

TCS 056 - 2019

Specification for

The Supply and Installation

of

Lane Use Signs for Freeway Management

April 2019
Revision A

TCS 056 – 2019

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 VicRoads website at the following address:

<https://www.vicroads.vic.gov.au/business-and-industry/technical-publications/electrical-and-intelligent-transport-systems>

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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.

**Intelligent Transport Systems
60 Denmark Street Kew 3101
Phone: (03) 9854 2158**

Revision History

Version	Revision	Date	Author	Description
2008		April 2008	M1	Developed for M1 project as VRT
2011		May 2011	M80	Reviewed and updated
2014	A	Sep 2014	RO	Reviewed and converted to TCS format
2016	A	Feb 2016	RO	Minor revision
2019	A	April 2019	ITS	Inclusion of installation section

PREFACE

A. TELECOMMUNICATIONS EQUIPMENT

All telecommunications equipment shall comply with relevant requirements of the Australian Communications and Media Authority (ACMA). Such equipment shall be labelled with a Regulatory Compliance Mark.

B. CHANGES TO THIS SPECIFICATION

The main changes to this specification from the previous version are listed below:

- Addition of Installation Section.

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SECTION 1 SCOPE AND GENERAL

1.1 SCOPE

- 1.1.1 This Specification covers the supply and general installation requirements of Lane Use Signs (LUS) in fixed, on-road applications for use by VicRoads within the State of Victoria, as part of a Lane Use Management System and may also be referred to as LUMS signs.
- 1.1.2 Within this specification a LUS is defined as a device for the purpose of providing speed limit and lane control information to road-users in numeric and symbolic format.
- 1.1.3 The design and manufacture of all components of a LUS shall be undertaken in accordance with this specification and individual tender documents.
- 1.1.4 This specification assumes the use of LED technology to create the displays. However, alternative technology that meets the performance requirements of this specification may be considered.

1.2 GENERAL

- 1.2.1 Any reference to 'sign' within this document shall be taken to mean 'Lane Use Sign'.
- 1.2.2 Each sign shall generally comply with the relevant requirements of Australian Standard 5156: Electronic Speed Limit Signs. This VicRoads specification covers any additions and/or exceptions to AS 5156 as detailed in Section 2.2.1 of this specification. Where this specification differs from AS 5156 this document shall have precedence.
- 1.2.3 Each sign shall typically be mounted centrally above each lane of a carriageway on a gantry or adjacent to the carriageway such as on freeway entry ramps, such that it is clearly visible from each lane of the carriageway of the approach to which each sign applies.

1.3 INTELLECTUAL PROPERTY

In relation to all intellectual property used in, or to operate, the LUS, the contractor grants to VicRoads non-exclusive licence to "use, modify and/or sell" or do anything else that without the licence, could be breach of the licensors Intellectual Property. Intellectual Property shall include, but not be limited to, the following:

- Software;
- Source code;
- Schematic diagrams;
- Circuit and wiring diagrams;
- Listings of components and sub-components;
- Any and all operational and maintenance documentation

SECTION 2 RELATED SPECIFICATIONA AND DRAWINGS

2.1 GENERAL

- 2.1.1 The supply and installation of the signs shall conform to the latest versions of relevant Australian Standards.
- 2.1.2 All installation works shall conform to the relevant VicRoads specifications and related specifications and standards as indicated throughout this document.
- 2.1.3 The following related Australian Standards are referenced:

AS 1742	Manual of Uniform Traffic Control Devices
AS 1743	Road signs - Specifications
AS 1744	Forms of letters and numerals for road signs
AS 2578	Traffic signal controllers
AS/NZS 3000	Wiring Rules
AS 5156	Electronic speed limit signs
AS 60038	Standard voltages
AS 61000.6.3	Generic standards – Emission standard for residential, commercial and light industrial environments
AS 61558	Safety of power transformers, power supply units and similar

- 2.1.4 The following VicRoads specifications and documents are referenced:

TCS 060	VicRoads extensions to RMS protocol for roadside devices
TCS 061	ITS Field Cabinet
TCG 016	Product Compliance Process for ITS and Electrical Products
MFH	VicRoads Managed Freeway Handbook

- 2.1.5 The following VicRoads Standard Drawings are referenced:

TC-2260	Non-Accessible LUMS Gantry-General Arrangement
TC-2261	Non-Accessible LUMS Gantry Internal Conduiting and Mounting Arrangement
TC-2262	Non-Accessible LUMS Gantry-Gantry Leg Cabinet
TC-2263	Non-Accessible LUMS Gantry-Column Base Plate Details
TC-2264	Non-Accessible LUMS Gantry-Foundation Conduit Details
TC-2265	Non-Accessible LUMS Gantry-Typical Gantry Earthing Arrangement
TC-2266	Non-Accessible LUMS Gantry-Electrical and Communications Cable Connections Details
TC-2267	Non-Accessible LUMS Gantry-Leg Security Mesh – Typical Arrangement
TC-2268	Non-Accessible LUMS Gantry-Gantry Leg Access Openings – typical Arrangement
TC-2270	Accessible LUMS Gantry-

TC-2272	Accessible LUMS Gantry-LUS Mounting Arrangements
TC-2273	Accessible LUMS Gantry-Conduit Route – 1 of 6
TC-2274	Accessible LUMS Gantry-Conduit Route – 2 of 6
TC-2275	Accessible LUMS Gantry-Conduit Route – 3 of 6
TC-2276	Accessible LUMS Gantry-Conduit Route – 4 of 6
TC-2277	Accessible LUMS Gantry-Conduit Route – 5 of 6
TC-2278	Accessible LUMS Gantry-Conduit Route – 6 of 6
TC-2279	Accessible LUMS Gantry-Gantry Leg Cabinet
TC-2280	Accessible LUMS Gantry-Access Ladder and Cage Details
TC-2281	Accessible LUMS Gantry-Access Walkway and Handrail – 1 of 4
TC-2282	Accessible LUMS Gantry-Access Walkway and Handrail – 2 of 4
TC-2283	Accessible LUMS Gantry-Access Walkway and Handrail – 3 of 4
TC-2284	Accessible LUMS Gantry-Access Walkway and Handrail – 4 of 4
TC-2285	Accessible LUMS Gantry-Cladding Details
TC-2286	Accessible LUMS Gantry-Foundation Conduit Details
TC-2287	Accessible LUMS Gantry-Typical Gantry Earthing Arrangement
TC-2288	Accessible LUMS Gantry-Electrical and Communications Cable Connections Details
TC-2289	Accessible LUMS Gantry-Leg Security Mesh – Typical Arrangement
TC-2310	Structure Mounted LUMS-Elevation Typical Arrangement
TC-2311	Structure Mounted LUMS-General Arrangement Layout
TC-2312	Structure Mounted LUMS-Mounting Arrangement Type 1
TC-2313	Structure Mounted LUMS-Mounting Frame Type 1
TC-2314	Structure Mounted LUMS-Mounting Arrangement Type 2
TC-2315	Structure Mounted LUMS-Mounting Frame Type 2
TC-2316	Structure Mounted LUMS-Mounting Arrangement Type 3
TC-2317	Structure Mounted LUMS-Mounting Frame Type 3
TC-22318	Structure Mounted LUMS-Anti-Vandal Cowling
TC-22319	Structure Mounted LUMS-unction Box, Electrical and Communications Cable Connection Detail
TC-2220	VSLs Pole and Base Plate
TC-2233	VSLs Pole Foundation Concrete
TC-2234	VSLs Pole Spread Footing

2.1.6 The following additional documents are referenced:

RMS Specification TSI-SP-003	Communications protocol for roadside devices
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2.2 EXCEPTIONS AND CLARIFICATIONS TO AS 5156

The following changes or clarifications to AS 5156 are summarised in Table 2.1 below:

