TCS 015:2021

Specification

Variable Message Signs
for
Fixed Installations

Supply and installation

May 2021
Revision: A

VICTORIA State Government | Department of Transport

TCS 015:2021

Foreword

This specification has been developed by DoT (Roads). 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 DoT (Roads).

VicRoads Standard Drawings, Specifications and Guidelines are available for downloading from the VicRoads website:
https://www.vicroads.vic.gov.au/business-and-industry/technical-publications/electrical-and-intelligent-transport-systems
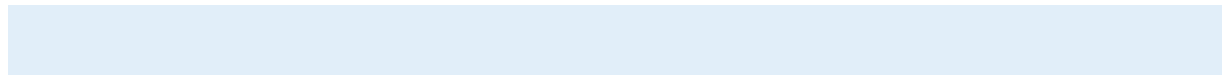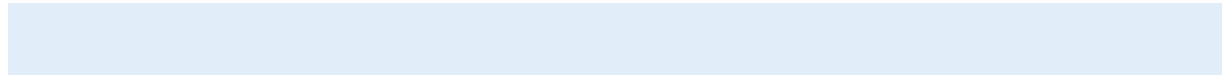
Specification updates. VicRoads specifications and associated standard drawings are subject to periodic review. To keep the specifications up to date, amendments or new editions are issued as necessary. It is therefore important for users of VicRoads specifications to ensure that they have the latest version and associated amendments.

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Revision History

Version	Revision	Date	Author	Description
2000			ITS	Version 4 released
2004			ITS	Version 5 released
2011			ITS	Version 6 released
2016	A	Feb 2016	ITS	Specification fully revised and reformatted
2021	A	May 2021	ITS	- Revised and updated to reflect new AS 4852.1:2019 - Updated to DoT template - Replace references to RMS with TfNSW - Added requirement for type approval - Expansion of preparation and installation sections

Contents

SECTION 1   SCOPE AND GENERAL

1.1   SCOPE

1.1.1   This document covers the requirements for the design, manufacture and installation of variable message signs (VMS) used in fixed applications by DoT (Roads) within the State of Victoria.

1.1.2   Within this specification a VMS is defined as a roadside device for the purpose of providing real time, changeable advice to road users in an alpha-numeric and/or symbolic format.

1.1.3   VMS covered by this specification shall include A, B and C size as defined in AS4852.1.

1.1.4   This specification replaces TCS 034 for arterial road VMS.

1.1.5   The design and manufacture of all components of a VMS shall be undertaken in accordance with AS4852.1:2019, this specification and individual contract documents.

1.2   GENERAL

1.2.1   VMS's shall comply with the Australian Standard AS 4852.1:2019: Variable message signs – Part 1: Fixed signs". This DoT (Roads) specification covers any additions and/or exceptions to the Standard.

12.2   Where this specification differs from AS 4852.1:2019, this specification shall have precedence.

1.2.3   Messages shall be capable of being displayed on the VMS via STREAMS using the TfNSW VMS communication protocol as detailed in the RMS specification TSI-SP-003.

1.2.4   The sign shall typically be mounted above a carriageway on a gantry or adjacent to the carriageway such that it is clearly visible from each lane of the carriageway of the approach to which each sign applies.

1.2.5   The sign shall be designed to provide legible, changeable alpha-numeric information relating to on-road incidents, real time traffic information, travel time information and other traffic management activities during both daytime and night-time operations.

1.2.6   The sign design and operation shall comply with the requirements of AustRoads Guide to Traffic management Part 10, Variable Message Signs.

1.2.7   Where specified in individual contract documents, the sign shall include a four-colour pictogram section as specified in Section 6 of this specification.

1.2.8   Where a Pictogram is specified in individual contract documents, it shall be capable of displaying colour messages on the Pictogram area using the TfNSW VMS communication protocol as detailed in the TfNSW specification TSI-SP-003 together with the TfNSW specification ITSM-TO-ITS-CSI-002 and VicRoads extension to the RMS protocol, Appendix B.

1.3   CCTV CAMERA

1.3.1   Where existing CCTV coverage is not available, and where specified in individual contract documents, a CCTV camera mounted on the VMS or associated support structure will be provided and installed in accordance with TCS-067.

1.4   INTELLECTUAL PROPERTY

1.4.1   In relation to all Intellectual Property used in/or to operate the VMS , 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.

1.4.2   Intellectual Property shall include, but not be limited to, the following:

- Software
- Source code(s)
- Schematic diagrams
- Circuit diagrams
- Wiring diagrams
- Listings of components and sub-components
- Any and all operational and maintenance documentation

1.5   TYPE APPROVAL

1.5.1   All equipment to be supplied under this specification shall hold current DoT (Roads) 'Type Approval' certification.

1.5.2   To obtain DoT (Roads) 'Type Approval' the supplier must submit evidence of compliance in accordance with Appendix F of this specification

1.5.3   Compliance with this version of this specification and subsequent DoT (Roads) Approval does not constitute automatic approval against future versions of this specification.

1.5.4   Where it is considered necessary, Dot (Roads) may withdraw current Type Approval and request that the affected product be re-submitted for evaluation against future versions of this specification.

1.6 ACRONYMS

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

AC	Alternating Current
ACMA	Australian Communications and Media Authority
ANSI	American National Standards Institute
AS	Australian Standard
AS/NZS	Australian Standard / New Zealand Standard
ANSI	American National Standards Institute
CCTV	Closed circuit television camera
DC	Direct Current
DoT (Roads)	Department of Transport (Roads) *(formerly VicRoads)*
ELV	Extra Low Voltage (42V AC)
EMC	Electromagnetic Compatibility
IP	Internal Protection
ITS	Intelligent Transport Systems
LED	Light Emitting Diode
LV	Low Voltage (240V AC)
NATA	National Association of Testing Authorities
PE Cell	Photo Electric Cell
RAI	Road Asset Inventory (DoT's ITS asset database and management tool)
STREAMS	DoT (Roads) ITS platform.
TfNSW	Transport for NSW *(formerly Roads and Maritime Services RMS)*
VMS	Variable Message Sign

SECTION 2 - RELATED SPECIFICATIONS AND DRAWINGS

2.1 AUSTRALIAN STANDARDS

2.1.1 The fabrication and supply of all components shall conform to the latest version of all relevant Australian Standards.

2.1.2 The following related Australian Standards are referenced:

AS 4100	Steel structures
AS 4852.1: 2019	Variable message signs – Part 1: Fixed signs
AS 5100	Bridge Design
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

2.2 DOT (ROADS) SPECIFICATIONS

2.2.1 The fabrication and supply of all components shall conform to the relevant DoT (Roads) specifications, and related specifications and standards, as indicated throughout this document.

2.2.2 The following DoT (Roads) Specifications are referenced:

Contract Standard Section 732	ITS Devices Installation
Contract Standard Section 736	ITS device testing and integration.
TCG 016	Product Compliance Process for ITS and Electrical Products
TCN 011	Modems for ITS devices
TCS 067	Digital CCTV cameras

2.3 DOT (ROADS) STANDARD DRAWINGS

The following DoT (Roads) Standard drawings are referenced:

TC-1203	Traffic signal controller foundation details
TC-2230	Single type ITS field cabinet foundation

2.4 ADDITIONAL SPECIFICATIONS

2.4.1 The fabrication and supply of all components shall conform to the following specifications and drawings as indicated throughout this document.

2.4.2 The following specifications are referenced:

Austroads	Guide to Traffic Management Part 10: Traffic Control and Communication Devices, Section 5 Electronic Signs
BTN 2010/001	DoT (Roads) Bridge Technical Note BTN 2010/001 November 2010 Design of Steel Cantilever and Portal Sign Structures and High Mast Light Poles
IEEE 802.3	IEEE Standard for Information Technology – Specific Requirements: Part 3
TfNSW Specification ITSM-TO-ITS-CSI-002	Colour Sign Interface *Only available from RMS*
TfNSW Specification TSI-SP-003	Communications protocol for roadside devices *Only available from RMS*

2.5 EXCEPTIONS AND CLARIFICATIONS TO AS 4852.1:2019

Changes or clarifications to AS 4852.1:2019 are summarised in Table 2.1 below.

AS 4852.1 Clause	Description	TCS 015 Exception / Clarification
3.1.2	Surface finish	Refer to clause 3.2.2
3.1.4	Access doors	Refer to clause 3.2.3
3.1.5	Double socket outlet	Refer to clause 3.2.4
3.1.6	Mounting	Refer to clauses 3.2.5 and 3.2.6
3.2	Roadside cabinet	Refer to clause 3.3
3.2.7	Facility switch	Refer to clause 7.15
4.6	Communications equipment	Refer to clause 4.7
5.1.1.1	Display characteristics	Refer to clause 5.2
5.1.2	Display dimensional requirements	Refer to clause 5.3
5.1.4.2	Font shapes	Refer to clause 5.4
5.1.6	Display changes due to facility switch operation	Refer to clause 7.15
5.1.10	Conspicuity devices	Refer to clause 5.8
6	Operation and control	Refer to Section 7

TABLE 2.1 – Changes and clarifications to AS 4852.1

SECTION 3   MECHANICAL REQUIREMENTS

3.1   GENERAL

3.1.1   The design and construction of all structural steel work shall ensure compliance with the required design life specified in AS4852.1, Clause 2.2.

