem.

5.3.2 Data format on this port shall be:

1 Start bit, 8 Data bits, 1 Parity bit (odd), and 1 Stop bit, making 11 bits in all per "character" or byte.

5.3.3 LED indicators shall be provided for both sending and receiving of the synchronous and master control link signals to indicate polling and reply activity on that link.

5.3.4 This serial communications port is intended to be connected to a SCATS compatible modem, but shall also have the facility to interface directly to other future ITS equipment via a standard RS232 interface or a standard 2-wire voice-grade telephone line via an ACMA-

approved line protection device. As such, the RS232 interface shall present TD (Transmit Data), RD (Received Data, CD (Carrier Detector), RTS (Request to Send) and Signal Ground to an external device.

5.3.5 The selection of either option shall be configurable by the installer, preferably using the same DB25 connector, providing ACMA regulations and EMC specifications are not thereby compromised.

5.3.6 The SCATS compatible modem that is used to connect the XM/serial port to the network must also perform the initial negotiation phase with the SCATS Central Manager as described in Section 5.5 below.

## 5.4 ETHERNET COMMUNICATION PORT (NETWORK PORT)

5.4.1 The controller's Control Module shall include an Ethernet port for networking purposes. This port shall be used to provide a network interface to connect to an external network device. This network device can be a modem that has an Ethernet port, a network router or a network switch.

5.4.2 The connection type shall be an RJ45 port using IEEE 802.3 Ethernet standard. It shall be capable of at least both 10 and 100 Mbps connection speed.

5.4.3 The network interface shall be compatible with the TCP/IP protocol. The method of IP address allocation for this Ethernet interface shall be selectable between these two common methods – DHCP or static IP. For the static IP configuration, the IP address, netmask and default gateway shall be configurable.

5.4.4 The network parameters for this connection shall be configurable. The configuration of these parameters shall be done using an external device, eg. a laptop computer. It is preferable that these parameters are stored in a removable storage medium (eg. flash memory or similar) to simplify maintenance or replacement of controller equipment on-site.

5.4.5 It is preferable that configuration and operational data be available to a PC connected anywhere within the SCATS network. This data should include the current configuration parameters for the controller and communications setup; and information about the current operational state of the controller.

5.4.6 This Ethernet port will be used to connect the controller to the network for SCATS communication. For this purpose, the controller shall perform the initial network negotiation phase with the SCATS Central Manager as described in Section 5.5 below.

5.4.7 The Ethernet communication port shall also be able to be used for communications other than the SCATS connection.

## 5.5 SCATS CONNECTION

5.5.1 The traffic signal controller shall be connected using the 'Network' option as defined in the SCATS system. This option requires the controller or the modem to perform the initial network negotiation phase with the SCATS Central Manager to determine which SCATS Regional Computer is set up to connect to this site. This phase is required before an operational SCATS link can be established between the controller and the regional computer.

5.5.2 This negotiation phase is performed by the SCATS compatible modem if the serial port is used to connect the controller to the SCATS network. If the Ethernet port is used, this phase is performed by the controller.

5.5.3 The parameters required as part of this SCATS network negotiation phase are to be stored in either the modem or the controller. These parameters include the IP address of the SCATS Central Manager and the TCP port number to use.

5.5.4 It is preferable that these parameters be stored in a removable storage medium (eg. flash memory or similar) to simplify maintenance and/or replacement of controller equipment on-site. These parameters shall be configurable using an external device, eg. a laptop computer.

## 5.6 SCATS NETWORK DIAGRAM

5.6.1 This diagram shows the configuration of the SCATS network:

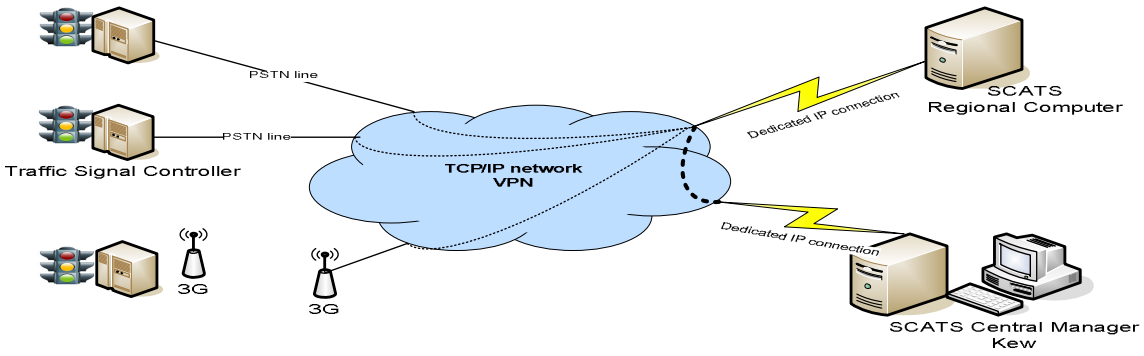


**FIGURE 1: SCATS Network Diagram**

## 5.7 MODEM

### 5.7.1 Modem Location

5.7.1.1 The modem shall be installed securely on the controller equipment shelf in accordance with the modem manufacturer's requirements.