AS 5156 Clause	Description	Exceptions to AS 5156 Clause
2.1.1.1	Display characteristics	Refer Section 6 for details on additional displays required.
2.1.1.4	Display changes due to facility switch operation	Refer to Section 5 of this specification
2.1.1.7	Conspicuity devices	Clause does not apply
2.1.2.4	Pixel arrangement - Discrete character signs	Clause does not apply
2.1.3.3	Pixel/LED - Pixel modules	Clause does not apply
3.1.1	Host control	Refer to Section 5 of this specification
3.2.1	Product host control system	Refer to Section 5 of this specification
3.2.2	Facility switch	Refer to Section 5 of this specification
3.3	Remote control	Refer to Section 5 of this specification
3.5	Communication protocol	Refer to Section 5 of this specification
3.7	Fall-back operation	Refer to Section 5 of this specification
4.1.2	Mechanical requirements - Sign enclosure	Clause (c) modified Clause(d), (f) & (g) does not apply
4.1.3	Mechanical requirements - Sign mounting facilities	Refer to Section 8 of this specification
4.1.4.1	Control housing - Construction and positioning	Clause does not apply (refer VicRoads specification for ITS Field Cabinet TCS 061)
4.1.4.2	Control housing - Anti-vandalism measures	Clause does not apply (refer VicRoads specification for ITS Field Cabinet TCS 061)
4.1.4.3	Control housing - Power and communication equipment	Clause does not apply (refer VicRoads specification for ITS Field Cabinet TCS 061)
4.1.5.1	Facility switch – General	Refer Section 5 of this specification
4.1.5.2	Facility switch - Control housing	Refer Section 5 of this specification
4.1.5.4	Facility switch - Mounting	Refer Section 5 of this specification
4.2.3	Battery backup	Clause does not apply
4.4	Solar power	Clause does not apply
4.7	Markings and labels	None
5.2	Enclosure protection	Clause (b) does not apply (refer VicRoads specification for ITS Field Cabinet TCS 061)
Appendix A	Photometric Test Procedures	None
Appendix B - B2.3	Display changes due to external switch inputs	Clause does not apply
Appendix B - B2.4	Graphics requirements	Modified text as follows: "The graphical images must be individually created (drawn) using a facility within the sign's software package"
Appendix B - B4.1	Graphics requirements	Refer to VicRoads specification for extensions to RMS protocol for roadside devices TCS 060
Appendix B - B4.2	Message numbering for speed displays	Refer to VicRoads specification for extensions to RMS protocol for roadside devices TCS 060
Appendix B - B4.3	Frame numbering for other displays	Refer to VicRoads specification for extensions to RMS protocol for roadside devices TCS 060

Appendix B - B4.4	Message numbering for other displays	Refer to VicRoads specification for extensions to RMS protocol for roadside devices TCS 060
Appendix B - B4.5	Standard bitmap display images	Information only. Alternate image definitions may be considered
Appendix B - B4.6	Bitmap definitions for other displays	Information only. Alternate image definitions may be considered
Appendix C - C1	Sign clearances	Clause does not apply
Appendix C - C2	Sign access	Clause does not apply
Appendix D	Wireless communications	Clause does not apply

Table 2.1 – Exceptions and Clarifications to AS 5156

SECTION 3 ACRONYMS

3.1 ACRONYMS

The acronyms used in this document shall be interpreted as follows:

ACMA	Australian Communications and Media Authority
AS	Australian Standard
CLI	Command Line Interface
CSV	Comma Separated Values
DHCP	Dynamic Host Configuration Protocol
DNS	Domain Name System
EMC	Electromagnetic Compatibility
FDS	Freeway Data Station
FP	Field Processor
GNSS	Global Navigation Satellite System
HTTP	Hypertext Transfer Protocol
HTTPS	Hypertext Transfer Protocol Secure
ICMP	Internet Control Message Protocol
IEEE	Institute of Electrical and Electronics Engineers
IP	Internet Protocol
ITS	Intelligent Transport System
LED	Light Emitting Diode
LUMS	Lane Use Management System
LUS	Lane Use Sign
NEMA	National Electrical Manufacturers Association
NMS	Network Management System
NTP	Network Time Protocol
RAI	VicRoads Road Asset Inventory database
RMS	Roads and Maritime Services of NSW
SC	Sign Controller
SNMP	Simple Network Management Protocol
SSH	Secure Shell
SSL	Secure Sockets Layer
STREAMS	An ITS communications/control platform used by VicRoads to manage traffic operations on freeways
TCP/IP	Transmission Control Protocol/Internet Protocol
TLS	Transport Layer Security

SECTION 4 OPERATION

4.1 GENERAL

- 4.1.1 Signs shall display symbols and speed limits using LED pixels.
- 4.1.2 The annulus shall be created using red LEDs preformed into the annulus shape.
- 4.1.3 The numeral display shall be created using a matrix of white LEDs located within the annulus.
- 4.1.4 Arrow displays shall be created using the required LEDs within the matrix with the end of the arrow and the tip of the arrow extending into the annulus.
- 4.1.5 Cross displays shall be created using red LEDs located within the matrix area and extend into the annulus.
- 4.1.6 The background of the sign display shall be black. Figure 4.1 below shows an example of the sign face layout.

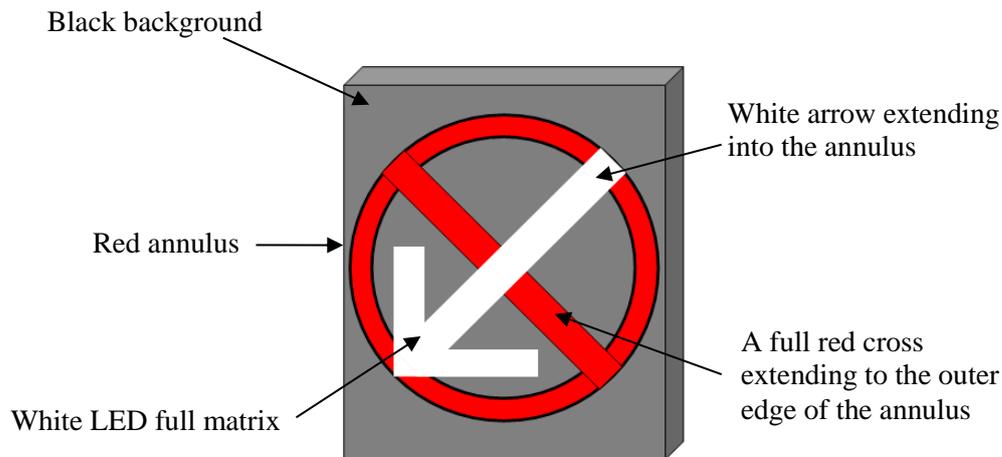


Figure 4.1 – Example sign face layout

- 4.1.7 Signs shall be able to display individual frames and messages and shall implement all functions described by the RMS Protocol Specification TSI-SP-003 and VicRoads Specification TCS 060 - "VicRoads extensions to RMS protocol for roadside devices".
- 4.1.8 In normal operation, the sign shall show one of the displays indicated in Table 4.1 below.

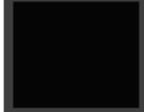
Message Description	Sample Image
Speed limit with steady red annulus (indicates lane is open for use at the normal speed limit)	
Reduced speed limit with inner part of the red annulus flashing	
White 'merge' and 'exit' arrow(s)	
Red cross (indicates lane is closed)	
Blank	

Table 4.1: Typical Displays

4.1.9 This sign shall display each of the symbols specified within this specification.

4.1.10 The white LED matrix display shall allow for the following:

- Display of any bitmap image set via the RMS protocol. Examples of such symbols may include special lane use symbols as required, bus lane symbols, transit lane symbols and truck lane symbols.
- Have a resolution which will enable the display of all the required symbols in this specification and as per Australian Standard AS 1742.
 - For speed limit numerals, the character size shall be as per AS 1744. The overall size of the sign shall be as per AS 1743.
 - Inclusion of red LEDs for the generation of the 'red cross' display.
 - Display of the white arrows.

4.2 SPEED LIMIT DISPLAYS

4.2.1 The default display shall be the posted speed limit as specified within individual tender documents.

4.2.2 When displaying the posted speed limit the annulus shall display all rings in a steady state.

4.2.3 When displaying a reduced speed limit, the inner rings of the annulus shall flash in accordance with AS 5156.

4.2.4 The outer ring of the annulus shall be prohibited from flashing.

4.3 WHITE ARROWS

4.3.1 The sign shall be able to display a single white ‘merge’ arrow symbol on the internal white LED matrix.

4.3.2 The arrow symbol shall extend through the annulus as shown in Figure 4.2 and be a comparable size to the red cross symbol.

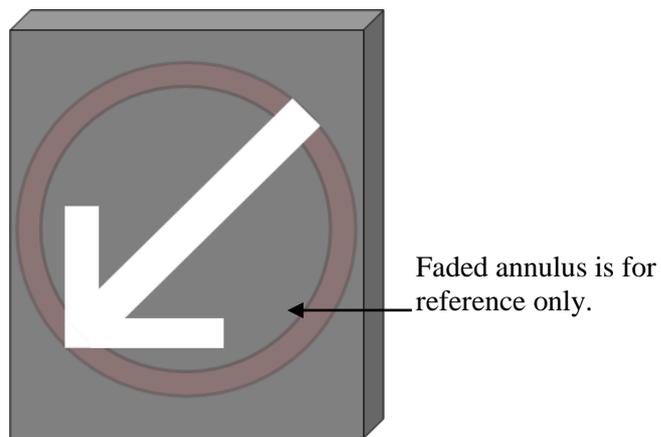


Figure 4.2 – Left-Down Arrow

4.3.3 As a minimum, the sign shall be able to display the arrow symbols listed in Table 4.2.

Name	Description	Symbol
1 Left down arrow	Merge left	
2 Right-down arrow	Merge right	
3 Left up arrow	Exit Left	
4 Right up arrow	Exit Right	

Table 4.2 – Merge Arrows

4.4 RED CROSS

The sign shall be able to display a single red cross spanning the full outside diameter of the speed limit annulus, as shown in Figure 4.3 and Table 4.3.