3.1.2   The internal components of the sign, such as pixel display modules, control units and heating and cooling equipment shall be arranged in modules of a size capable of being removed and re-installed in-situ by hand from the access walkway. The construction and layout of the cabinet, framework and electronic driver networks should facilitate this requirement.

3.2   SIGN ENCLOSURE

3.2.1   The general construction requirements for the sign shall comply with AS 4852.1, Section 3.1.

3.2.2   The **surface finish** of the rear of the sign enclosure shall be matt grey in accordance with AS 4852.1, Clause 3.1.2.

3.2.3   **Access doors** shall be hinged left or right in accordance with AS 4852.1, Clause 3.1.4.

3.2.4   A **double socket outlet** within the sign enclosure shall be provided for test equipment and other required sign use in accordance with AS 4852.1, Clause 3.1.5.

3.2.5   Where required by the sign manufacturer, facility to adjust the angle of the mounted sign shall be provided in accordance with AS 4852.1, Clause 3.1.6.

3.2.6   Where the sign optics have been designed for the sign to be installed vertical, the facility to adjust the sign is not required.

3.2.7   Where the design does not incorporate a covering window, details regarding matrix sealing, cleaning and other pertinent matters shall be provided by the supplier.

3.3   ROADSIDE CABINET

3.3.1   A roadside cabinet will typically be provided in accordance with AS 4852.1, Clause 3.2.

3.3.2   Preference is for a small pole mounted cabinet on the support structure for termination of incoming mains power and communications (where required) and to provide a connection for local control.

3.3.3   Where required, a ground mounted roadside cabinet shall be provided.

3.3.4   Ground mounted cabinets shall be either a Universal Roadside cabinet or an ITS Field cabinet.

3.3.5   Ground mounted cabinets shall be installed on a foundation as per the following:

- Where a Universal roadside cabinet is used, a foundation in accordance with standard drawing TC-1203.
- Where an ITS cabinet is installed, a foundation in accordance with standard drawing TC-2230.

3.3.6   A **facility switch function** shall be provided internally in the cabinet by manual switch or software switch. A physical facility switch accessible from the exterior of the cabinet shall not be provided.

3.4   SIGN SUPPORT STRUCTURE AND ASSOCIATED FOOTING

3.4.1   The sign support structure may be required to be supplied and installed as part of the works or may be provided by others.

3.4.2   Details of the requirements for supply and installation of the sign support structure shall be provided in individual contract documents.

3.4.3   See Appendix E for general information regarding support structures.

SECTION 4   ELECTRICAL REQUIREMENTS

4.1   GENERAL

4.1.1   The electrical system of the sign shall comply with AS 4852.1, Section 4.

4.1.2   Transformers used within the sign and/or sign control system shall comply with AS 61588.

4.1.3   All cables and wires shall be insulated with a material not inferior to V-90 grade PVC and shall be suitably labelled.

4.1.4   The electrical system shall incorporate the following facilities:

- A main switchboard located within the ground level Sign Controller cabinet to include a mains switch, a circuit breaker to protect the expected load of the complete VMS and a double socket outlet with integrated RCD.
- A sub-switchboard located within the VMS enclosure with a mains switch, a separate circuit breaker for each individual 240 volt circuit within the VMS.
- The VMS enclosure shall include as many socket outlets as is required for normal VMS operation, plus one extra double socket outlet for maintenance use. Each socket outlet shall include an integrated RCD.

4.2   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 ±15 %.

4.3   INTERNAL PROTECTION

All equipment including data lines shall be internally 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.

4.4   SIGN INTERNAL POWER DISTRIBUTION

4.4.1   Terminal strips are the preferred connecting arrangement for power distribution to the all internal components.

4.4.2 Where socket outlets are used to distribute power amongst the signs internal components, a suitable retaining arrangement shall be used to ensure that the plug-top cannot come loose from the socket outlet in normal operation.

4.5 POWER CONSUMPTION

4.5.1 VMS shall have a maximum power consumption of 200W per 3,000 LED's.

4.5.2 In-rush current at switch-on shall be not more than 4 times the normal peak operational current.

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

(a) Power usage per 3,000 LED's.
(b) Maximum power with all pixel illuminated.
(c) In rush current at switch on.

4.6 EMC COMPLIANCE

4.6.1 All equipment covered by this specification shall comply with EMC requirements as specified in AS 4852.1, Clause 4.5.

4.6.2 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 shown in Figure 5.

`Figure 4.1 - RCM compliance label**

4.7 COMMUNICATIONS EQUIPMENT

4.7.1 Modems shall meet the requirements of Technical Notice TCN 011 and be 'accepted' for use by DoT.

4.7.2 The type of modem to be used shall be specified in individual contact documents.

4.7.3 Typical modem types used for VMS include 3/4G, ADSL and fibre-optic.

SECTION 5   DISPLAY AND OPTICAL REQUIREMENTS

5.1   GENERAL

5.1.1   The sign shall comply with all requirements specified in AS 4852.1, Section 5.

5.1.2   Where a pictogram is specified, it shall comply with Section 6 of this specification.

5.1.3   Symbols generated on the sign shall comply with layouts approved by DoT.

5.1.4   This Section relates to the main text area of the VMS and does not relate to the pictogram area.

5.2   DISPLAY CHARACTERS

Sign size categories shall be applied for the prevailing approach speed as specified in AS 4852.1, Table 5.1 and Appendix B. For information, AS 4852.1, Table B1 has been reproduced in Table 5.1 below.

Sign size category	Minimum equivalent character height	Approach speed
A	200	≤ 60
B	320	>60 - <90
C	400	≥ 90

Table 5.1 – Display character size categories (from AS 4852.1 Table 5.1 and Table B1)

5.3   DISPLAY DIMENSIONAL REQUIREMENTS

5.3.1   The VMS text display shall be as specified in Table 5.2 below.

Display Resolution	Display pixels (wide)	Display pixels (high)	Reference
Standard	124	29	AS4852.1, Table 5.2
High	248	58	AS4852.1, Table 5.2
Maximum*	256	128	STREAMS

Table 5.2 – Display dimensional categories (from AS 4852.1 Table 5.2)

* This resolution shall only be used where specified in individual contract documents.

5.3.2   The resolution of 372 X 87 pixels (triple resolution) as specified in AS 4852.1, Table 5.2 shall not be used as this is outside the operational parameters of STREAMS.

5.3.3   The dimension of the housing shall be the minimum practical required to house the specified display.

5.4 CHARACTER FORMATS

5.4.1 Character formats and fonts shall conform to the requirements of AS 4852.1, Clause 5.1.4.

5.4.2 Standard operation of the sign shall permit the generation of default Font 2 characters as specified in AS 4852.1, Clause 5.1.4.1.

5.4.3 In addition to the standard operation, the sign shall be capable of generating:

(a) double stroke characters; and
(b) various fonts and proportional spacings.

5.5 DISPLAY CHANGES

5.5.1 Standard display changing shall comply with AS 4852.1, Section 5.1.5.

5.5.2 The total time for standard display changing shall not be greater than 0.5 seconds. Successive flashing of any display shall occur at a rate of 0.5 second on and 0.5 second off.

5.6 COLOUR SIGNS

5.6.1 Colour signs that generate the colours specified in AS4852.1, Table 5.5 are acceptable provided they comply with all photometric requirements of AS4852.1 and comply with the following requirements.

Note: The use of other colours is only allowed where approval is provided by the Network Design Team and for the specified application.

5.6.2 Colours may be generated by the use of 4-colour LED's or RGB LED's as shown in AS4852.1, Figure 5.3.

5.6.3 Where RGB LED technology is used, the LED's shall be:

(a) single package, three chip LED's.
(b) 'filtered' through a lens or other optical system or otherwise designed to provide the observer with a single pixel to view, that produces a true colour without any visibility of the individual LED's used to generate the colour pixel.

5.6.4 Where coloured LED's are used, they shall have a service life rated at not less than 10 years as specified in AS4852.1, Clause 5.1.1.4. During this service, life any degradation of any single LED (i.e. red, green or blue) shall not cause the displayed colour to shift outside the chromaticity coordinates specified in AS4852.1, Table 5.6.

5.6.5 RGB signs shall be capable of being programmed to prevent any other colours other than red, yellow, green and white being displayed.

5.7 GRAPHICS REQUIREMENTS

For signs with a higher resolution than standard, it is preferred that graphic images are displayed on the main display without the requirement for a separate pictogram display.