### 5.7.2 Connection to the Controller for Fixed Line Communications

5.7.2.1 The modem shall be connected to the traffic signal controller via the XM port on the controller's logic module or Ethernet port. See Figure 2.

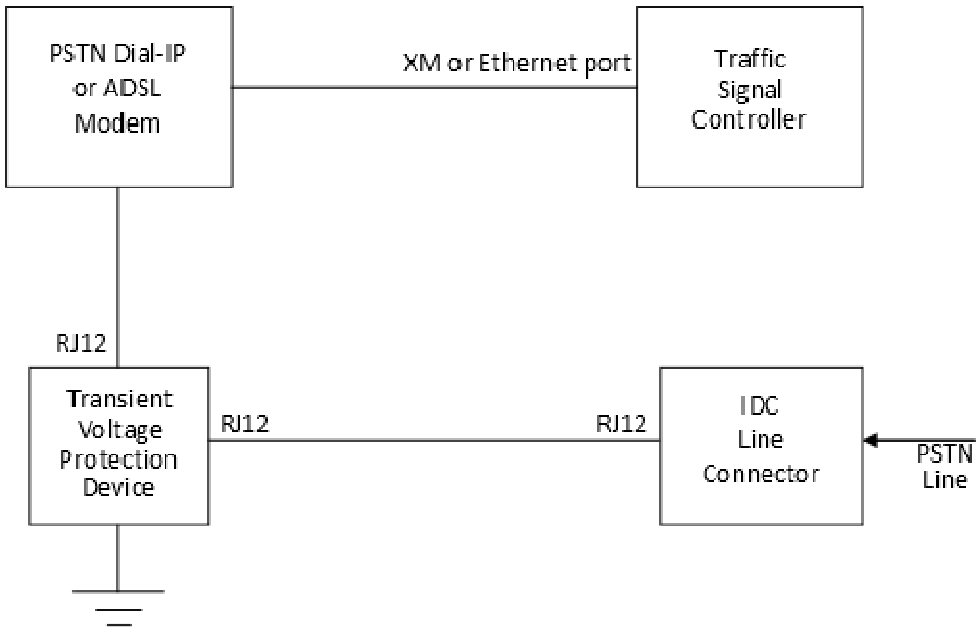


**FIGURE 2: Connection Schematic for fixed line via XM or Ethernet port**

### 5.7.3 Connection to the Controller for Mobile (3G) Communications

5.7.3.1 The 3G modem shall be connected to the traffic signal controller via the XM port on the controller's logic module or the Ethernet port. See Figure 3.

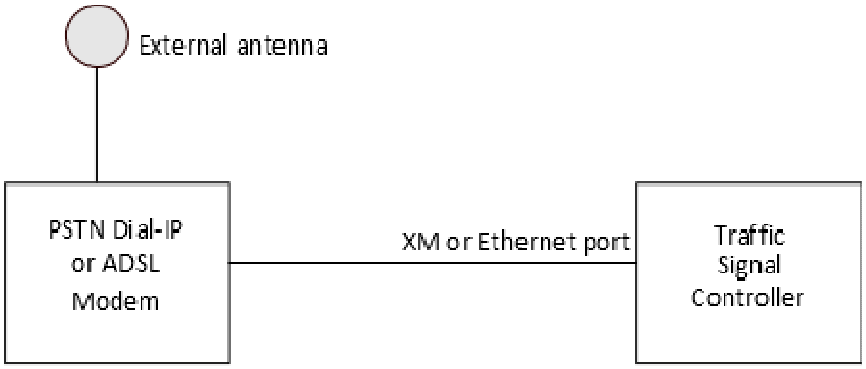


**FIGURE 3: Connection Schematic for 3G via XM or Ethernet port**

5.7.3.2 The 3G modem shall also be connected to an external antenna.

### 5.7.4 Connection to the Telecommunications Network

5.7.4.1 For PSTN or ADSL connections, the modem shall connect to the telecommunications line within the controller telecommunications hatch via an IDC type connector (e.g. a Krone connector) arrangement.

5.7.4.2 Modems that use the 3G wireless mobile network shall have an external antenna installed on top of the cabinet. This antenna shall be weather and impact resistant, and be discrete so as not to attract attention.

5.7.4.3 The antenna shall provide a minimum nominal gain of 2 dBi, and be compatible with existing 3G mobile networks, currently using 850MHz HSDPA/UMTS standards.

5.7.4.4 All three types of modems (dial-up, ADSL or 3G) shall have the ability to be configured to connect to the TCP/IP network using a username and password provided by VicRoads.

5.7.4.5 Modems using the 3G network shall have the ability to be configured to use a particular APN (access point name) provide by VicRoads.

5.7.4.6 In addition, this username and password is required to be used to log in to the network and a network address (IP address) to be provided on a successful log-in.

5.7.4.7 The modem shall be configured to respond to network ‘pings’ so that the central system will be notified if communications to the modem is broken.