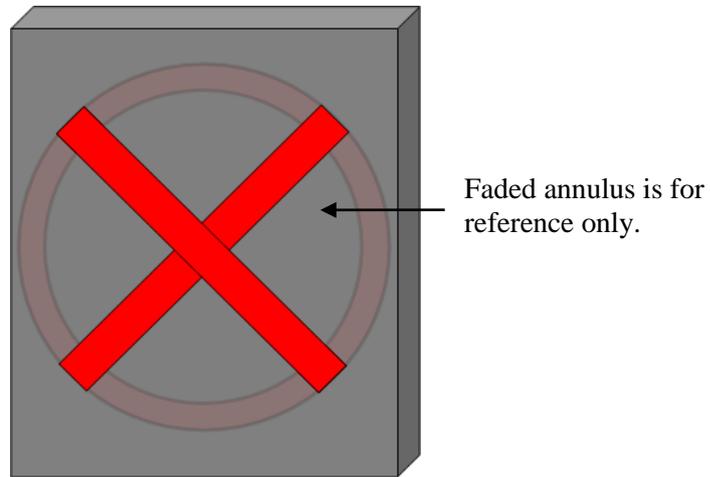


Figure 4.3 – Red Cross

Name	Description	Symbol
Cross	Lane closed	

Table 4.3 – Red Cross

SECTION 5 CONTROL

5.1 SIGN CONTROL PERFORMANCE AND CAPABILITY

- 5.1.1 The sign shall have the capability to support the speed limit and lane status displays being changed based on real time traffic conditions.
- 5.1.2 The VicRoads control system uses frame and message numbering as defined in VicRoads specification number TCS 060 - "VicRoads extensions to RMS protocol for roadside devices".
- 5.1.3 The control system from VicRoads to the Field Processor (FP) is VicRoads ITS Platform. See Appendix A.

5.2 SECURITY

- 5.2.1 VicRoads communications network must conform to the VicRoads Information Security Policy at all times.
- 5.2.2 The LUS shall be fully compliant with VicRoads communications security requirements.

5.3 SIGN CONTROLLER

- 5.3.1 The sign shall be controlled via a separate SC. Under normal operation, its main purpose is to provide both serial and two Ethernet interfaces to a third-party controlling device, over which RMS protocol shall be transmitted in order to control up to ten signs operating as a single logical group.
- 5.3.2 A single SC shall only control signs installed over a single carriageway with traffic flowing in one direction.
- 5.3.3 The SC shall be designed to be installed within a standard 19" rack based roadside cabinet in accordance with VicRoads specification TCS 061 ITS Field Cabinet. The rack-mounting chassis shall be no more than 2 RU in height, and either full or half 19" rack width. Half-width 19" modules shall be mountable on both the left and the right sides.
- 5.3.4 An alternative cabinet may be considered provided it is designed to be mounted onto the standard VicRoads cabinet foundation.
- 5.3.5 The SC shall retain all programming information achieved by the use of non-volatile memory.
- 5.3.6 All of the controller's communication and power interfaces shall be clearly and indelibly labelled on the controller housing. The SCs unique serial number shall also be shown on the front panel.
- 5.3.7 The response time (the latency from when VicRoads FP sends a request message to when a valid response message is received by the FP, i.e. the response time includes the time for transferring the request message from the FP to the sign controller via a serial or TCP/IP link,

sign controller processing time for generating a valid response message and the time for transferring the valid response from the sign controller to the FP via serial link or TCP/IP) shall be less than 2 seconds.

5.4 SIGN CONTROLLER ENVIROMENTAL REQUIREMENTS

- 5.4.1 The SC shall be constructed from sheet aluminium or other rustproof, durable materials. The SC housing shall be free of sharp edges.
- 5.4.2 All fixing hardware shall be rust proof and shall not cause galvanic corrosion between the fasteners, rack chassis and the housing.
- 5.4.3 The SC shall be able to operate continuously at ambient temperatures ranging from -10°C to 60°C at 95% relative humidity (non-condensing).

5.5 ADMINISTRATION AND CONFIGURATION INTERFACE

- 5.5.1 The sign controller shall provide an interactive browser based user interface using HTTP and HTTPS to provide monitoring, configuration and diagnostic related functions.
- 5.5.2 Providing a Command Line Interface (CLI) based configuration interface is not mandated, however, if provided, the interface shall:
- Support key-based and password authentication, with the capability to disable password authentication
 - SSH v2.x shall be required (SSH v1 shall not be used)
 - Only support CLI over TCP/IP. The SC shall not have any serial based console port on the controller chassis, which can be used to access the SC CLI interface.
- 5.5.3 The software shall provide for the display and monitoring of the sign controller configuration, including:
- Site Name.
 - Firmware version.
 - Current Temperature of the controller.
 - Main Power Supply status.
 - Backup Power Supply Status (if one exists).
 - Up Time (since last reset).
 - System time (Local date and time).
 - MAC Address(es) of all Ethernet port(s).
 - Current Active Control Mode (Local, serial, TCP or any other mode if present).
 - Facility Switch position.
 - All the signs connected to the controller and, for each sign, the following information shall be displayed:
 - RMS protocol Group ID.
 - RMS protocol Sign ID.
 - Dimensions (in pixel).
 - Luminance dimming control mode (Auto, Time based or Fixed).

- Current Luminance dimming level.
- RMS Protocol Session Status (Online / Offline).
- RMS Protocol Display Mode (Message, Frame or Plan).
- RMS Protocol Display Message Number/Frame Number/Plan Number.
- Current Sign firmware version.

5.5.4 Configuration Functions - The software shall allow a user to change sign controller and sign configurations using the browser interface. In general, all configuration changes shall be applied immediately and take effect without the need to restart/reset the sign controller. However, changing certain parameters may cause any currently active connection to be dropped, for example, the sign's password or seed offset, IP port number, etc. The following parameters shall be configurable.

- The Site Name - Text field with minimum 150 characters.
- Control Mode - The software shall allow a user to choose an active control mode from the following:
 - Local mode - When this mode is enabled, a user can use the browser interface to control the sign display to display a message or run test patterns. When this mode is disabled, a user shall not be able to use this web software to control the sign display to display a message or run test patterns.
 - Serial - When this mode is enabled, the master (refer to RMS protocol section 2.1) software can connect to sign controller via serial connection, and control the sign using RMS protocol. When this mode is disabled, and there is currently an active serial connection, the controller shall drop the connection and blank the sign(s).

When this mode is disabled and the master software attempts to connect to the sign controller via the serial connection using RMS protocol, the sign controller shall respond with a 'Reject' message (MI code 00h) with Application Error code '01' (Device Controller offline) to the 'Start Session' message (MI code 02h) sent by the master software. However, the sign controller shall still respond to 'Heartbeat Poll' messages (MI Code 05h) as specified in RMS Protocol Section 3.6.3.6. The sign controller shall adapt a new or separate sequence numbering N(s) and N(r) from the master to continue communication with the control system by responding with Status Replies to 'Heartbeat Poll' messages (MI Code 05h).

- TCP/IP - When this mode is enabled, the master (refer to RMS protocol section 2.1) software can connect to sign controller via TCP/IP connection, and control the sign using RMS protocol.

When this mode is disabled, if there is currently an active TCP/IP connection, the controller shall drop the connection and blank the sign(s). When this mode is disabled and the master software attempts to connect to the sign controller via TCP/IP using RMS protocol, the sign controller shall respond with a 'Reject' message (MI code 00h) with Application Error code '01' (Device Controller offline) to the 'Start Session' message (MI code 02h) sent by the master software. However, the sign controller shall still respond to 'Heartbeat Poll' messages (MI Code 05h) as specified in RMS Protocol Section 3.6.3.6. The sign controller shall adapt a new or separate sequence numbering N(s) and N(r) from the master to continue communication with the control system by responding with Status Replies to 'Heartbeat Poll' messages (MI Code 05h).

Note: the control mode is exclusive. Once a mode is chosen, the other two modes shall be disabled.

- Network configuration - The software shall allow a user to change the following network configurations:
 - IP address allocation (DHCP and static).
 - If the IP address allocation is static – the following parameters: IP Address, Subnet Mask, Default Gateway, Primary DNS and Secondary DNS.

Note: The sign controller shall have at least 2 Ethernet interfaces as specified in Clause 5.5. The software shall have separate network configuration for each Ethernet interface.