5.8 SIGN DIMMING CONTROL

5.8.1 The sign shall have the ability to dim the light output intensity of its display to comply with AS 4852.1, Section 5.1.9.

5.8.2 The supplier shall submit details of the peak normal and dimmed operational loads at the time of tender.

5.9 CONSPICUITY DEVICES

Conspicuity devices are not used.

5.10 LED PIXEL LIFESPAN REQUIREMENTS

The lifespan requirements for LED pixels outputs shall be in accordance with AS 4852.1, Clause 5.1.1.5 and Appendix D of this specification.

SECTION 6   COLOUR PICTOGRAM

6.1   GENERAL

6.1.1   Where specified in individual tender documents, C-size, standard resolution, monochrome VMS shall incorporate a pictogram display region mounted to the left of the text area of the sign as shown in Figure 6.1.

6.1.2   The pictogram region shall be a four colour (red, yellow, green and white) display.

6.1.3   The four colours shall typically be generated using individual red, yellow, green and white LED's.

6.1.4   As far as practicable, there shall be no visible delineation or border between the pictogram and text regions of the display. See Figure 6.1.
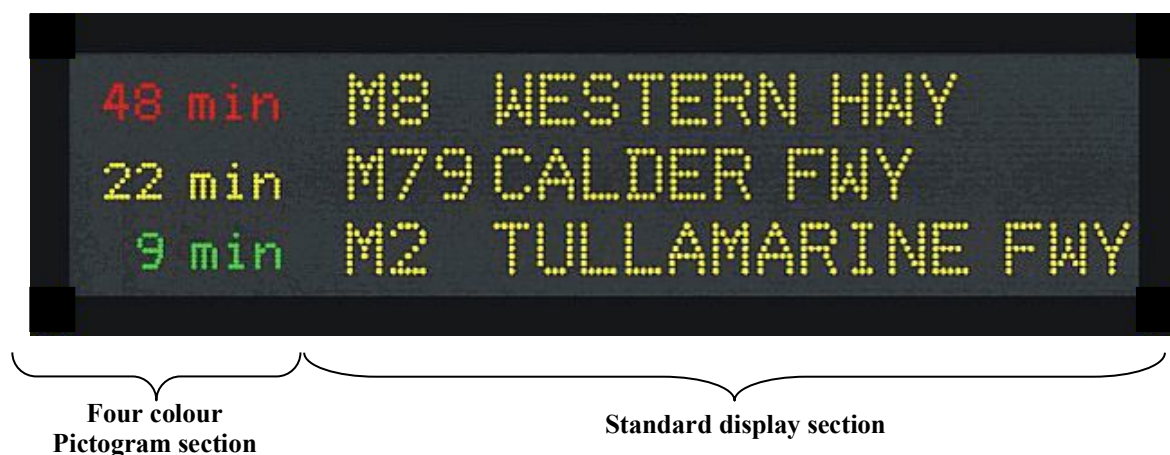
Figure 6.1 – Layout of VMS with pictogram

6.1.5   The pictogram shall operate according to TfNSW protocol ITSM-TO-ITS-CSI-002 Colour Sign Interface to provide pixel colour outputs of red, yellow, green and white (see Appendix B).

6.2   PICTOGRAM DISPLAY REGION

6.2.1   The pictogram display region of the sign shall be square in shape with 64 evenly spaced pixels both horizontally and vertically.

6.2.2   The pixels shall have a height to width ratio of 1:1.

6.2.3   The overall height of the pictogram region shall be the same as the text region.

6.2.4   The pictogram display shall be capable of displaying traffic conditions for up to three destinations. A typical display arrangement is shown in Figure 4.1.

6.2.5   The travel times shall be capable of displaying traffic conditions as follows:

    (a)   Green to indicate light traffic conditions.
    (b)   Yellow to indicate medium traffic conditions.
    (c)   Red to indicate heavy traffic conditions.

6.3   PICTOGRAM OPTICAL REQUIREMENTS

6.3.1   Optical Requirements

6.3.1.1   The optical requirements shall comply with AS 4852.1, Clause 5.2.

6.3.1.2   The photometric test procedures shall comply with AS 4852.1, Appendix C.

6.3.2   Colormetric Requirements

6.3.2.1   The colormetric requirements shall comply with AS 4852.1, Clause 5.2.4.

6.3.2.2   The colormetric test procedures shall comply with AS 4852.1, Appendix D.

6.3.3   Lifetime Performance Requirements

The lifetime performance requirements for LED pixels outputs shall be in accordance with Appendix D of this specification.

6.4   DISPLAY CHANGES

6.4.1   The complete sign shall be capable of displaying single frames on:

- the text and pictogram regions simultaneously.
- the text region only.
- the pictogram region only.

6.4.2   The complete sign shall be capable of displaying multi-frame messages on:

- the text region only.
- the pictogram region only.

6.4.3   Where the text display region is displaying a multi-frame message, the pictogram region shall display a static pictogram.

SECTION 7   OPERATION AND CONTROL

7.1   GENERAL

7.1.1   A communication link to the sign, as specified in the tender documents, shall be provided in accordance with AS 4852.1 Section 6 and the following requirements.

7.1.2   The sign shall be capable of the following:

(a) Displaying instantaneous messages downloaded from any third-party controlling device connected to the serial port or Ethernet port, which will temporarily override any current displays, strings or scheduling until the instantaneous messages are completed.
(b) Displaying frames in different appearance modes.
(c) Displaying any approved font, graphic or display which fits into the given matrix, irrespective of what pixels are on or off.
(d) Provide a list of alarms and reporting procedures.

7.1.3   This section on operation and control assumes the inclusion of the pictogram as specified in Section 6 of this specification.

7.2   SIGN CONTROL PERFORMANCE AND CAPABILITY

7.2.1   The sign shall be used for travel time information displays and the message will be updated every two minutes. Therefore, the sign shall have the capability to support writing at least 900 messages a day.

7.2.2   The DoT (Roads) control system uses frames numbers from 200 to 255 for displaying those frequently updated messages.

7.2.3   The response time (the latency from when DoT (Roads) 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 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) shall be less than 2 seconds.

7.3   SIGN CONTROLLER (SC)

7.3.1   The text region and the pictogram region (where required) shall each have a separate sign controller. The pictogram section is intended to display a static message (such as travel times, roadworks symbol, vehicle crash symbol).

7.3.2   Under normal operation, each sign controllers main purpose is to provide both serial and Ethernet interfaces to a third-party controlling device, over which TfNSW protocol shall be transmitted in order to control the mono-colour text region, and a 4 colour pictogram region if required, of the connected VMS.

7.3.3   The sign controller(s) shall be designed to be installed within a standard 19'' rack.

7.3.4 An alternative cabinet may be considered provided it is designed to be mounted onto the standard VicRoads cabinet foundation.

7.3.5 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.

7.3.6 If the sign has a text and a pictogram region, the Sign Controller shall ensure:

(a) If both regions are failed, not to display any messages on either region.
(b) If the pictogram region is failed but the text region is working, continue to display the message on the text region.
(c) If the pictogram region is working, but the text region is failed, not to display any messages on either region.

7.3.7 All of the controller's communication and power interfaces shall be clearly and indelibly labelled on the controller housing.

7.4 ADMINISTRATION AND CONFIGURATION TOOL

7.4.1 The **sign controller** shall provide an interactive browser-based user interface using HTTP and HTTPS to provide monitoring, configuration and diagnostic related functions.

7.4.2 Providing a Command Line Interface (CLI) based configuration interface is not mandated, however, if provided, the interface shall:

(a) Support key-based and password authentication, with the capability to disable password authentication
(b) SSH v2.x shall be required (SSH v1 shall not be used)
(c) 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.

7.4.3 The **software** shall provide for the display and monitoring of the sign controller configuration, including:

(a) Site Name
(b) Firmware version
(c) Current Temperature of the controller
(d) Main Power Supply status
(e) Backup Power Supply Status (if one exists)
(f) Up Time (since last reset)
(g) System time (Local date and time)
(h) MAC Address(es) of all Ethernet port(s)
(i) Current Active Control Mode (Local, serial, TCP or any other mode if present)
(j) Facility Switch position
(k) All the signs connected to the controller and, for each sign, the following information shall be displayed:

    i. TfNSW protocol Group ID
    ii. TfNSW protocol Sign ID
    iii. Dimensions (in pixel)
    iv. Luminance dimming control mode (Auto, Time based or Fixed)
    v. Current Luminance dimming level

vi.   TfNSW Protocol Session Status (Online / Offline)

vii.   TfNSW Protocol Display Mode (Message, Frame or Plan)

viii.   TfNSW Protocol Display Message Number/Frame Number/Plan Number

ix.   Current Sign firmware version

7.4.4   **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.

(a) **The Site Name** – Text field with minimum 150 characters.

(b) **Control Mode** – The software shall allow a user to choose an active control mode from the following:

    i.   **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.

    ii.   **Serial** – When this mode is enabled, the master (refer to TfNSW protocol section 2.1) software can connect to sign controller via serial connection, and control the sign using TfNSW 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 TfNSW 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.