5.7.4.8 The modem should ensure reliable connection to the network is maintained. Whenever it loses connection to the network, it should maintain attempts to re-connect within short timeout periods no less than once every minute. This will ensure that if a network outage occurs, the modem will re-connect as soon as the network problem is rectified.

### 5.7.5 Connection to SCATS

5.7.5.1 Modems that are connected to the XM port shall perform the initial network negotiation phase with the SCATS Central Manager as described in Section 5.5 above.

5.7.5.2 The parameters for this function shall be configurable and stored in the modem. Preferably, this storage will be on a removable storage medium to simplify maintenance or replacement of the modem on-site.

### 5.7.6 Transient Voltage Protection

5.7.6.1 A transient voltage protection device shall be installed between the telecommunications line connection and the modem and as close as possible to the communication line entry.

5.7.6.2 The transient voltage protection device shall be securely earthed in accordance with the manufacturers' requirements.

5.7.6.3 Both the 'in' and the 'out' connections of the transient voltage protection device shall be via RJ12 connectors.

### 5.7.7 Optional – Connection for CCTV Camera

5.7.7.1 If a CCTV camera is required to be installed at the traffic signal site, and there is a PSTN connection for SCATS, the same PSTN line can be used for the camera's ADSL connection. The wiring configuration is shown in Figure 4.

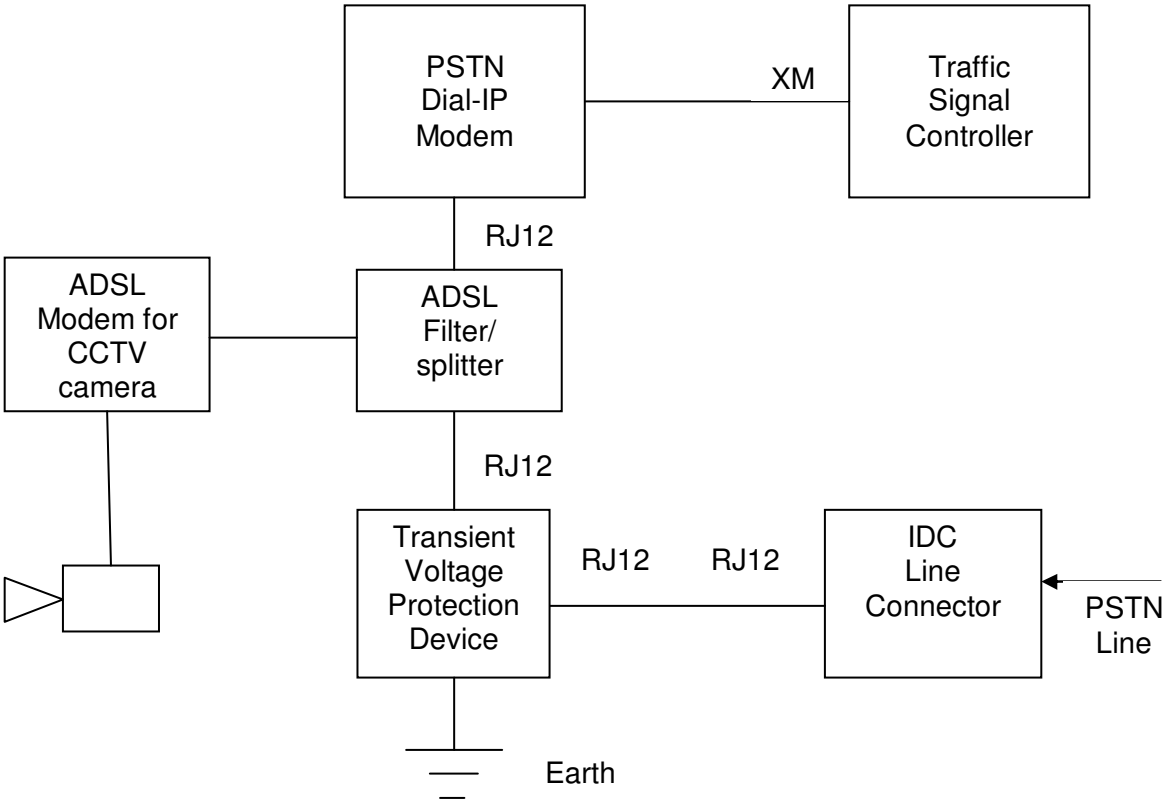


**FIGURE 4: Typical wiring configuration**

5.7.7.2 The ADSL splitter/filter is to be installed next to the transient voltage protection device. The phone port of the splitter is to be connected to the traffic signal for the SCATS connection, and the data port (or sometimes labelled ADSL/modem) is connected to the ADSL modem for the camera.

# SECTION 6 DETECTORS

## 6.1 GENERAL

6.1.1 The supplier shall install the requisite number of detectors in the controller as specified on the individual controller order.

## 6.2 VEHICLE DETECTORS

6.2.1 The detection equipment whether an integral part of the controller or an isolated unit shall comply with the appropriate sections of AS 2703, and include:

- a sensor unit which, when connected to suitable loops and to the power supply, will provide the specified operation;
- a power supply.