- RMS Protocol Configuration - The software shall allow a user to change the following RMS Protocol and communications related configuration parameters (see detail 5.10.1 – 5.10.9):
 - IP Port used for TCP/IP connection.
 - Session time out for TCP/IP connection (in seconds).
 - Security settings for TCP/IP connection (such as switch between no encryption and TLS encrypted , TLS port to be used).
 - Baud rate, Data bits, Parity and Stop bits for serial connection.
 - Session time out for serial connection (in seconds).
 - Seed offset (in Hex).
 - Password offset (in Hex).
 - Polling Address.
 - Broadcast Address.
 - Blanking Time out (in minutes, the duration that the sign controller will wait before blanking the sign after the active RMS protocol connection is disconnected.).
 - Sign ID and Group ID (For individual signs).
- Monitoring TCP Configuration - The software shall allow a user to change the following monitoring related configuration parameters (see Clause 5.10.10):
 - IP Port used for TCP monitoring.
 - Session time out for TCP/IP monitoring (in seconds).
- Luminance Dimming control - The software shall allow a user to change the following sign dimming control related configuration for each individual sign connected to the sign controller:
 - Luminance Dimming control mode (Auto, Time Based or Fixed). Three modes are defined in AS 4852.1 – 2009 Section 3.11.
 - The controller shall have pre-defined Melbourne ‘Dawn’ and ‘Dusk’ times for Time Based mode as specified in AS 4852.1 – 2009 Section 3.11 and the software shall allow a user to change those time settings.
 - Fixed Dimming Level (in ‘Fixed’ mode only).
- System Time - The software shall allow a user to change the current time, time zone, Daylight saving option and whether to use an NTP server for time synchronisation. The IP address(es) of the NTP servers shall be configurable.
- Security - The software shall:

- Allow a user to change the browser interface's username and password.
- Support both HTTP and HTTPS and allow a user to choose the access mode from 'HTTP only', 'HTTPS only' and 'Both HTTP and HTTPS'.
- Allow a user to change the TCP/IP ports used for 'HTTP' and 'HTTPS'.
- Allow a user to change the session timeout for the browser interface (duration after the last active web request received).

5.5.5 Control and testing

The software shall allow a user to perform local control and display test patterns functions specified in section 5.15 "Local Control" of this specification.

5.5.6 Administration

The software shall provide the following administration functions as specified in sections 5.5.7 to 5.5.13.

5.5.7 Firmware upgrade

- The software shall allow a user to upgrade the controller's firmware. After the firmware is upgraded, all existing pre-configured parameters (IP addresses, network mask, default gateway and etc) for the controller shall be maintained.
- The software shall allow a user to upgrade firmware for individual signs that are connected to the sign controller.
- The system shall ensure that the entire firmware file is successfully downloaded before attempting to apply the firmware upgrade.

5.5.8 Save /recover configuration to/from file.

- All of the configuration parameters for the controller shall be able to be saved and retained after rebooting the controller.
- The software shall allow a user to save the current configuration to a local file and be able to restore all the configuration parameters from the file.

5.5.9 Reboot and Reset.

The software shall allow a user to reboot/reset the controller with the following options:

- Reset to manufacturer default
- Reset to manufacturer default, except for the current network configuration (IP addresses, network mask, default gateway, etc).
- Reboot the controller with all configuration maintained.
- The sign controller shall provide a software interface to generate and execute all RMS protocol reset levels.

5.5.10 Reports/logs

The software shall provide separated log files, one for RMS protocol commands and another for any other system logs. All the logs shall be able to be displayed via the web interface and to be exported to plain text or CSV format files.

5.5.11 System event logs

The software should log the following system events as minimum:

- Controller and sign fault events
- RMS protocol connection events (only require connection and disconnection events)
- The login / logoff events for the browser interface software, including any failure attempts. The parameters to be logged include the attempted usernames, passwords and source IP addresses.

The software shall keep a minimum of the last 30 days or 5000 log entries, whichever limit comes first. Each log shall contain a timestamp with the resolution to 1ms.

5.5.12 RMS command logs

The software should log every RMS protocol command and response between the master software and the controller for the last 30 days or 5000 messages. If the storage memory is full, the control module shall delete the oldest records to make space for the new records as required. Each log shall contain:

- Message direction (from the master to the controller or vice versa)
- A timestamp with resolution to 1ms (The time the commands received or the response sent)
- The actually message detail in a Hex string.

5.5.13 Non functional requirements

(a) Performance - The software shall respond to every user interaction in less than 3 seconds (excluding delays in the network).

(b) Security

- The software shall verify the username and password before granting access to the system.
- The software shall support both HTTP and HTTPS and allow a user to choose access mode from 'HTTP only', 'HTTPS only' and 'Both HTTP and HTTPS'
- Only TLS shall be used for the HTTPS connection
- The current VicRoads document 'Information Security Standard: Cryptographic Controls' shall be complied with.
- After three successive failed login attempts, the minimum time allowed between login attempts shall be changed to 60 seconds.

(b) Bandwidth /network requirement

The software shall be designed to run on a relatively slow IP network, such as 3G/4G wireless network with around 500Kbps bandwidth and 500ms latency. The user interface shall be simple to avoid long response times. Where large amounts of information is to be displayed (such as logs), the information shall be displayed over multiple pages with page down and page up functions.

5.6 RESET AND MASTER RESET

5.6.1 On reset or reboot of the SC or any of the signs within the group (regardless of source), all of the signs within the group shall be set to blank.

- 5.6.2 The sign controller shall incorporate a reset button accessible on the front chassis. The reset button shall perform a soft reset to the SC and signs. All configurations within the SC and signs shall be maintained.
- 5.6.3 The sign controller shall not provide any hard reset (reset the controller to manufactory default) mechanism (such as button), which can be accessed via the chassis.

5.7 SIGN CONTROLLER PARAMETER DEFAULT SETTINGS

The default settings for key parameters within the SC shall be as shown in Table 5.1.

Parameter	Description	Default Setting
SC login user name	Username required for access to the SC's Web based tool	'Admin'
SC login password	Password required for access to the SC's Web based tool	To be provided by VicRoads.
SC Site Name	The SC's Site name to be displayed in the Web based tool	VicRoads allocated Site Number (RAI ID)
SC IP address	Selectable DHCP or statically configurable IP address and Netmask	Ethernet Interface 1: STATIC IP: 192.168.30.1 Mask: 255.255.255.0 Ethernet Interface 2: STATIC IP: 192.168.30.2 Mask: 255.255.255.0
RMS over, TCP/IP	TCP port numbers for RMS protocol connection (control and monitor)	no encryption : 43000 TLS encrypted: 43002 Default: no encryption
TCP/IP monitoring port	TCP port numbers for monitoring only over TCP/IP	no encryption : 43100 TLS encrypted: 43102 Default: no encryption
Default RMS address	RMS Protocol group and sign address	All addresses to start from 1
Serial configuration	Hardware serial settings	RS422 38400kbps, 8 N 1
Web Access Ports	TCP port number used for web access to the Web based tool	HTTP: 80 HTTPS using TLS: 443
Telnet	TCP port number used for connection to the CLI	TCP 6368 or SSH:2222
Control Mode	Default controller RMS control mode	Serial
Luminance Dimming Control Mode	Default Luminance Dimming Control Mode	Auto
RMS TCP Time out	Session time out for TCP/IP connection (in seconds)	300

RMS serial Time out	Session time out for serial connection (in seconds)	180
Blanking Time out	in minutes, the duration that the controller to black the sign after the active RMS protocol connection is disconnected	5
Web Access Timeout	in minutes, the duration that the current Web tool connection to be after the last active web request is received.	5

Table 5.1 – Sign controller key parameters

5.8 ETHERNET

The SC shall provide at least two 10/100 TX Ethernet interface. All Ethernet interfaces shall support the modes of communication and protocols detailed in Section 5.10 and 5.11 of this specification.

5.9 HARDWARE SERIAL PORT

- 5.9.1 The SC shall provide a minimum of one hardware serial port with a standard DB-9 connector. The port shall be used to control a group of one or more signs using RMS protocol.
- 5.9.2 The serial port shall function in accordance with Table 5.2.

Physical Interface Std.	RS422 and RS485 (autosensing, or software configurable)
Baud Rate	38400bps – 115200bps
Data bits / stop bits	Configurable (Typically 8, 1, N on RS422)
Parity	Configurable (Typically 8, 1, N on RS422)

Table 5.2 – Serial port function

5.10 RMS PROTOCOL FOR SIGN CONTROL AND MONITOR

- 5.10.1 The operation of the sign shall be controlled by means of the RMS communications protocol to comply with AS 4852.1 Section 4.5, via the physical serial and the Ethernet interfaces defined above. This protocol is defined in the RMS specification TSI-SP-003 “Communications Protocol for Roadside Devices” version 2.1 and VicRoads Specification TCS 060 - “VicRoads extensions to RMS protocol for roadside devices”.
- 5.10.2 Remote control of the sign shall be facilitated via the STREAMS ITS platform.
- 5.10.3 RMS “Heartbeat Poll” messages from the controlling device shall be serviced by the sign controller within 0.5 seconds of reception of the heartbeat request.