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

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

7.4.5   **Network configuration** – The software shall allow a user to change the following network configurations:

(a) IP address allocation (DHCP or static).

(b) If the IP address allocation is static – the following parameters: IP Address, Subnet Mask, Default Gateway, Primary DNS and Secondary DNS.

7.4.6 **TfNSW Protocol Configuration** – The software shall allow a user to change the following TfNSW Protocol and communications related configuration parameters:

(a) IP Port used for TCP/IP connection.
(b) Session time out for TCP/IP connection (in seconds).
(c) Security settings for TCP/IP connection (such as switch between no encryption and TLS encrypted, TLS port to be used).
(d) Baud rate, Data bits, Parity and Stop bits for serial connection.
(e) Session time out for serial connection (in seconds).
(f) Seed offset (in Hex).
(g) Password offset (in Hex).
(h) Polling Address.
(i) Broadcast Address.
(j) 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.).
(k) Sign ID and Group ID (For individual signs).

7.4.7 **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:

(a) Luminance Dimming control mode (Auto, Time Based or Fixed). Three modes are defined in AS 4852.1 – 2009 Section 3.11.
(b) The controller shall have pre-defined '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.
(c) Fixed Dimming Level (in 'Fixed' mode only).

7.4.8 **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.

7.4.9 **Security** – The software shall:

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

7.4.10 **Control and Testing** – The software shall allow a user to perform local control and display test patterns functions specified in Section 7.13 for Local Control and 7.17 for Display Test Patterns of this specification.

7.4.11 **Administration** – The software shall provide the following administration functions.

7.4.12 Firmware upgrade

(a) The software shall allow a user to the 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.

(b) The software shall allow a user to upgrade firmware for individual signs that are connected to the sign controller.

(c) The system shall ensure that the entire firmware file is successfully downloaded before attempting to apply the firmware upgrade.

7.4.13 Save /recover configuration to/from file.

(a) All of the configuration parameters for the controller shall be able to be saved and retained after rebooting the controller.

(b) 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.

7.4.14 Reboot and Reset.

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

(a) Reset to manufacturer default.

(b) Reset to manufacturer default, except for the current network configuration (IP addresses, network mask, default gateway, etc).

(c) Reboot the controller with all configuration maintained.

7.4.15 Reports/logs

The software shall provide separated log files, one for TfNSW 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 text or CSV format files.

7.4.16 System event logs

The software shall log the following system events as minimum:

(a) Controller and sign fault events.

(b) TfNSW protocol connection events (only require connection and disconnection events).

(c) 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.

7.4.17 TfNSW command logs

The software should log every TfNSW protocol commands and response between the master software and the controller for the last 30 days or 5000 messages. Each log shall contain:

(a) Message direction (from the master to the controller or vice versa).

(b) A timestamp with resolution to 1ms (The time the commands received or the response sent).

(c) The actually message detail in a Hex string.

7.4.18 Non-functional requirements

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

(b) **Security -**

 i. The software shall verify the username and password before granting access to the system.
 ii. 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'.
 iii. Only TLS shall be used for the HTTPS connection.
 iv. The current VicRoads document 'Information Security Standard: Cryptographic Controls' shall be complied with.
 v. After three successive failed login attempts, the minimum time allowed between login attempts shall be changed to 60 seconds.

(c) Bandwidth /network requirement

The software shall be designed to run on a relatively slow IP network, such as 3G 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.

7.5   RESET

7.5.1   On reset or reboot of the sign controller and/or VMS (regardless of source), the VMS's display shall be set to blank.

7.5.2   The sign controller shall incorporate a reset button accessible on the front chassis. The reset button shall perform a soft reset the SC & Connected VMS. All configurations within the SC and VMS shall be maintained.

7.5.3   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.

7.6 SIGN CONTROLLER PARAMETER DEFAULT SETTINGS

The default settings for key parameters within the SC shall be as shown in Table 7.1.

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	STATIC IP: 192.168.30.1 Mask: 255.255.255.0
TfNSW over, TCP/IP	TCP port numbers for TfNSW protocol connection	No encryption TCP: 43000 TLS encrypted TCP:43002 Default: no encryption
Default TfNSW address	TfNSW 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: TCP 80 HTTPS using TLS: TCP 443
Telnet	TCP port number used for connection to the CLI	TCP 6368
Control Mode	Default controller TfNSW control mode	TCP
Luminance Dimming Control Mode	Default Luminance Dimming Control Mode	Auto
TfNSW TCP Time out	Session time out for TCP/IP connection (in seconds)	300
RTA 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 RTA/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 7.1 – Sign controller key parameters

7.7 ETHERNET

7.7.1 The SC shall provide at least one 10/100 TX Ethernet interface. The Ethernet interface shall support the modes of communication and protocols detailed in Sections 7.8, 7.9 and 7.10 of this specification.

7.7.2 A Cat6 Ethernet cable shall be used to connect the SC to the network switch. The length of the Cat6 Ethernet cable shall not exceed 100m.

7.8 TFNSW PROTOCOL FOR SIGN CONTROL

7.8.1 The operation of the sign shall be controlled by means of the TfNSW 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 TfNSW specification TSI-SP-003 "Communications Protocol for Roadside Devices" current version 2.1.

7.8.2 Remote control of the sign shall be facilitated via STREAMS.

7.8.3 In order to implement the 4-colour operation of the VMS pictogram element, extensions to the default TfNSW protocol message suite as defined by VicRoads (provided in Appendix B) will be required. The TfNSW specification for this is ITSM-TO-ITS-CSI-002 Colour Sign Interface.

7.8.4 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 TfNSW protocol specification.

7.8.5 The sign controller shall support all fault logging and diagnostic functionality provided by the TfNSW protocol.

7.8.6 TfNSW "Heartbeat Poll" messages from the controlling device shall be serviced by the sign controller within 0.5 seconds of reception of the heartbeat request.

7.8.7 The sign controller may also support customised messages for special functions. In this case, such messages shall be in TfNSW 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 TfNSW protocol messages for integration with 3rd party software vendors.

7.8.8 The sign controller shall fully implement all defined TfNSW protocol layers including error checking as described in the TfNSW protocol specification, and with changes as described in Appendix B of this specification.

7.9 OTHER PROTOCOLS

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

  (a) ICMP (ping).
  (b) NTP (to set & maintain the SC / VMS 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 TfNSW 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.*

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

7.9.2   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.

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

(a) The control system shall be the client and the sign is the server.
(b) The focus is on communication privacy and integrity, therefore, neither client nor server authentication is required.
(c) 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.
(d) The sign controller shall perform as a TLS server endpoint and does not need to authenticate the client.
(e) TLS v1.2 shall be supported.

7.10   HARDWARE SERIAL PORTS:

7.10.1   The SC shall provide a minimum of two hardware serial ports with standard DB-9 connectors. Each of the ports shall correspond to the text and pictogram elements respectively and shall provide control of these sign elements using TfNSW protocol.

7.10.2   Both of the serial ports shall function in accordance with Table 7.2:

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

Table 7.2 – Serial port function

7.11 DIAGNOSTIC FUNCTIONS

7.11.1 The sign controller shall monitor the fault status of the connected VMS and provide this fault information through appropriate TfNSW 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 sign controller is temporarily lost. Such buffered events shall be made available to the controlling device when requested upon communications resuming.

7.11.2 Diagnostics functions shall be provided to monitor the text and pictogram VMS display elements, as well as the sign's internal subsystems. All diagnostic information and logs shall be accessible using TfNSW protocol through each of the sign controller's serial communications interfaces and Ethernet interface.

7.11.3 As a minimum, the sign controller shall monitor the following:

(a) The loss of communications between the SC and the VMS display elements.
(b) The loss of mains power to the VMS.
(c) Pixel check* results for the connected VMS‡.
(d) Sign temperature (i.e. over-heat/cool status).
(e) Ambient light sensor failure.
(f) All other VMS / SC subsystem fault conditions.

7.11.4 Where a standard format for any given fault report is not defined by the TfNSW protocol, the format shall be fully documented and disclosed to DoT (Roads) for integration with 3rd party systems.

7.11.5 All faults shall be detected and logged for reporting within thirty (30) 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.*

7.12 MONITORING, FAULT LOGGING AND REPORTING

7.12.1 The control functions of the sign shall be capable of monitoring the operation of the sign in accordance with AS 4852.1 Clause 6.7.