6.2.2 The detection equipment shall operate as specified and shall not be affected in any way by the presence of any high frequency transmitter or any other source of interference which may be induced into the detection equipment. Adequate precautions shall be taken to prevent any interactions between sensor units connected to different loops or between different loops.

6.2.3 Each sensor unit or channel shall be associated with a separate inductive loop and shall have a dedicated LED indication on the detector's front panel when a vehicle is detected,.

6.2.4 Each sensor unit or channel shall be clearly marked with the appropriate detector identification code.

6.2.5 The unit must be capable of operating the loop with up to 300 metres of detector loop feeder cable.

# SECTION 7 SITE TEST FACILITIES

## 7.1 TEST FUNCTIONS

7.1.1 Facilities shall be provided in the Controller for the following test functions to aid in setting up and commissioning of sites, site upgrades and ongoing maintenance:

## 7.2 GROUP FLASH

7.2.1 As a convenient aid to check intersection cabling, the controller shall incorporate a facility to briefly flash each colour in a particular signal group in such a way that it cannot be interpreted by the road user as a genuine signal.

Note: This facility shall only be invoked whilst the controller is in a “Maintenance Mode” (i.e. not controlling traffic) and require access key level protection.

## 7.3 LAMP LOADS

7.3.1 Facilities shall be provided to allow reading lamp wattages for all groups and colours at the site during normal operation.

# SECTION 8 PREPARATION PRIOR TO INSTALLATION

## 8.1 TESTING

8.1.1 When the Contractor is given an order for the installation of a controller, it shall be prepared and configured for installation at the nominated site in accordance with the Operational Design Sheets provided with the order.

8.1.2 The controller, with the personality (Cardbus or EPROM) installed, shall be tested “on line” to a SCATS Test Region under appropriate load conditions for a period of not less than 48 hours.

8.1.3 The Contractor shall undertake an Operational Test to verify the correct operation of the controller. The test shall verify that:

- the controller initiates in the correct start-up sequence and ‘reset’ in the pivot phase.
- the controller defaults to flash, or no display for pedestrian operated signals, for all conflicting signal groups in accordance with the Group Conflict Chart.
- all signal phases identified in the Operational Design Sheets operate when the appropriate detector input is activated.
- all detector inputs activate the corresponding phase(s).
- the minimum and maximum time settings for each phase complies with the Operational Design Sheets.
- the facility switch operates correctly.
- call-record and other outputs (GWTP and NRT signs as examples) operate correctly.

8.1.4 All instruments and testing facilities shall be supplied by the Supplier. Such testing facilities shall provide full simulation of all inputs and monitoring of all outputs.

8.1.5 On completion of successful testing, the Contractor shall affix a signed and dated label to the inside of the controller door.

8.1.6 The label shall provide the Contracting Company’s name, the printed name and signature of the technician/manager carrying out the operational test and date of signing.

8.1.7 Unless specifically requested, all preparation, testing and pre-commissioning works shall be completed within seven working days of the availability of the Operational Design Sheets and the personality.

## 8.2 TEST REPORT

8.2.1 The Contractor shall prepare a report on the Operational Test identifying all the key tests undertaken, the outcomes of the tests and the actions taken.

8.2.2 The report shall be provided to the Superintendent at least 24 hours prior to the proposed time of installation of the controller.

## 8.3 CONTROLLER CABINET LABEL

8.3.1 The Contractor shall supply a standard cabinet label, in accordance with VicRoads Standard Drawing TC-2100, together with the numerals required for the site number as advised by VicRoads.

# SECTION 9 INSTALLATION AND COMMISSIONING

## 9.1 INSTALLATION

9.1.1 The Contractor shall carry out all works necessary for the proper installation and operation of the controller including communication with the VicRoads central SCATS computer.

9.1.2 The contractor shall deliver the controller to site and install it on the controller base provided by others.

9.1.3 When the controller cabinet is installed next to the kerb or traffic lane, it shall be oriented so that the door is furthest from the traffic flow.

9.1.4 The contractor shall be responsible for all terminations within the controller, including:

- mains power supply cables;
- multicore power cables;
- detector feeder cables;
- telecommunication cable;
- special purpose cables, for example linking cable, train signal input cable or fire station input cable; and
- any other required cable.

9.1.5 The “drain” conductor in each feeder cable shall be earthed in the controller.

9.1.6 One end of all spare multicore power cable cores must be earthed in the controller

## 9.2 POWER SUPPLY

9.2.1 The contractor shall submit all necessary paperwork to the appropriate electrical distribution company and provide copies to VicRoads.

## 9.3 COMMUNICATIONS

9.3.1 On receipt of clearance from the communication provider, the contractor shall connect the communication line in the controller.

## 9.4 COMMISSIONING

9.4.1 The Contractor shall carry out a “flash” test of the site in the presence of the Superintendent, after giving the Superintendent 90 minutes advance warning.