- 5.10.4 If a controlling device (usually a VicRoads field processor) sends an RMS command which is not supported, then the SC shall reply with a Reject Message with an appropriate Application Error Code as defined in the RMS protocol specification.
- 5.10.5 The sign controller shall support all fault logging and diagnostic functionality provided by the RMS protocol.
- 5.10.6 The sign controller may also support customised messages for special functions. In this case, such messages shall be in RMS protocol format and shall be fully documented for integration with 3rd party systems. The proposed customised messages shall be provided to VicRoads for review and approval before implementation. The supplier shall supply full details of any such customised RMS protocol messages for integration with 3rd party software vendors.
- 5.10.7 The sign controller shall fully implement all defined RMS protocol layers including error checking as described in the RMS specification TSI-SP-003 “Communications Protocol for Roadside Devices” version 2.1 and VicRoads Specification TCS 060 - “VicRoads extensions to RMS protocol for roadside devices”.
- 5.10.8 Either one of the Ethernet Interface can be used for remote control over TCP/IP, however the sign controller shall only allow one RMS TCP/IP connection in any one time. Once any one of the Ethernet Interfaces is having an active RMS TCP/IP session, all other Ethernet Interfaces shall reply with “Reject” message to any RMS TCP requests.
- 5.10.9 Monitoring over TCP/IP

This feature is to allow third party software to monitor the sign displays in real time. The sign controller shall respond to RMS “Heartbeat Poll” messages via a separate TCP port as specified in RMS Protocol Section 3.6.3.6. The sign controller shall adapt a new or separate sequence numbering N(s) and N(r) from the master to continue communication with the control system by responding with Status Replies to ‘Heartbeat Poll’ messages (MI Code 05h).

5.11 OTHER PROTOCOLS

- 5.11.1 In addition to standard TCP/IP detailed above, the SC shall support the following protocols as a minimum:

- ICMP (ping).
- NTP (to set & maintain the SC / LUS clocks).

Note: The SC shall set its time based on the configured NTP server or the manual input from the admin and configuration interface. However, once the SC is connected to master software via RMS protocol and if the master software uses the ‘Update Time’ command to update the SC’s time, the SC shall use the time set by the master software until the RMS protocol session is disconnected.

- HTTP (interface for admin and configuration).
- HTTP using TLS (secure interface for admin and configuration).

- 5.11.2 Where encryption is enabled, the SC shall provide a facility to securely upload encryption certificates and/or change the encryption password from a remote location.

- 5.11.3 Where encryption is enabled, TLS shall be used as the encryption mechanism. TLS shall be implemented as follows:

- The control system shall be the client and the sign is the server.
- The focus is on communication privacy and integrity - therefore, neither client nor server authentication is required.
- The sign controller shall be able to have a TLS certificate (with private key) uploaded to be used as a server certificate, to be used in the negotiation of a secure TLS/SSL connection.
- The sign controller shall perform as a TLS server endpoint and does not need to authenticate the client.
- TLS v1.2 shall be supported.

5.12 DIAGNOSTIC FUNCTIONS

- 5.12.1 The SC shall monitor the fault status of the connected signs and provide this fault information through appropriate RMS protocol messages. This fault logging system shall log all events as they occur. The reporting system shall also buffer reportable events when communication to the SC is temporarily lost. Such buffered events shall be made available to the controlling device when requested upon communications resuming.
- 5.12.2 All diagnostic information and logs shall be accessible using RMS protocol through each of the SC's serial and Ethernet communications interfaces.
- 5.12.3 The SC shall monitor and provide a fault log containing information about the operational status of each individual sign. The fault report shall include the following as a minimum:
- Status of communications between the SC and each individual LUS.
 - The status of mains power at each individual sign.
 - Pixel check* results for each individual sign connected to a SC.
 - Ambient light sensor failure.
 - Sign temperature (i.e. over-heat/cool status).
 - All sign subsystem fault conditions.
- 5.12.4 The SC shall incorporate a display test function that will have each sign display its current address.
- 5.12.5 Where a standard format for any given fault report is not defined by the RMS protocol, the format shall be fully documented and disclosed to VicRoads for integration with third party systems.
- 5.12.6 All faults shall be detected and logged for reporting within 5 seconds of the fault occurring.

* NOTE: *Any LED pixel shall be deemed "faulty" if it does not behave as expected. Such behaviour shall include pixels remaining in the wrong state (on or off), pixels which flicker, and pixels which exhibit reduced or increased brightness compared to properly functioning pixels.*

‡ NOTE: *If the pixel check test requires pixels in the sign face to be momentarily lit, then this test shall only be run once per day at any configurable time. The fault report for this test may also be updated on a daily basis in this case.*

5.13 FAULT RESPONSE

5.13.1 All signs connected to a SC shall automatically respond to faults according to Table 5.3 below.

5.13.2 The control functions of the sign shall be capable of monitoring the operation of the sign in accordance with AS 4852.1 Section 4.6.

5.13.3 For groups of more than 1 sign all signs shall be blanked completely in the case that any individual sign has become blank due to a fault or other condition.

Failure types		Responses	RMS Error code to be used
i.	Where mains power is lost to the SC OR any individual sign.	<ul style="list-style-type: none"> The entire display area of all signs within the group shall be completely blanked. Create a log in the SC specifying power failure for affected device(s).	Controller Err Code: 01
ii.	Where the communication link to either of the SC's physical serial ports is lost or adversely affected.	<ul style="list-style-type: none"> The entire display area of all signs within the group shall be completely blanked. Create a log in the SC detailing which serial interface was affected.	Controller Err Code: 02
iii.	Where an established communication link over TCP/IP is lost or interrupted.	<ul style="list-style-type: none"> The entire display area of all signs within the group shall be completely blanked. Create a log in the SC detailing the nature of the link loss.	Controller Err Code: 02
iv.	Where the communication between one or more signs and the SC itself is lost or adversely affected.	<ul style="list-style-type: none"> The entire display area of all signs within the group shall be completely blanked. Create a log in the SC detailing the specific type of communications failure to the LUS sign.	Controller Err Code: 05
v.	Where internal faults are detected within the SC and/or any of the signs within the group, i.e. watchdog timeout	<ul style="list-style-type: none"> The entire display area of all signs within the group shall be completely blanked. Create a log in the SC specifying the nature of the failure.	Error Code from Appendix C of RMS protocol as appropriate
vi.	Where 10 percent or more of LEDs comprising any of the symbols defined in earlier Sections have failed OR have become faulty* OR are affected to the extent that the resultant displays may be confusing to the public.	<ul style="list-style-type: none"> The entire display area of all signs within the group shall be completely blanked. Create a log in the SC of the type & extent of the LED failure(s).	Controller Err Code: 08

Table 5.3 – Fault Responses

5.14 MANUAL OVERRIDE FACILITY SWITCH

- 5.14.1 A 3-position manual override facility switch interface shall be provided. The switch (complete with key) shall be supplied with the SC and shall be an Australian Standard traffic signal controller facility switch with a recessed triangular spigot as defined in AS 2578. The switch shall be able to be mounted to the front face of the SC or within its own 19" rack mounted unit no more than 1 RU in height.
- 5.14.2 The SC shall report the current position of the manual override facility switch to a controlling device through a status reporting mechanism using RMS protocol, and through the SCs monitoring interface.
- 5.14.3 The sign controller shall report the current position of the facility switch using RMS protocol by reporting error code 10 (hex) "Facility Switch Override" if the switch is not in the AUTO position.
- 5.14.4 The switch shall only switch extra low voltage.
- 5.14.5 The switch shall not switch low voltage.
- 5.14.6 The operation of the 3 switch positions shall respond according to Table 5.4 below.

Position label	Action
AUTO	All attached signs shall operate under normal control
OFF	All signs are completely blanked
TEST	Test pattern where all LEDs in all connected signs are fully illuminated

Table 5.4 – Facility Switch Positions

- 5.14.7 Each position of the facility switch shall be indelibly and durably labelled as per Figure 5.1 below.

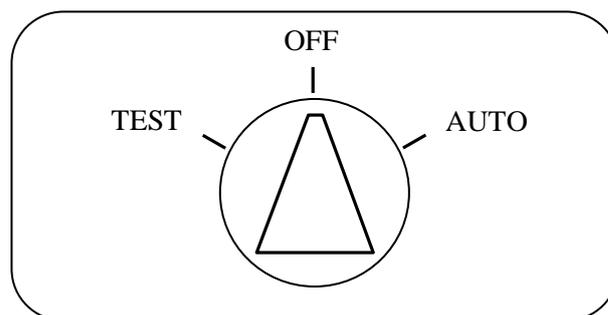


Figure 5.1 – Facility switch relative positions and labelling

5.15 LOCAL CONTROL

- 5.15.1 The ground level access shall include RS 232 and Ethernet connections and also include a 240V socket outlet with integral RCD.

5.15.2 The Ethernet interface shall provide the sign with the following:

- At least two IEEE 802.3 10/100 Base TX Ethernet interface with RJ-45 socket connection.
- Support for DHCP and static IP addressing.
- Sign management and configuration via Ethernet using SSH or HTTP/HTTPS protocol.

5.15.3 The sign shall be capable of being programmed in accordance with AS 4852.1 Section 4.4.

5.16 REMOTE CONTROL

5.16.1 Standard operation of the sign shall be via a remote system as defined in AS 4852.1, Section 4.3.

5.16.2 The sign controller shall be able to be controlled via either serial connection or Ethernet connection by using RMS protocol.