7.12.2 The VMS shall automatically respond to faults according to Table 7.3 below.

	Failure types	Responses	RTA Error code to be used
i.	Where mains power is lost to the SC OR the VMS itself.	▪ The entire display area of the VMS 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.	▪ The entire display area of the VMS 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.	▪ The entire display area of the VMS 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 the SC and the VMS itself is lost or adversely affected.	▪ The entire display area of the VMS shall be completely blanked. ▪ Create a log in the SC detailing the specific type of communications failure to the VMS sign .	Controller Err Code: 05
v.	Where internal faults are detected within the SC and/or VMS itself, i.e. watchdog timeout etc.	▪ The entire display area of the VMS shall be completely blanked. ▪ Create a log in the SC specifying the nature of the failure.	Error Code from Appendix C of TfNSW protocol as appropriate
vi.	Where 10 percent or more of Led's in either the pictogram display and/or the text display elements of the VMS have failed OR have become faulty* OR are affected to the extent that the resultant displays may be confusing to the public.	▪ The entire display area of the VMS shall be completely blanked. ▪ Create a log in the SC of the type & extent of the LED failure(s).	Controller Err Code: 08

Table 7.3 – Fault Responses

7.13 LOCAL CONTROL

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

7.13.2 The Ethernet interface shall provide the sign with:

(a) at least one IEEE 802.3 10/100 BaseTX Ethernet interface with RJ-45 socket connection.
(b) support for DHCP or static IP addressing.
(c) sign management and configuration via Ethernet using SSH or http/https protocol.

7.13.3 The sign shall be capable of being programmed in accordance with AS 4582.1, Clause 6.5.

7.13.4   The software for local operation shall be capable of the following facilities:

    (a)   Word wrap.
    (b)   Auto centring.
    (c)   Auto placing of text on screen.

7.13.5   The above features shall be incorporated together with all display changing parameters as detailed in Section 3.

7.13.6   The frames and/or message strings produced locally shall be capable of being directly displayed on the sign, over-riding the current scheduled program.

7.14   REMOTE CONTROL

7.14.1   Standard operation of the sign shall be via a remote system as defined in AS 4852.1, Clause 6.3.

7.14.2   The sign controller shall be able to be controlled via either serial connection or Ethernet connection by using TfNSW protocol via STREAMS.

7.14.3   The communications link between the host computer and the VMS 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.

7.15   MANUAL OVERRIDE FACILITY SWITCH FUNCTION

7.15.1   Further to AS 4852.1 an external facility switch shall not be provided. Rather, a facility switch 'function' shall be provided to enable local, manual override control over the sign display.

7.15.2   The facility switch 'function' may be provided by either a hardware or software switch.

7.15.3   The facility switch 'function' shall be located within the roadside cabinet and shall not be accessible externally on the cabinet.

7.15.4   The switch shall provide for three display modes as detailed in Table 7.4.

OFF	VMS display completely blank
TEST	The VMS shall display the chequered test pattern on both the text and pictogram display elements – the pictogram pattern shall consist of 4 colours in accordance with Section 2.18 of this specification.
AUTO	VMS to operate normally

Table 7.4 – Facility switch positions

7.15.5   The switch shall only switch extra low voltage.

7.15.6   The switch shall not switch low voltage.

7.15.7   The sign controller shall report the current position of the facility switch through a status reporting mechanism using RMS protocol and through the sign controller's text-based menu (CLI)

7.16   FALL-BACK SYSTEM

The sign shall incorporate the ability to fall back to a pre-defined operation mode when a major system failure occurs in accordance with AS 4852.1, Clause 6.8.

7.17   DISPLAY TEST PATTERNS

7.17.1   The sign shall be capable of generating test patterns on both the text and pictograms sections of the sign.

7.17.2   The test patterns shall include, as a minimum, the following specified sections showing:

  (a)   all pixels off;
  (b)   all pixels on; and
  (c)   a chequered pattern where no two adjacent pixels are on.

7.17.3   For RGB displays, and in the pictogram section (where provided), the above test patterns shall be cyclically displayed in each of the four colours (red, yellow, green and white), one colour at a time. The transition time between colours shall be 3 seconds.

7.18   FIRMWARE UPGRADE

7.18.1   The sign controller shall provide a facility to remotely upgrade the firmware of the VMS display elements, and the controller itself.

7.18.2   The upgrade process shall first require the sign controller command line interface password to be correctly entered.

7.18.3   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.

SECTION 8   DOCUMENTATION

8.1   DOCUMENTATION

The following shall be supplied with every VMS in both hard copy and soft copy:

(a) Overview of the sign design and layout.
(b) Overview of the sign software.
(c) Full documentation of the sign software and firmware.
(d) Structural drawings.
(e) Complete wiring diagrams.
(f) List of all major components and sub-components.
(g) Operation and maintenance manual including routine maintenance requirements and fault-finding methodology.
(h) Proposed maintenance plan.
(i) Recommended list of spare parts for maintenance.

SECTION 9 INSTALLATION AND COMMISSIONING

9.1 GENERAL

All works associated with pre-installation testing, installation and commissioning shall be carried out in accordance with the requirements of individual contract documents, Standard Sections 732 and 736, and this specification.

9.2 PRE-INSTALLATION TESTING

9.2.1 Prior to installation of the VMS in the field, all required testing shall be carried out in accordance with Standard Section 736.

9.2.2 The above pre-installation tests shall include the following:

(a) Factory acceptance test (FAT) in accordance with 736.07(b).
(b) Off-site Proof of Performance Testing (Pre-POP) in accordance with 736.07(c).
(c) Off-site Subsystem Integration Testing (Pre-SIT) in accordance with 736.07(d).

9.3 INSTALLATION

The Contractor shall carry out all works necessary for the proper installation and operation of the VMS in accordance with individual contract documents, this specification and Standard Section 732, including communication with the DoT (Roads) STREAMS system.

9.4 CCTV CAMERA

9.4.1 If possible, a VMS should be located in a position that enables it to be viewed using an existing DoT (Roads) VicRoads CCTV camera.

9.4.2 Where a new CCTV camera is to be installed, it shall be installed in accordance with VicRoads specification TCS 067, Digital CCTV Camera.

9.5 MAINS POWER SUPPLY

The contractor shall submit all necessary paperwork to the appropriate electrical distribution company and provide copies to DoT (Roads).

9.6 COMMUNICATIONS

On receipt of clearance from the communication provider, the contractor shall connect the communication line to the VMS.

9.7 COMMISSIONNG

9.7.1 Following the installation of the VMS in the field, commissioning and all required testing shall be carried out in accordance with Standard Section 736.

9.7.2 The commissioning and post-installation tests shall include the following:

(a) Proof of Performance Testing (POP) in accordance with 736.07(f).
(b) Subsystem Integration Testing (SIT) in accordance with 736.07(g).
(c) System Acceptance Testing (SAT) in accordance with 736.07(h).
(d) Integration Testing in accordance with 736.09.
(e) Operational Performance Testing (OPT) in accordance with 736.07(i).

9.7.3 CCTV cameras shall be tested and commissioned in accordance with TC067.

9.7.4 The contractor shall apply the cabinet label with the site number to the roadside cabinet.

APPENDIX A – DOT (ROADS) ITS PLATFORM

(Informative)

A1 GENERAL

A1.1 DoT (Roads) ITS platform currently uses the STREAMS system.

A1.2 STREAMS is owned and maintained by Transmax, a Queensland based company which is part of Queensland Main Roads.

A1.3 STREAMS is an integrated control system which is being used by DoT (Roads) to operate ITS Freeway Management Devices on its 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 Control Signs (LCS)

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, a virtual FP may be located at a DoT (Roads) facility.

APPENDIX B – DOT (ROADS) EXTENSION TO TfNSW PROTOCOL FOR VMS

(Normative)

B1   INTRODUCTION

B1.1   This appendix defines requirements for sign controllers to implement TfNSW protocol (TSI-SP- 003 ver2.1) as the communication protocol between Variable Message Signs and the DoT (Roads) ITS Central Control System. Note that the protocol used by DoT (Roads) is based on v2.1 of TSI-SP-003 instead of the newer version 3.1.

B1.2   The definitions for handling colour is based on an TfNSW protocol document (ITSM-TO-ITS-CSI-002) that describes the extensions to the base TfNSW protocol.

B2   GENERAL IMPLEMENTATION REQUIREMENTS

B2.1   Sign controllers shall utilise TfNSW Protocol - 'Communication Protocol for Roadside Devices' Specification No. TSI-SP-003 version 2.1 as the communication protocol for STREAMS to monitor and control the signs.

B2.2   The sign controller shall fully implement all defined protocol layers as described in the TfNSW protocol with following exceptions:

- The serial connection defined in section 3.2 Physical Link and section 3.3 is not the only valid physical link. The sign controller shall also support running TfNSW protocol over Ethernet via a TCP/IP Socket. When Ethernet is being used, the sign controller shall run as a TCP/IP Socket server and the DoT (Roads) Central Control System will run as TCP/IP Socket client.
- For security reasons, the sign controller shall support TfNSW protocol messages being transmitted with no encryption or encrypted with TLS.
- The current DoT (Roads) 'Information Security Standard: Cryptographic Controls' shall be complied with.
- Application messages for HAR and Weather Systems (MI code 40-48 and 80-87) defined in the protocol are not required to be implemented.