9.4.2 The Contractor shall advise the Superintendent when the controller is ready for “switch-on”.

9.4.3 The Contractor shall activate the controller after being directed by the Superintendent and when safe to do so.

9.4.4 Unless directed by the Superintendent, the Contractor shall remain in attendance until the site has attained full operational status including communication with the VicRoads central SCATS computer.

9.4.5 Following full operation of the controller, the Contractor shall measure the power consumption reading for the traffic signal site, enter the reading into the Power Consumption Report (Appendix E) and forward the Report to the Superintendent within two business days.

9.4.6 The contractor shall record the time and date of “switch-on” on the Controller Record Card in the controller.

9.4.7 The Contractor shall ensure that a copy of the Operation Sheets, cable connections and controller record card are left in the controller cabinet.

9.4.8 The contractor shall apply the cabinet label with the site number to the controller.

## 9.5 REMODEL SITES

9.5.1 At remodel sites, the Contractor shall de-commission and remove the redundant controller, and store the full unit for future use, or arrange delivery to another holding location, as directed by the Superintendent.

9.5.2 The contractor shall be responsible for maintaining the controller in “as removed from site” condition until the controller is delivered to, and accepted by a nominated third party, or held in storage until directed by VicRoads to undertake preparation as a second hand controller for another site, or removal from storage for transfer to a third party or disposal.

9.5.3 All traffic signal controllers removed from traffic signal sites remain the property of the relevant VicRoads Region.

# SECTION 10 DOCUMENTATION

## 10.1 GENERAL

10.1.1 The Supplier shall provide three complete sets of documentation, including circuit diagrams and instruction manuals on all aspects of the operation, hardware, software, maintenance and diagnostics.

## 10.2 INSTRUCTION MANUALS

10.2.1 Each set of instruction manuals shall contain:

- a complete set of electrical circuits, including logic and timing diagrams;
- a detailed description of the operation of the equipment;
- full instructions on the setting up and adjustment of the equipment and the checking or test procedure to be adopted;
- mechanical details of main cabinets and sub-assemblies;
- laboratory testing and setup procedures;
- on site diagnostic procedures;
- strapping options and significance of strapping;
- diode matrix; significance of diode positions.

## 10.3 SOFTWARE DOCUMENTATION

10.3.1 The following software documentation shall be provided, if requested by VicRoads:

- Memory map.
- Functional description of memory map.
- RAM data definition and application.
- Operations and programming manuals.
- Full software listing of the hardware-related software
- Intersection personality tables, including synchronous linking tables, if any, unless such provision would contravene the contractors pertinent RTA SCATS licence obligations.

## 10.4 UPDATING SERVICE

10.4.1 The Supplier shall have available an updating service covering all controller documentation. Any updates to documentation previously supplied shall be forwarded to VicRoads within a reasonable time of being released.

# APPENDIX A

## FLEXILINK OPERATION

## SPECIFICATION FOR SCATS FLEXILINK OPERATION

**CONTENTS**



### A1 INTRODUCTION

Flexilink is a mode of linked operation in which there is a fixed cycle length for each plan. In order to give greater flexibility of efficiency over normal fixed time systems, Flexilink allows a measure of vehicle actuated control so that phases can be allowed to 'gap out' and phases that are not demanded will not run.

Flexilink plans are changed by time of day.

When connected to a SCATS regional computer, the Flexilink data is loaded into the local controller RAM through the master. Flexilink shall operate whenever the master orders Flexilink mode. If the master orders Flexilink or a fallback of Flexilink and then communications with the master are lost, the controller shall operate Flexilink using the RAM data.

### A2 PHASE SEQUENCE

The controller shall allow for at least two (and preferably at least four) independent phase sequences. Where there are two sequences, the Y + signal shall select the second sequence. Where there are more than two sequences, there shall be some means of selecting sequences using the presence of any of the general signals (Y +,Z-,Z+,Q-,Q+, XSF) or combinations of these.

The Flexilink program shall check that the phase sequences entered in the personality are valid. A valid sequence must not include phases that are not defined in that personality and must not have any phase listed more than once. If the sequence is not valid, the controller shall operate Flexilink isolated and shall log a fault.

If the phase sequence changes and the running phase is not in the new sequence, then the pivot phase is assumed to be next in sequence.

## A3 PIVOT PHASE

The first phase listed in the selected sequence is defined as the pivot phase.

The software shall place a permanent demand on this phase whenever the controller is operating full Flexilink.

The reference point for the start of each cycle is the call pulse for the pivot phase. This pulse may occur at any step of the cycle generator.

## A4 PLAN DATA

The controller shall allow storage of at least eleven independent Flexilink plans. Each plan has data in the following format:

| | | |
|---|---|---|
| CL | = | Cycle length |
| A | = | Call A pulse |
| B | = | Call B pulse |
| C | = | Call C pulse |
| D | = | Call D pulse |
| E | = | Call E pulse |
| F | = | Call F pulse |
| G | = | Call G pulse |
| R- | = | Release signal |
| R+ | = | Release signal |
| Y- | = | Link signal |
| Y+ | = | General signal |
| Z- | = | General signal |
| Z+ | = | General signal |
| Q- | = | General/Release signal |
| Q+ | = | General/Release signal |

### A4.1 Cycle Length

The CYCLE LENGTH is expressed in two second steps (and should have the option in the personality of selecting 1 sec steps). Thus, an entry of 30 corresponds to a cycle length of 60 seconds. If the CL entry is zero, Flexilink isolated shall operate. The cycle generator shall increment from 0 to CL-1 in two second steps. The maximum cycle length shall be 253 steps (i.e. 506 seconds).