5.16.3 The communications link between the host computer and the SC shall be specified in individual tender documents. Typically, the communications link shall be via fibre-optic cable or the 3G/4G wireless network using compatible modems.

5.17 FIRMWARE UPGRADE

5.17.1 The SC shall provide a facility to remotely upgrade the firmware of the sign display elements and the SC itself.

5.17.2 Upgrade of all firmware shall be able to be performed remotely over the Ethernet interface via an IP network.

5.17.3 The upgrade process shall first require the SC login password to be correctly entered.

5.17.4 If communication is lost during any firmware upgrade, the device being upgraded shall revert to its previous firmware version and settings automatically without the need to power cycle the device.

5.18 INTERLOCKING

5.18.1 The SC shall provide interlocks that will prevent the display of particular combinations of symbols and/or speed limits on adjacent signs over a single carriageway.

5.18.2 These interlocks shall prevent the display of combinations that are considered by VicRoads to be:

- Dangerous.
- Logically conflicting.
- Ambiguous.

- 5.18.3 The identification of such combinations shall be made in consultation with VicRoads.
- 5.18.4 All SC's supplied as part of any contract shall have the identified interlocks pre-configured. These pre-configured interlocks shall not be able to be changed or overridden by any party other than the SC manufacturer.

5.19 CONFIGURABLE SPEED LIMIT INTERLOCKS

The SC shall provide configurable parameters for both the minimum and maximum allowable speed limit displays on a group of signs.

5.20 CONFLICTING SYMBOL INTERLOCKS

Examples of sign symbols that shall be prevented through interlocking include, but not limited to, the examples listed in Table 5.5.

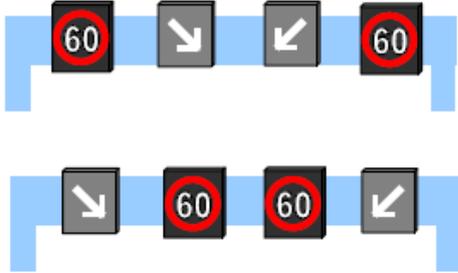
DESCRIPTION	EXAMPLES*
No differential speed limit at one site**	
Merge arrows cannot point towards each other within one site	
Lane merge signal cannot point towards a closed lane	
Lane merge signal cannot point into side barrier or emergency stopping lane	
One blacked out sign requires whole site to be blacked out	
Left/right "Exit Only" signal must only be used on the furthest left/right lane	

Table 5.5 – Examples of Illegal sign displays

* One example of many combinations ** One site refers to a single SC.

SECTION 6 DISPLAY REQUIREMENTS

6.1 DISPLAYS

- 6.1.1 Size C Lane Use Signs with respect to AS 1743 shall be used.
- 6.1.2 The sign's speed display symbol (numerals and red annulus) shall be based on the layout of the R4-1 signs (as specified in individual tender document) in accordance with AS1743.
- 6.1.3 The shape and type-setting of the speed limit numerals shall be in accordance with AS1744.
- 6.1.4 The sign may be square in shape using the minimal (horizontal) dimension to set the overall size. Where this is to be done the contractor shall seek agreement from VicRoads based on a concept design.

6.2 CHARACTER FORMAT

- 6.2.1 The display of numerals for the purpose of speed regulation shall comply with the fonts defined in AS 1744 for use on a Regulatory Sign R4-1, as defined in the Australian Standard AS 1742.
- 6.2.2 The speed limit numerals shall be white and centrally located within the red annulus. The displays generated on the sign shall generally comply with the requirements of Rule 21 Part 3 and Rule 316, Part 5 of Road Rules-Victoria and relevant Sections of AS 1742, AS 1743 and AS 1744.

6.3 DISPLAY CHANGES

The total time for standard display changing shall not be greater than 0.5 seconds.

6.4 SIGN DIMMING CONTROL

- 6.4.1 Sign shall be capable of dimming as specified in AS5156.
- 6.4.2 Dimming shall take into account when sun is positioned behind the sign and gantry.

6.5 DISPLAY – ANNULUS

6.5.1 The number of pixel rings used for the annulus shall be as specified in Table 6.1 below.

Sign Size	Number of pixel rings ¹	Number of inner rings to flash	Inner annulus diameter mm	Outer annulus diameter mm	Annulus thickness mm	Equivalent static annulus thickness mm (AS 1743)
C	5	4	~730	~870	70 ± 5	90

Table 6.1 - Annulus size requirements

¹ Pixel rings are the number of evenly spaced rings of LEDs which constitute the annulus

6.5.2 The total thickness of the annulus (i.e. inside pixel ring to outside pixel ring) will typically be slightly less than the requirement of AS 1743 due to flaring of the LED's.

SECTION 7 ELECTRICAL REQUIREMENTS

7.1 GENERAL

- 7.1.1 The complete sign and ancillary devices shall comply with the requirements of AS/NZS 3000.
- 7.1.2 Transformers used within the sign and/or sign control system shall comply with the appropriate parts of AS 61558.
- 7.1.3 All cables and wires shall be insulated with a material with a degree of protection not inferior to V-90 grade PVC and shall be suitably labelled.
- 7.1.4 All LED display modules shall operate from extra low voltage (ELV).
- 7.1.5 The sign electrical system shall provide a facility to isolate mains power to an entire group of signs from ground level.
- 7.1.6 Inrush current at switch on shall be not more than 20% of normal peak operational current.

7.2 OPERATING VOLTAGE

The mains supply voltage shall be deemed to be 230Vac +10%, -6% in accordance with AS 60038 Section 2. The system and or sub-elements of the system shall be capable of operating satisfactorily from the same within $\pm 15\%$.

7.3 POWER

The supplier shall submit the following details of the power load of each individual sign:

- a) Normal peak operation.
- b) Dimmed operation.
- c) In-rush current at switch on.

7.4 CIRCUIT BREAKERS

- 7.4.1 Each sign shall be protected by an individual circuit breaker located at ground level.
- 7.4.2 Each circuit breaker shall be clearly labelled as to which sign it protects.

7.5 INTERNAL PROTECTION

All equipment internal to the sign and SC shall be protected against damage resulting from:

- Lightning strikes at or near the sign/gantry.
- Electrical transients on power cabling.
- Electrical transients on communications wiring.
- Radio frequency interference.
- Static electrical discharge.
- Any harmonics arising from the above and any equipment in the cabinet.

7.6 EMC COMPLIANCE

7.6.1 All equipment covered by this specification shall comply with Clause 5.5 of AS 5156.

7.6.2 It should also comply with the relevant requirements of the Australian Communications and Media Authority (ACMA) for EMC and shall be labelled with a conforming RCM compliance label as detailed in Figure 7.1.

7.6.3 The RCM compliance label consists of the RCM and the supplier identification.



Figure 7.1 - RCM compliance label

7.7 SOCKET OUTLETS

Socket outlets shall not be used to distribute power amongst the signs internal components. Terminal strips shall be used for power distribution where necessary.

SECTION 8 HOUSING AND MOUNTING SYSTEM

8.1 GENERAL

8.1.1 The overall sign assembly consisting of a Housing and Mounting Base shall be modular. The two distinct modular components referred to in this section are:

- Housing - Refers to the sign head containing the LED display and driver circuitry etc.
- Mounting base - Refers to a sturdy bracket fixed to a support structure such as a gantry or pole.

8.1.2 The way in which the housing and the mounting base come together is referred to as the “mounting system”. As a default, a ‘cocoon’ type arrangement shall be used where the housing slides in and out of a ‘cocoon’ style mounting base (see Figure 8.1). The contractor shall liaise with VicRoads in order to determine the most appropriate method for marrying the housing with the mounting base in the case that this default method is deemed inappropriate, or, counteracts any of the performance requirements required by this specification.

8.1.3 A sign housing secured to a mounting base will herein be referred to as a “sign assembly”.

8.1.4 The supplier of the sign shall provide the actual lane use sign and mounting bracket as separate individually procurable items.

8.2 HOUSING

8.2.1 No access doors are required on the sign housing since there is no requirement for the sign to be field serviceable. The sign shall be factory serviceable.

8.2.2 If the housing is built as a sealed unit it shall incorporate a suitable ventilation/valve system to equalize air pressure within the unit while inhibiting any moisture ingress.

8.2.3 The housing shall be designed for a minimum in-field life at least ten years. During this time the freeway environment shall have no detrimental effect on the structural integrity or visual appearance (including colour fading) of the finished housing.

8.2.4 All surfaces of the housing shall be free from sharp edges or protrusions.

8.2.5 All metal seams shall be continuous welded. Spot welding shall not be used.

8.2.6 All fixing hardware shall be rust proof and shall not cause galvanic corrosion between the fasteners and any part of the housing.

8.2.7 The front face of the sign shall be matt black in accordance with AS 5156.

8.2.8 The sides and rear of the housing shall be black or grey.

8.2.9 The height and width of the sign housing shall be designed so that no part of the LUS ESLS annulus is closer than 40mm to the outside edge of the enclosure.