B2.3   CRC calculation.

There are two places in the protocol requires CRC calculation.

- CRC calculation is required for every message as a part of the full data packets, which is defined in the protocol section 3.3.2.3. **Note**: Transmitted data (i.e. ASCII-HEX encoded data as defined in section 3.3.1) is to be used for this CRC calculation.
- CRC calculation is also required for some of the Application Layer messages, such as 'sign set text frame' and 'Sign set graphics frame'. **Note**: Message data (i.e. Not ASCII-HEX encoded data) is to be used for this CRC calculation.

Example:

The message example in Appendix D of the protocol contains both application message level CRC and data packet level CRC.

Here is the message in Hex (before ASCII-HEX encoded)

<SOH>00 00 02<STX> 0A 4A 08 05 03 01 09 53 4C 4F 57 20 44 4F 57 4E C8 B7 BE 44 <ETX>

- C8B7 is the application message CRC, which is calculated on other hex data in the same application message, i.e. "0A 4A 08 05 03 01 09 53 4C 4F 57 20 44 4F 57 4E", total 16 bytes.

- BE44 is the data packet CRC, which is calculated on ASCII-HEX encoded data in the packet except the <ETX> control byte and the CRC bytes them self, i.e. "<SOH>00 00 02<STX> 0A 4A 08 05 03 01 09 53 4C 4F 57 20 44 4F 57 4E C8 B7" convert to ASCII-HEX, which is "01 30 30 30 30 30 32 02 30 41 34 41 30 38 30 35 30 33 30 31 30 39 35 33 34 43 34 46 35 37 32 30 34 34 34 46 35 37 34 45 43 38 42 37", total 44 bytes. (<SOH> & <STX> are control characters, not required to be ASCII-HEX encoded)

B2.4   Further to section 3.5 of that protocol specification, here is another message exchange example:

	System to Sign Controller	Sign Controller to System	Notes
1	START SESSION	ACK Password seed	Request to start session from central system to sign
2	PASSWORD (N(S)=0, N(R)=0)	ACK (N(R)=0) Acknowledge (N(S)=0, N(R)=0)	Password accepted, link established, sign is online
3	Heartbeat Poll (N(S)=0, N(R)=0)	ACK(N(R)=1) Status reply (N(S)=0, N(R)=1)	
4	Extended Status Request (N(S)=1, N(R)=1)	ACK(N(R)=2) Extended Status Reply (N(S)=1, N(R)=2)	
5	Heartbeat Poll (N(S)=2, N(R)=3)	NAK (N(R)=2)	Incorrect N(R) sent by system to sign results in a NAK
6	Heartbeat Poll (N(S)=2, N(R)=2)	ACK(N(R)=3) Status reply (N(S)=2, N(R)=3)	Corrected
7	Heartbeat Poll (N(S)=4, N(R)=3)	NAK (N(R)=3)	Incorrect N(S) sent by system results in a NAK
8	Heartbeat Poll (N(S)=3, N(R)=3)	ACK(N(R)=4) Status reply (N(S)=3, N(R)=4)	
9	End session (N(S)=4, N(R)=4)	ACK(N(R)=5) Acknowledge (N(S)=4, N(R)=5)	Sign is offline

Message exchange example

B2.5   Usage of 'revision' field in Application Layer Messages.

There is a 'Revision' field in some of the Application Layer messages, such as 'Sign Set Text Frame' and 'Sign Set Graphics Frame'. It is valid for the DoT (Roads) Central Control System not to update this field value when sending those messages to the sign controller i.e, the DoT (Roads) Central Control System can use '0' as the 'Revision' field value.

B2.6   DoT (Roads) Variable Message Signs are to be interpreted as 'graphics Signs' when using the protocol.

For example, when the sign controller sends message 'Sign Extended Status Reply', 'number of rows/columns of pixels' shall be returned for fields of message position 25 and 26.

B2.7   When the current session ends, the sign(s) should be blank.

B3   SPECIFIC IMPLEMENTATION FOR FREEWAY VMS WITH TWO DISPLAY REGIONS

B3.1   This section defines the specific requirements for implementing TfNSW protocol for Freeway VMS with two regions – a pictogram display region and a text display region.

B3.2   TfNSW protocol TSI-SP-003 does not include support for one sign controller that is connected to a sign with two display regions that have different pixel dimensions. To continue using TSI-SP-003, new messages are proposed to be added to the RMS protocol to handle this type of sign referred to as a "composite sign".

B3.3   ~~There are two specific requirements:~~

~~a) In general, both regions (the pictogram region and the text region) shall be in sync operating as one large message sign. i.e. where the text display region and the pictogram region are both displaying a multi-frame message, the timing of the display of individual frames on both regions shall occur simultaneously.~~

~~b) If the number of frames, transition times or frame display times are different between the pictogram and the text region, the synchronisation does not apply.~~

B3.4   New protocol messages for composite VMS

The following three new messages are proposed to support freeway composite VMS that have two display regions, a pictogram and a text region. For these new messages, a sign ID of 1 refers to the pictogram region, and an ID of 2 refers to the text region.

B3.4.1 Sign Set Composite Graphics Frame

This new message is identical to the TfNSW message Sign Set Graphics Frame (MI code 0x0B) from the document TSI-SP-003, except for the addition of the sign ID field. This message defines a frame for either the pictogram or the text region (for monochrome regions).

Position	Bytes	Value	Description
1	1	MI Code	E0h
2	1	BYTE	Frame ID – identifies the frame as it is stored in the sign controller's memory
3	1	BYTE	Revision - identifies the modification level of the frame
4	1	BYTE	Sign ID
5	1	BYTE	Number of rows of pixels in sign
6	1	BYTE	Number of columns of pixels in sign
7	1	BYTE	Colour
8	1	BYTE	Conspicuity devices
9	2	WORD	Length of graphics frame in bytes
11	Variable	BYTE	Graphics frame
...	2	WORD	Message CRC - calculated for all the bytes in the application message

B3.4.2 *Sign Set Composite Colour Frame*

This new message is identical to the TfNSW message Sign Set Colour Frame (MI code 0x1D) from the document TfNSW Colour ITSM-CSI-002, except for the addition of the sign ID field. This message defines a colour frame for either the pictogram or the text region.

Position	Bytes	Value	Description
1	1	MI Code	E1h
2	1	BYTE	Frame ID – identifies the frame as it is stored in the sign controller's memory
3	1	BYTE	Revision - identifies the modification level of the frame
4	1	BYTE	Sign ID
5	1	BYTE	Number of rows of pixels in sign
6	1	BYTE	Number of columns of pixels in sign
7	1	BYTE	Colour (red =1, green=2, blue=5)
8	1	BYTE	Conspicuity devices (**not used**)
9	2	WORD	Length of graphics frame in bytes
11	Variable	BYTE	Graphics frame
...	2	WORD	Message CRC - calculated for all the bytes in the application message

B3.4.3 Sign Set Composite Message

This new message is to define a display message to be stored in the sign controller's memory. It is similar to the RMS message "Sign Set Message", MI code 0x0C).

Position	Bytes	Value	Description
1	1	MI Code	E2h
2	1	BYTE	Message ID – identifies the message as it is stored in the sign controller's memory
3	1	BYTE	revision - identifies the modification level of the frame
4	1	BYTE	*Sign ID
5	1	BYTE	*transition time between frames (in seconds x 0.01)
6	1	BYTE	*Number of frame definitions (frame ID and frame ON time)
7	1	BYTE	*frame ID
8	1	BYTE	*frame ON time (in seconds x 0.1)

*field may be repeated depending on the number of signs attached to the sign controller
** field may be repeated depending on the number of frames in the message for a particular sign ID

The master software may define frames for only some of the signs that are attached to this sign controller. For example, only frames for the text region (sign ID 2) may be defined in a composite message. In this case, when a sign display message is requested, the sign controller will only display frames for the text region and blank the pictogram region (if a message was previously displayed).

In general, whenever a message is defined with frames for only some of the signs attached to this sign controller, the sign controller shall blank all the other signs that have no frames defined.

The following dot points from TfNSW -TSI-SP003 for Sign Set Message, section 3.6.3.13, also apply to this message definition, with changes as noted below.

- Message number 00 Hex cannot be changed and always means to reinstate the display from the current active plan or blank the sign if no plan is active
- A non-zero transition time shall cause a blanking of the complete display. Frames which are permanently on shall also be blanked.
- A message must contain at least one frame definition. A **sign ID** number of zero indicates that no more sign/frames (ID numbers and ON times) follow within the message. This allows a message to consist of only definitions for some regions of the sign.
- Length errors shall be reported by the sign controller where a message has no frame definitions or when a message is terminated by zero and further frames are defined afterwards.

B3.5 Error handling

a) The sign controller shall respond with error code 08 "MI Code not supported by device controller" for the following RMS protocol messages as they do not define a sign ID.