### A4.2 Call Phase

The CALL PHASE entries specify the cycle generator steps at which the call phase pulses occur for each phase. These entries can take any value from 0 to CL-1. Any other value (normally 254) corresponds to an unused phase.

### A4.3 Release Signals

The RELEASE SIGNALS (R-, R+, Q-, Q+) may be set to provide either continuous release, pulse release or no release. A value of 255 corresponds to continuous release. A value from 0 to CL-1 corresponds to pulse release. Any other value (normally 254) shall result in no release.

### A4.4 Link Signal

The LINK SIGNAL (Y-) entry must be set to 255 to establish full Flexilink operation. Any other value (normally 254) shall invoke Flexilink isolated.

### A4.5 General Signals

The GENERAL SIGNALS (Y+, Z-, Z+, Q-, Q+, XSF) shall be able to control at least the following facilities:

- Time setting substitutions (e.g. walk and delay times)
- Automatic introductions of pedestrian movements
- Placing phase calls
- Inhibiting phase calls
- Selection of phase sequence
- Masking detectors
- Stop extension of nominated detectors or approaches
- Switching “No Right Turn” or similar lanterns on and off

These signals may be continuous, pulsed or not active as for the release signals.

## A5 CALL PHASE PULSES

The occurrence of a call pulse shall cause the termination of the running phase, subject to minimum timers and movement to the requested phase if and only if:

a. The requested phase is not currently running;
b. The controller is not already proceeding to the requested phase;
c. The requested phase has a demand;
d. The requested phase has not been passed over since the controller last left the pivot phase;
e. The call phase pulse is in the correct order as specified in the selected phase sequence; and
f. The transition from the running phase to the requested phase is not prohibited.

A fundamental principle of Flexilink operation shall be to service demanded phases in the same order as the selected sequence even if this means sacrificing linking. In this regard, the following shall apply:

a. Once a call phase pulse has occurred for a phase which is not demanded, it shall not be possible to go to that phase until the pivot phase is passed again;

b. Once a phase has been passed over, it cannot run until the pivot phase is passed again;

c. The Flexilink program shall check that the call phase pulses occur in the same order as the selected sequence. If this is not so and there is a demand for any skipped phase, then the controller shall revert to Flexilink isolated. If a call phase pulse is not next in sequence, but the skipped phase(s) have no demand, then the controller shall remain in the full Flexilink:

d. When a call pulse occurs for a demanded phase, but the running phase is unable to terminate due to the timing of Minimum Green, Walk or Pedestrian Clearance, the call pulse shall be stored. As soon as the running phase is free to terminate, the stored pulse shall be acted on. The controller shall provide for storage of one or two such call pulses so that if call pulses continually arrive within minimum times, the phases will run further and further behind synchronisation. There shall be some means of determining when the controller is running far enough out of synchronisation to justify reverting to Flexilink isolated.

## A6 LOOKAHEAD FEATURE

When a call pulse arrives for a phase which has no demand, the controller may remain in the current phase (i.e. False Green) or proceed to a demanded phase that is later in the sequence (i.e.Lookahead).

Provision shall be made in the controller personality to nominate the phases to which each call pulse can 'lookahead'. It would be preferable for the programmer to be able to make this specification independently for each sequence.

When a call phase pulse occurs and the requested phase has no 'lookahead' and no demand, then the controller may remain in the running phase. The time allocated for the requested phase is thus available to the running phase. During False Green, the controller may respond to any release that becomes active.

If the requested phase has a 'lookahead' and no demand, the controller shall proceed to the next demanded phase of those nominated in the personality, provided that no demanded phase would be passed over. If none of the nominated phases are demanded, or if a demanded phase would have to be passed over, then the controller shall remain in the running phase.

If the phase requested by the call phase pulse is the running phase or has been passed over since the controller left the pivot phase, the pulse shall be ignored completely. That is, no Look ahead can occur in such cases.

## A7 PSEUDO PHASE

The pseudo phase is defined to be either the running phase or the last phase to receive a call pulse, whichever is the later in the phase sequence.

## A8 RELEASE FEATURE

Whenever a release is active, the current phase shall terminate, subject to minimum timers and move to the next demanded phase in sequence if and only if:

a. The next demanded phase has not been passed over since the controller last left the pivot phase:
b. Transition to the next demanded phase is not prohibited; and
c. The relevant gap or density timers have expired.

If no release is active the current phase shall not terminate until a call phase pulse occurs.