8.3 MOUNTING

- 8.3.1 The housing shall be constructed with mounting / fixing hardware that allows for quick mounting and unmounting in order to minimize the duration of installation / change-over works.
- 8.3.2 The housing and any ancillary equipment shall be free from sharp corners, edges and protrusions, which may cause injury to personnel or damage to components during installation and removal from the mounting base.

8.4 FRONT VIEWING WINDOW

- 8.4.1 The front viewing window shall be provided in accordance with AS 5156 Clause 4.1.2 (a).
- 8.4.2 The size of window area shall be such that, when installed, all parts (including the sides and bottom edges) of the display face shall be fully visible at minimum viewing angles of +/- 30° in the horizontal plane and -45° in the vertical plane from a surface-normal at the centre of the display face.
- 8.4.3 The contractor shall ensure that any integral (perforated or other type) LED 'mask' used shall not in any way perturb the appearance of the displayed symbols and speed limits throughout the above mentioned minimum viewing angles.

8.5 MOUNTING BASE

- 8.5.1 The mounting base shall be fixed to a gantry or suitable pedestal. Each sign is to be provided with a mounting base which shall allow quick changeover of the sign.
- 8.5.2 The rear of the mounting base shall be matt grey or matt black.
- 8.5.3 The mounting base shall have the following features as minimum:
- Ability to be fixed to gantries and suitable poles.
 - Contains the address associated with the attached sign so as to allow swapping of the sign with no communication configuration required.
 - Quick disconnect/re-connect cable couplings for power and communication lines (these shall be part of the mounting bracket).
 - There shall be one power cable and one communication cable only.
 - Drainage shall be provided to prevent the build up of moisture and organic material within the mounting base.
- 8.5.4 The mounting system shall be tool-less. No loose fasteners shall be used during quick installation/removal of the sign to/from the mounting system. The communication and power cable couplings shall also be tool-less and free of any physically separable fastening components.
- 8.5.5 All cable couplings shall be weatherproof and will not adversely affect the IP rating of the overall sign assembly. All cabling shall be fully concealed within the sign assembly. Cables not coupled to a sign shall be protected from weather to prevent corrosion while the bracket is not populated with a sign.

8.5.6 The installation/removal of the sign to/from the mounting base shall be performed from a work platform by one or two people. The combined time for the removal and installation of the sign shall take no longer than five minutes (once all work platforms and personnel are in place).

8.5.7 Figure 8.1 shows an example sign and mounting system.

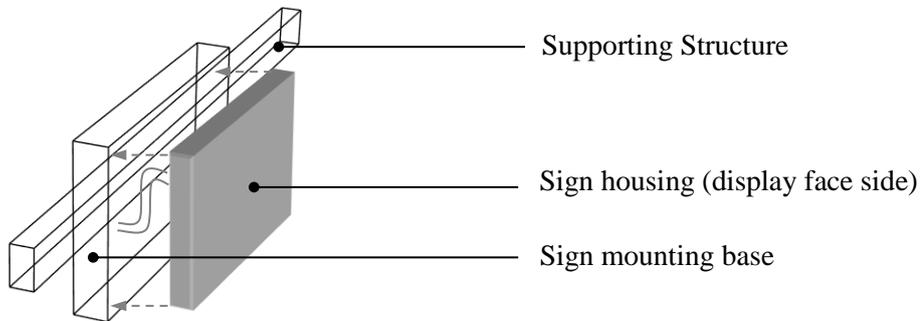


Figure 8.1 – Mounting System Example

8.6 MARKINGS

In addition to the markings and labels identified in AS5156 Section 4.7, each individual sign housing and mounting base unit shall be legibly and durably marked on the rear or interior surfaces with the date that the sign was installed in the field.

SECTION 9 - INSTALLATION AND COMMISSIONING

9.1 GENERAL

- 9.1.1 The LUS and all associated communications and power wiring shall be installed in accordance with all the manufacturer's instructions.
- 9.1.2 All installation works associated with LUS and associated equipment shall comply with the relevant clauses of:
- a) Contract Standard Section 732; and
 - b) The requirements of individual contract documents.
- 9.1.3 All pits and conduits shall be installed in accordance with Contract Standard Section 733.
- 9.1.4 All communication and power cables shall be run in separate conduits on gantry/structure.
- 9.1.5 All communication and power cables between gantry/structure/pole and sign shall be run inside waterproof flexible hose with matching weatherproof glands.
- 9.1.6 All communication and power cables shall be labelled at both ends. All cables should be neatly trained and organised.
- 9.1.7 The sign group controller shall be installed in the associated ITS field cabinet.
- 9.1.8 Signs shall be commissioned in accordance with Contract Standard Section 736 and the requirements of individual contract documents.

9.2 LUS SUPPORT STRUCTURES

- 9.2.1 Signs shall be positioned so that each is located directly above the associated lanes.
- 9.2.2 LUS sign may be installed in any of the following support structures:
- Non-Accessible Gantry;
 - Accessible Gantry, and;
 - On a Structure (ie. overpass).
- 9.2.3 The sign support structure shall be specified in individual tender documents.
- 9.2.4 Installation of signs on non-accessible gantries shall be in accordance with the referenced drawings in Table 9.1 below:

Drawing Number	Title
TC-2260	General Arrangement
TC-2261	Internal Conduiting and Mounting Arrangement
TC-2262	Gantry Leg Cabinet
TC-2263	Column Base Plate Details
TC-2264	Foundation Conduit Details
TC-2265	Typical Gantry Earthing Arrangement
TC-2266	Electrical and Communications Cable Connections Details
TC-2267	Leg Security Mesh – Typical Arrangement
TC-2268	Gantry Leg Access Openings – typical Arrangement

Table 9.1 – Standard Drawings for LUS on Non-Accessible Gantry

9.3.5 Installation of signs on accessible gantries shall be in accordance with the standard drawings in Table 9.2 below:

Drawing Number	Title
TC-2270	General Arrangement
TC-2272	LUS Mounting Arrangements
TC-2273	Conduit Route – 1 of 6
TC-2274	Conduit Route – 2 of 6
TC-2275	Conduit Route – 3 of 6
TC-2276	Conduit Route – 4 of 6
TC-2277	Conduit Route – 5 of 6
TC-2278	Conduit Route – 6 of 6
TC-2279	Gantry Leg Cabinet
TC-2280	Access Ladder and Cage Details
TC-2281	Access Walkway and Handrail – 1 of 4
TC-2282	Access Walkway and Handrail – 2 of 4
TC-2283	Access Walkway and Handrail – 3 of 4
TC-2284	Access Walkway and Handrail – 4 of 4
TC-2285	Cladding Details
TC-2286	Foundation Conduit Details
TC-2287	Typical Gantry Earthing Arrangement
TC-2288	Electrical and Communications Cable Connections Details
TC-2289	Leg Security Mesh – Typical Arrangement

Table 9.2 – Standard Drawings for LUS on Accessible Gantry

9.3.6 Installation of signs on structures shall be in accordance with the standard drawings in the table below:

Drawing Number	Title
TC-2310	Elevation Typical Arrangement
TC-2311	General Arrangement Layout
TC-2312	Mounting Arrangement Type 1
TC-2313	Mounting Frame Type 1
TC-2314	Mounting Arrangement Type 2
TC-2315	Mounting Frame Type 2
TC-2316	Mounting Arrangement Type 3
TC-2317	Mounting Frame Type 3
TC-22318	Anti-Vandal Cowling
TC-22319	Junction Box, Electrical and Communications Cable Connection Detail

Table 9.3 – Standard Drawings for LUS on a Structure

9.3.7 Signs installed on posts or pedestals adjacent to lanes (typically operated as ESLS) shall be installed in accordance with the standard drawings in Table 9.4 below:

Drawing Number	Title
TC-2220	VSLS Pole and Base Plate
TC-2233	VSLS Pole Foundation Concrete
TC-2234	VSLS Pole Spread Footing

Table 9.4 – Standard Drawings for LUS on Accessible Gantry

9.4 ELECTRICAL SUPPLY

9.4.1 Electrical supply for signs shall be from the associated ITS Field Cabinet in which the Sign Controller is housed.

9.4.2 All signs installed over a single carriageway with traffic flowing in one direction shall be powered from the same supply (i.e. same circuit breaker).

9.5 COMMUNICATIONS

Signs shall be controlled via a hardwired communications link (i.e. a serial connection) from the associated STREAMS Field Processor

9.6 INSTALLATION RECORDS

9.6.1 After installation of the signs and SC, the Contractor shall provide VicRoads a GNSS record of:

- The location of each installed sign.
- The location of the installed SC.

9.6.2 All GNSS coordinates shall be given in electronic format in GDA94 coordinate projection.

9.6.3 The Contractor shall apply through VicRoads ITS Group for an allocation of a sign site number. All GNSS records shall contain this sign site number.