- Sign Set Graphics Frame (MI code 0x0B)
- Sign Set Message (MI code 0x0C)
- Sign Set Colour Frame (MI code 0x1D, from document RMS Colour ITSM-CSI-002)

b) When one or both regions fail and need to be blanked as specified in TCS-015, the Sign Controller shall ensure:

- If both regions are failed, not to display any messages on either region;
- If the pictogram region is failed but the text region is working, continue to display the message on the text region;
- If the pictogram region is working, but the text region is failed, not to display any messages on either region.

Note, in this situation, the master software may still send non-blank sign display commands to the sign controller, the sign controller shall decide to accept or reject the display commands based on the above requirements.

For the definition of 'failed' here, refer to Table 2.5 in section 2 of this document.

B3.6   Other requirements/notes

a) The protocol message 'Sign display frame' is not required to be implemented. The sign controller shall send back a 'Reject' response with error code '08h - MI Code not supported by device controller'.
b) Only Messages (not frames) can be defined in 'Set Set Plan' command, otherwise the sign controller shall send back a 'Reject' response with error code '02h –Syntax error in command'.
c) The sign controller is not required to respond to 'Sign Request Stored frame/Message/Plan' commands as specified in RMS protocol. The sign controller shall send back a 'Reject' response with error code '08h - MI Code not supported by device controller'.
d) From the comments portion of the 'Sign Set Message' definition in the RMS protocol, dot points 4, 5, 6 & 8 are not required to be implemented.

B4   SPECIFIC IMPLEMENTATION REQUIREMENTS FOR COLOUR DISPLAYS

B4.1   This section describes the DoT (Roads) implementation of the protocol used to interface with variable message signs that can display multi-colour messages.

B4.2   The protocol is based on the TfNSW protocol document ITSM-TO-ITS-CSI-002 that describes the extensions to the original protocol document for signs (TfNSW TSI-SP-003).

B4.3   The extensions to the protocol allow a multi-colour frame to be uploaded to a variable message sign. All other messages remain the same, and the sequence for displaying messages also remain the same. These extensions also limit the colours to be specified to the following four.

- Red
- Green
- Red + green = yellow
- Red + green + blue = white

B4.4   MESSAGE SEQUENCE AND PROCESS

As defined in the TfNSW protocol document, the sign will accept a new message, Sign Set Colour Frame, opcode 0x1D ("Colour" spelling is as per TfNSW) that will be used to specify a colour frame to the sign. As per the document: "Setting a multiple colour frame is done by setting three frames where each frame specifies a basic colour."

The implications of this process are as follows:

- If a particular colour is not supported by the sign, then the sign should return error "0x0c – Colour not supported by sign controller" (refer: TSI-SP-003)
- In order to use a colour graphic frame, all three colour frames must be set before that frame is used, for example in a "Sign Set Message" command. If a frame is attempted to be used before all three colour frames are set, the sign should return an error "0x13 – Frame, message or plan undefined"
- The sign should use the colour mixing formulas as above to determine what colour each sign pixel is.
- The sequence and timing of the definition of each colour frame is not important as long as all three frames are defined in a "Set Colour Frame" before that frame is used.

B4.5   COLOUR AND MONOCHROME FRAMES

a) The sign should not require or designate any particular frame to be colour or monochrome. A frame can change between colour and monochrome depending on the last graphic frame definition message.

(Note: monochrome frames can have colour, but only one colour for all lit pixels)

b) If the most recent frame definition message is "Sign Set Graphics Frame" (opcode 0xbh), then that frame becomes a monochrome frame for message display purposes. Similarly, if a "Sign Set Colour Frame" message is set for that same frame, then it becomes a colour frame, and will require all three frame colours to be defined before it can be used.

APPENDIX C - GENERAL REQUIREMENTS FOR TESTING

(Informative)

C1   GENERAL

This Appendix is included to provide a summary of the testing that is required for VMS and at what stage testing and test results are required.

For details of the tests see the references provided.

C2   TESTS REQUIRED AS PART OF TYPE APPROVAL SUBMISSION

The following tests and associated test reports are required to be submitted as part of any submission of a VMS for evaluation for DoT (Roads) type approval.

Test Type	References
Photometric	AS 4852.1, Section 5 Appendix F.2 of this specification
EMC	AS 4852.1, Section 4 Section 4.6 of this specification
Environmental	AS 4852.1, Section 7
STREAMS certification	Appendix A of this specification
Operation with TfNSW protocol	Appendix B of this specification

C3   PRE-INSTALLATION INTEGRATION TESTING

The following testing is required to be carried out as part of pre-installation integration testing.

Test Type	References
FAT	Standard Section 736.07(b)
Pre-POP	Standard Section 736.07(c)
Pre-SIT	Standard Section 736.07(d)

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C4   POST-INSTALLATION INTEGRATION TESTING

The following testing is required to be carried out as part of the post-installation integration testing.

Test Type	References
POP	Standard Section 736.07(f)
SIT	Standard Section 736.07(g)
SAT	Standard Section 736.07(h)

C5   OPERATIONAL PERFORMANCE TESTING

The following testing is required to be carried out during the first 90 days of operation as part of the post-installation operational performance test.

Test Type	References
OPT	Standard Section 736.07(i)

APPENDIX D - LIFETIME PERFORMANCE REQUIREMENTS

(Informative)

D1   SCOPE

The purpose of this test is to ensure that the degradation of the VMS unit is within acceptable limits. The test is designed to measure the deterioration in performance of the optical properties of the active elements as well as the deterioration in the optical properties of any transparent protective cover.

D2   REQUIREMENTS

The requirements are that:

- after 12 months operation in the field, the VMS shall demonstrate an optical performance as described in AS 4852.1, Clause 5.2 that is not less than 95% of the values determined at its initial compliance testing.
- after 36 months operation in the field, the VMS shall demonstrate an optical performance as described in AS 4852.1, Clause 5.2 that is not less than 85% of the values determined at its initial compliance testing.

D3   SAMPLE PREPARATION

D3.1   The sample provided at the time of the initial compliance testing will be taken and located outdoors in the same position as its intended use in the field. This will then be left to weather for 12 months. The intention is that the transparent protective cover be exposed to similar weathering conditions as the initially compliant VMS placed in the field. Consequently, it is not necessary that the discrete element module, initially provided in the casing, remains in the casing for the weathering exposure periods.

D3.2   After the initially compliant sign has been operating in the field for 12 months, a module is selected from the sign face and removed. This module is then placed in the weathered casing and the tests carried out as described in AS 4852.1, Clause 5.2.

D3.3   The casing is then placed outdoors again to continue weathering for a further 24 months, i.e. a total of 36 months.

D3.4   After the initially compliant sign has been operating in the field for 36 months, a module is selected from the sign face and removed (not the module that replaced the one that was removed at the 12 months period).   This module is then placed in the casing which has now been weathered for 36 months and the tests carried out as described in AS 4852.1, Clause 5.2.

D3.5   All tests shall be carried out on a sample test area not less than 100mm in diameter in accordance with Figure D1.

Emitters = Active segments
Element = Passive segments
Cell = Natural rectangle which surrounds emitters and element
thus gives basic unit dimension for a matrix

Measurement Area

B1 - Cell Spacing
C1 - Emitter spacing
D1 - Element spacing

If the emitters are not symetrical around the centre
of the cell, the horizontal and vertical equivelant
stroke width will be different