The control of when releases are active shall be achieved by the following four features:

a. Auto Release
b. R- Release Signal
c. R+ Release Signal
d. Q- Release Signal

e. Q+ Release Signal

The release signals (R-, R+, Q-, Q+) can be set in the Flexilink plan data to be continuous, absent or pulsed (refer Clause A4.3).

The controller personality shall provide for each of the four release features to become active during nominated pseudo phases or the green of nominated signal groups. It would be preferable for the programmer to be able to make this specification independently for each phase sequence. It shall be possible for the release features to apply to one or more pseudo phases and/or one or more signal groups.

Auto releases and continuous release signals shall be active whenever the associated pseudo phase is current or the associated signal group is green.

Pulsed release signals shall become active from the instant the pulse occurs, providing the associated pseudo phase is current or the associated signal groups is green. The release shall remain active whenever these conditions exist.

Notwithstanding the above, if the pivot phase begins early, it shall not be able to release until after the call pivot phase pulse occurs. Thereafter, it shall be able to terminate whenever a release becomes active.

While operating full Flexilink, maximum timers shall have no effect.

## A9 SCHEDULE DATA

The schedule data is used to change Flexilink plans by time of day. The controller shall allow storage of at least twenty independent schedules. Each schedule shall have data in the following format:

Date Code: Time (Hours and Minutes); Plan Number

The day code allows the specified plan number to be introduced on one day in the week or in some combination of days in the week. The day codes shall be as follows:

| | | |
|---|---|---|
| 0 | = | End of Schedules |
| 1 | = | Sunday |
| 2 | = | Monday |
| 3 | = | Tuesday |
| 4 | = | Wednesday |
| 5 | = | Thursday |
| 6 | = | Friday |
| 7 | = | Saturday |
| 8 | = | Monday through Friday |
| 9 | = | Monday through Saturday |
| 10 | = | Tuesday, Wednesday and Thursday |
| 11 | = | Monday and Friday |
| 12 | = | Monday, Friday and Saturday |
| 13 | = | Saturday and Sunday |
| 14 | = | All days of the week |
| 15 | = | No day of the week |

A day code of zero shall indicate that the schedule and all subsequent schedules are not used.

The time for plan change is specified in hours and minutes on the basis of the 24 hour clock. Midnight shall be represented by zero hours, zero minutes.

At the exact time that a plan changes, the Flexilink cycle generator shall be set to zero.

When the controller is powered up or switched to Flexilink mode, it shall analyse the schedule data to determine what Flexilink plan should be running and the time at which the plan would have introduced. The current Flexilink cycle generator step shall be determined on the basis that the plan had been running since the last plan introduction time.

## A10 FLEXILINK ISOLATED

Flexilink isolated shall operate whenever the controller is nominally in Flexilink mode under the following conditions:

a. Clock is not calibrated;
b. Phase sequence is not valid;
c. Schedule data or plan data is not valid;
d. Current plan has no Y- signal (i.e. Y- is not 255);
e. Current plan has cycle length of zero;
f. A call pulse arrived that is not in the same order as the selected sequence and there is a demand for any skipped phase;
g. The controller is running a reasonable degree behind synchronisation.

Under conditions (a) to (c) above, the controller shall operate the same phase sequence as for isolated. Under the other conditions, the controller shall adopt the phase sequence selected by the general signals in the current Flexilink plan and the general signals shall be able to invoke any special facilities.

During this mode of operation, demanded phases shall be serviced in order, under normal vehicle actuated operation, including maximum timing. No artificial demand for the pivot phase shall be placed.

The controller shall report Flexilink as the mode of operation to the master.

If the controller reverts to Flexilink isolated under conditions (f) or (g) above, it shall resume full Flexilink as soon as the running phase is synchronised with the call pulses. The Flexilink program shall provide some method of regaining synchronisation as soon as possible but without resting for too long in any phase.

## A11 PEDESTRIAN RE-INTRODUCTION

The Pedestrian movements that run in the pivot phase shall be able to re-introduce the pivot phase, subject to demand, when the call pivot phase pulse occurs.

## A12 PHASE STRUCTURE

The SCATS Flexilink Plan Data has been designed on the phase philosophy rather than the group philosophy. Thus, for a group controller to comply with SCATS Flexilink operation, the status of the signal groups must always comply with some phase structure. In particular, while a phase is running all the vehicle signal groups that are expected to be green in that phase must be displaying green

If connected to a SCATS regional computer, the controller shall report the correct phase and the correct phase status.

# APPENDIX B

## GUIDELINES FOR PURCHASING AND INSTALLATION

INFORMATIVE

### B1 DETAILS TO BE INCLUDED WHEN ORDERING

When ordering a controller, the following details are to be provided:

- The number of vehicle and pedestrian groups;
- Location for installation;
- The number and type of detectors;
- Whether the field circuits are to be at mains voltage or ELV;
- If a connection to SCATS is required, and what type of communication network is to be used
- If an uninterruptible power supply is to be included;
- If a gas sensor is to be provided;
- If a connection for a standby generator is to be provided and the rating of the connection;
- The number of pedestrian Wait Indicator outputs required;
- Whether any special facility inputs/outputs are required.