APPENDIX A

VICROADS ITS PLATFORM

(Informative)

A1 GENERAL

- A1.1 VicRoads ITS communications/control platform currently uses the STREAMS system.
- A1.2 STREAMS is owned and maintained by Transmax Pty Ltd, a Queensland based company which is part of Queensland Main Roads.
- A1.3 STREAMS is an integrated control system which is being used by VicRoads to operate its ITS Freeway Management Devices on Melbourne's freeway network.
- A1.4 All ITS field devices must be compatible with STREAMS.
- A1.5 Typical ITS field devices connected to and operated by STREAMS include:
- Variable Message Signs (VMS)
 - Freeway Data Stations (FDS)
 - Ramp metering/control signs
 - Lane Use Signs (LUS)
- A1.6 The above devices are typically connected to STREAMS via a Field Processor (FP).

A2 FIELD PROCESSOR

- A2.1 The FP is used to interface internet protocol (IP) and serially connected field devices to STREAMS.
- A2.2 Communications between the FP and the ITS Field Device is typically RMS protocol.
- A2.3 The FP is typically installed within an ITS Field Cabinet.
- A2.4 The ITS Field Cabinet is typically located adjacent to the freeway.
- A2.5 In some situations, the FP may be located in VicRoads building at Kew.
- A2.6 LUS system connected to STREAMS typically use fibre optic cable or wireless connection between VicRoads and the Field Processor (FP).
- A2.7 LUS are typically connected to the FP via a copper cable using STREAMS compatible LUS protocol.
- A2.8 A typical STREAMS connection schematic is shown in Figure A1.

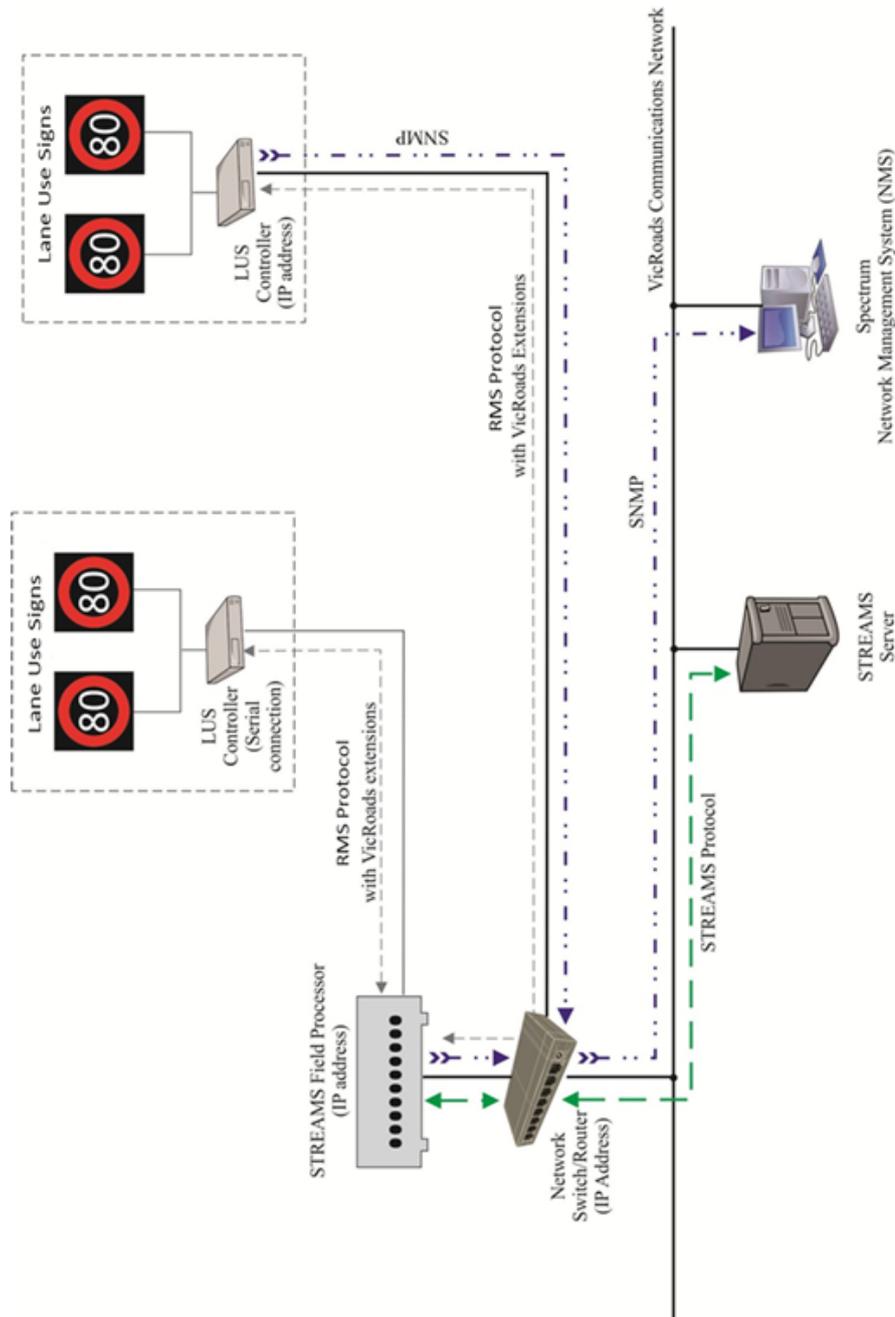


Figure A1 - LUS connected to STREAMS

A3 COMPLIANCE WITH STREAMS

- A3.1 LUS must be fully compliant and compatible with STREAMS.
- A3.2 To ensure compliance with STREAMS, the supplier shall obtain a compliance certificate from Transmax Pty Ltd for operation on VicRoads LUS system.
- A3.3 A copy of Transmax Pty Ltd certification shall be provided to VicRoads.

A4 SPECTRUM NETWORK MANAGEMENT SYSTEM

- A4.1 The Spectrum Network Management System (Spectrum NMS) is a communications monitoring/management system used to monitor/manage IP addressable devices connected to the VicRoads communication network.
- A4.2 Spectrum NMS can be used to monitor/manage any device that has an IP address without any modification required by the device.

APPENDIX B

GUIDELINES FOR TENDERING

(Informative)

B1 DETAILS TO BE INCLUDED WHEN TENDERING

The following details should be considered when preparing tender documents:

- The numbers of signs.
- The proposed activation mode.
- The mounting arrangements for the signs.

APPENDIX C

REQUIREMENTS FOR APPROVAL

(Normative)

C1 GENERAL

Ramp Control signs for use on VicRoads projects are required to hold current VicRoads Type Approval.

The Product Compliance evaluation process shall be carried out in accordance with VicRoads Guideline TCG 016.

To enable assessment for the purpose of granting Type Approval, the supplier must provide the following:

- a. A complete working sample of the sign.
- b. An outline drawing showing the general presentation and overall dimensions of the complete sign
- c. Documentation to demonstrate that the sign has been manufactured and supplied under an approved quality assurance system.
- d. Documentation to demonstrate that the sign conforms to the requirements of VicRoads Specification. This may be by means of submitting test results from approved and appropriately qualified independent testing organisations, or providing the manufacturer's assurance that the product complies with each paragraph of the specification.

Alternatively, the supplier may submit evidence of Type Approval of the same product by another Australian State Road Authority, together with details of volume and period of usage by other jurisdictions.

C2 REQUIRED NATA ACCREDITED TESTING

Notwithstanding C1 above, the manufacturer/supplier shall submit test results from a NATA accredited testing organisation to demonstrate compliance with the following:

- a. Photometric performance in accordance with AS 5156.
- b. Environmental compliance in accordance with AS 5156.

C3 COMPATIBILITY WITH RMS PROTOCOL

The supplier shall provide evidence of compatibility with RMS protocols TSI-SP-003 and ITSM-TO-ITS-CSI-002.

C4 STREAMS COMPATIBILITY

The supplier shall provide evidence of compatibility with STREAMS.

C5 OTHER REQUIRED INFORMATION

- C5.1 Confirmation that the manufacturer is on the VicRoads Register for the Pre-qualification for Supply of On-Road Electronic Devices
- C5.2 Copy of LED manufacturer's specification for each LED type used.
- C5.3 VicRoads may require additional information or testing to be carried out as part of its evaluation of the product.

C6 ASSESSMENT PROCEDURE

- C6.1 The assessment procedure for a LUS may include, but not limited to, the following:
- a. Assessment of construction, workmanship and critical dimensions;
 - b. Preliminary assessment of the sign under continuous burning at the VicRoads Test Rack for a period of not less than three months; and
 - c. Evaluation of the submitted data against the requirements of the specification.
- C6.2 Where some of these procedures have been completed prior to formal submission, the results will be considered in the evaluation, provided there is no relevant change in the design of the sign.
- C6.3 The supplier is to state whether tests carried out prior to formal submission were carried out on an identical sample of the sign.
- C6.4 VicRoads may require a trial installation of the sign to be undertaken.

C7 TYPE APPROVAL

- C7.1 The decision to grant a Certificate of Type Approval is at the sole discretion of VicRoads.
- C7.2 If the product is approved, a Certificate of Type Approval will be provided to the supplier. Until such time as this Certificate is issued, the product is not to be used for VicRoads works.