B - Cell
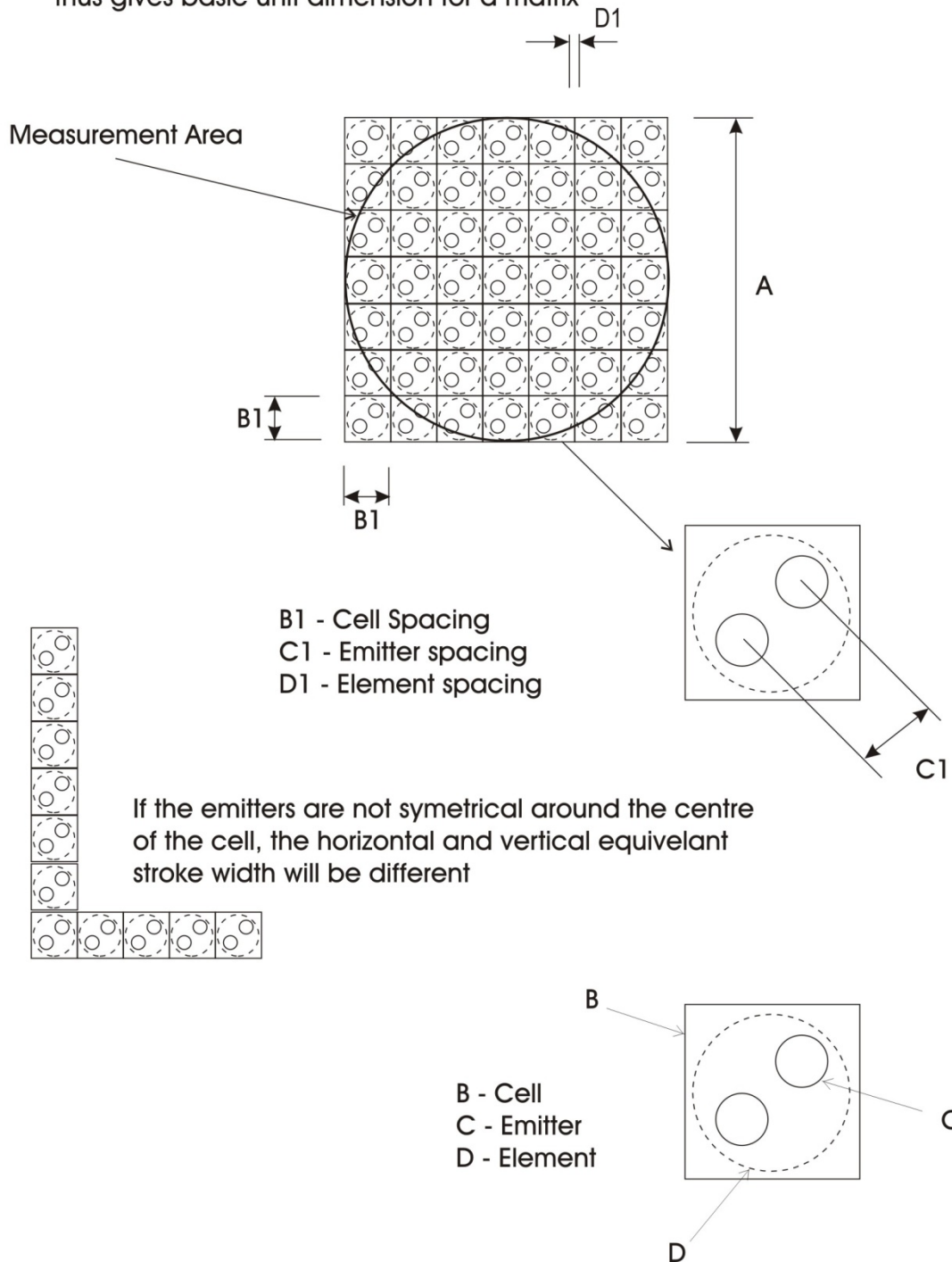C - Emitter
D - Element

Figure D1 – 100mm diameter test area

APPENDIX E – SIGN SUPPORT STRUCTURE

(Informative)

E1   SIGN SUPPORT STRUCTURE AND ASSOCIATED FOOTING

E1.1   Details of the requirements for supply and installation of the sign support structure shall be provided in individual contract documents.

E1.2   The sign support structure may be required to be supplied and installed as part of the VMS works or may be provided by others.

E1.3   Typically, VMS are mounted on one of the types of support structure detailed in Table E.1 below.

Support structure	Typical Road Type	Typical sign location	Typical sign attachment method
Accessible portal gantry	Managed Motorway or Freeway	Centre of carriageway	Rear of sign
Non-accessible portal gantry	Managed Motorway or Freeway	Centre of carriageway	Rear of sign
Cantilever gantry	Arterial Road	Side of carriageway over a lane	Rear of sign
Column	Arterial Road	Side of carriageway	Base of sign

Table E.1: Support structures and typical application

E1.4   Generally, the sign support structure and associated footing shall comply with:

- Bridge Technical Note BTN 014 (V2.1 November 2019) Code of Practice for Sign gantries and lighting masts (see the following link); https://www.vicroads.vic.gov.au/business-and-industry/technical-publications/bridges-and-structures
- AS 5100 Bridge Design.

E1.5   Where the support structure is supplied and installed by the VMS supply contractor, the support structure shall be proof engineered by a DoT pre-qualified engineering consultant.

E1.6   All power supply, control and communication cabling shall be routed internally through the gantry or support column and shall enter the sign enclosure through appropriately constructed and sealed entry holes

E2   SIGN ACCESS PLATFORM

E2.1   Where specified in individual contract documents, the sign support structure shall include rear access to the signs integral components via a fixed access platform complying with the requirements of AS1657:2019.

E2.2   Access to the platform shall typically be via a ladder complying with the requirements of AS1657:2019.

E2.3   Typically, sign access platforms for:

- **Accessible portal gantries** shall typically be supplied by others as part of the gantry.
- **Non-accessible gantries** shall typically be supplied by others as part of the gantry.
- **Cantilever gantries** shall typically be supplied with the VMS.
- **Column mounted** VMS shall typically be supplied with the VMS.

E2.4   Details of the access platform and who is supplying it will be provided in individual contract documents.

E2.5   Where the sign is mounted on a single or double column, a mower strip not less than 1 metre larger than the base projection of the support column shall be installed around the base of the column(s).

APPENDIX F - REQUIREMENTS FOR TYPE APPROVAL

(Normative)

F1.   GENERAL

F1.1   Variable Message Signs shall be subjected to the following evaluation procedures for Type Approval. The issuing of type approval does not negate the requirement to comply with Section 9 of this specification and the requirements of Standard Section 736.

F1.2   To enable assessment for the purpose of granting type approval, the Supplier is to submit the following documentation:

   (a)   An outline drawing showing the general presentation and overall dimensions of the complete Sign.
   (b)   Specifications of LED's used.
   (c)   Details of how the required life expectancy of the LED's will be achieved.
   (d)   Documentation to demonstrate that the Sign conforms to the requirements of DoT (Roads) Specification. This shall include submitting all required test results and a clause-by-clause statement, with appropriate evidence, demonstrating that the product complies with this specification and the Australian Standard AS 4852.1.

F2.   REQUIRED NATA ACCREDITED TESTING

The supplier shall submit test results from a NATA accredited (or equivalent) testing organisation to demonstrate compliance with the following.

AS4852.1 Clause	Requirement
4.5.1	EMC – Immunity
4.5.2	EMC – Emissions
5.2.1	*Luminance and luminance ratio
5.2.2	*Luminance matching of colours
5.2.3	*Luminance intensity uniformity
5.2.4	*Chromaticity
7.1	Temperature and humidity
7.2	Enclosure protection

*Where a separate pictogram region is required, separate photometric tests shall be applied to this region in additional to the tests of the text region.

F3.   OTHER REQUIRED TESTING

DoT (Roads) may require additional information or testing to be carried out as part of its evaluation of the product.

F4. COMPATIBILTY WITH TfNSW PROTOCOL

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

F5. STREAMS COMPATIBILTY

The supplier shall provide evidence of compatibility with STREAMS.

F6. ASSESSMENT PROCEDURE

F6.1   The assessment procedure for a Variable Message Sign will include, but not be limited to, the following:

- Assessment of construction, workmanship and critical dimensions.

- Evaluation of the submitted data against the requirements of the specification.

- Operation of the sign using the manufacturer's software.

F6.2   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. The supplier is to state whether tests carried out prior to formal submission were carried out on an identical sample.

F7. 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.

F8 LIFETIME PERFORMANCE TESTING

DoT (Roads) may, at its sole discretion, require the supplier shall install a test module as described in AS 4852.1, Appendix C.1 in a suitable location for the purpose of conducting the lifetime performance testing as detailed in Appendix D of this specification.

If a module fails the meet the optical requirements at either of the specified time intervals, type approval may be withdrawn.

APPENDIX G - GUIDELINES FOR PURCHASING AND INSTALLATION

(Informative)

G1.   DETAILS TO BE CONSIDERED AND/OR INCLUDED WHEN TENDERING

When tendering, the following details should be considered and included in the tender document as required:

- Sign size required (i.e. A-size, B-size or C-size)
- If a C-size, monochrome sign, is a pictogram area required?
- Is a ground cabinet required for the Sign Controller or is it intended to be installed within an existing ITS Field Cabinet?
- Is the sign to be installed on existing gantry or supplied with support column(s)?
- Proof engineering if intended to be installed on support column.
- The point of supply – Is the Contractor required to supply and install the mains supply including cable, conduits, pits, circuit breakers and connections from the nominated point of supply to the VMS housings or is this to be undertaken by others?
- The communications line - Is the Contractor required to supply and install the communications lines or is this to be undertaken by others?
- The installation of guard rail if required.
- The installation of a CCTV camera if required (recommended).
- The supply and installation of stickers on each VMS and/or the support structure, in accordance with either standard drawing TC-2100 for Standard Cabinet Label or standard drawing TC-2105 for Pedestal Controller Label, displaying the site number.

G2.   DOCUMENTATION

The contractor shall be required to provide, as a minimum, the following documentation with the tender submission:

- Details of the calculated maximum demand of the Variable Message Sign.
- Details of to the technologies proposed to be used in the display elements including optical/photometric and life performance details of the proposed technology to be used.
- Documentation required under Appendix E of this specification to demonstrate compliance with this specification.
- Documentation required by Section 8 of this specification.