### B2 PRE-DELIVERY PRODUCTION TESTS

Prior to a controller being delivered, it shall undergo Production tests as detailed in Appendix D.

### B3 PRE-INSTALLATION TESTING AND ACCEPTANCE

Prior to a controller being installed, it shall undergo testing and VicRoads inspection as detailed in Section 8.

# APPENDIX C

## REQUIREMENTS FOR TYPE APPROVAL

### C1 GENERAL

The controllers supplied shall conform to a sample previously supplied to, and formally Type Approved by, VicRoads. Such approval shall be signified by the issue of a Certificate of Type Approval.

No such Certificate will be issued without the Supplier providing documentary evidence of successful inspection and testing of electrical and environmental aspects to which reference is made in this Appendix by an accredited, registered testing authority.

Reference to "approved" within this specification shall mean individual components or methods that have previously been approved by VicRoads.

Any new item of equipment, including sub-assemblies or modules, or major re-design shall require the Supplier to resubmit the equipment for Type Approval. The Supplier shall not commence production of any new or re-designed item of equipment (including module or sub-assembly) until after receipt of written notification from VicRoads that type tests/ evaluation have/has been successfully completed.

All tests shall be carried out by the Supplier at his own expense under the supervision of the Superintendent or his representative. All labour and equipment required for the environmental tests shall be supplied by the Supplier.

### C2 REQUIRED TESTS

The Supplier will be required to demonstrate, by means of testing carried out by an independent NATA approved laboratory, that the controller conforms to the following requirements as detailed in AS 2578:

- Ambient conditions (clause 1.4.1)
- Shock (clause 1.4.4.1)
- Vibration (clause 1.4.4.2)
- Electromagnetic compatibility (clause 1.4.5)
- Weather resistance (clause 1.4.6)
- Acoustic noise (clause 1.4.6)

VicRoads reserves the right to request other test to demonstrate conformity with this specification and to AS 2578.

## C3 OFF STREET TESTS

VicRoads shall require the Supplier to provide a sample controller for off-street evaluation and LED compatibility testing.

LED compatibility testing is a critical part of the evaluation and must therefore be successfully completed prior to installing a controller in the field for field testing.

## C4 FIELD TEST

VicRoads reserves the right to require a field test for up to six months. In such a situation, VicRoads shall purchase and install up to a maximum of four complete controllers at selected sites in the Melbourne Metropolitan area for the purpose of field evaluation.

During the period of six months when the controllers are installed in the field any faults or failures which occur in the following areas of the equipment shall be repaired by the contractor and recorded by VicRoads:

- Control module and associated components
- Any internal connections or connectors
- Integral wiring of the controller
- Manually operated switches
- Operation under the SCATS system
- Hinges and locks

Upon completion of the period of evaluation the faults or failures (if any) will be analysed.
If in the opinion of the VicRoads the faults or failures could affect the long term viability of the controller the trial may be required to continue until such time as a successful corrective action has been undertaken to eliminate any design flaws that are considered to be responsible for the faults or failures.

## C5 REMEDIAL ACTION FOLLOWING TYPE TESTS

If the equipment fails to pass the type test/evaluation or any single part of them, VicRoads will advise the Supplier to that effect. In that event the equipment shall be subjected to the complete sequence of type tests after the necessary modifications are carried out by the Supplier.

## C6 TYPE APPROVAL

If the product is approved a certificate of Type Approval will be issued. Until such time as this certificate is issued, the product is not to be used in the state of Victoria for purposes other than field testing.

# APPENDIX D

## PRODUCTION TESTS

### D1 PRODUCTION TESTS

The Supplier shall carry out the following production tests on each item of equipment prior to delivery:

(a) All printed-circuit cards after assembly shall be pretested at appropriate voltage levels to exercise every available function;

(b) Each computer with associated interfacing shall be subject to a heat test under normal operating conditions in the following sequence :

(c) Place in an oven and raise to 70 - 75 degrees C.

(ii) Once the unit reaches temperature it is to remain at that temperature for 20 minutes.

(iii) Allow unit to cool to ambient temperature.

(iv) Repeat steps (i), (ii) and (iii) twice more (making a total of three cycles).

If failure occurs during any cycle then the whole heat soaking procedure steps (i), (ii), (iii) and (iv) must be repeated. During this heat soak test the computer and the associated interfacing shall be fully exercised and its performance monitored.

Production tests shall form part of the manufacturer's Quality system.

### D2 PRODUCTION TEST REPORT

Upon completion of a successful production test, a report shall be prepared. At the time of delivery the report shall be provided with the controller.

# APPENDIX E

## POWER CONSUMPTION REPORT

# Power Consumption Report

| | |
|---|---|
| Site Name: | |
| Suburb/City: | Site No: |

| | |
|---|---|
| Voltage | |
| Current Reading (minimum) | |
| Current Reading (maximum) | |

**Readings carried out by:**

| | |
|---|---|
| Signed: | Date: |
| Print Name: | Company: |