

Technical Specification

**Transport and Main Roads
MRTS262 Temporary Variable Message Signs**

July 2017

Copyright



<http://creativecommons.org/licenses/by/3.0/au/>

© State of Queensland (Department of Transport and Main Roads) 2017

Feedback: Please send your feedback regarding this document to: tmr.techdocs@tmr.qld.gov.au

Contents

- 1 Introduction1**
- 2 Definition of terms1**
- 3 Reference documents2**
- 4 Quality system requirements4**
 - 4.1 Samples for acceptance 4
 - 4.2 Warranty 4
- 5 Operational requirements5**
 - 5.1 Key TVMS components and function 5
 - 5.2 General operation 5
 - 5.3 Control methods..... 5
 - 5.4 Safety requirements..... 6
- 6 Mechanical, physical, enclosure and mounting requirements6**
 - 6.1 General 6
 - 6.2 Design life 6
 - 6.3 Mounting 6
 - 6.3.1 *General mounting requirements*.....6
 - 6.3.2 *Vehicle mounts*.....6
 - 6.3.3 *Trailer mounts*.....6
 - 6.3.4 *Concrete block mounts*.....7
 - 6.4 Exterior finish and surfaces 7
 - 6.5 Front cover 7
 - 6.5.1 *Material*.....7
 - 6.5.2 *Retention method*7
 - 6.6 Condensation prevention..... 7
 - 6.7 Enclosures 7
 - 6.7.1 *Display enclosure*8
- 7 Electrical requirements8**
 - 7.1 General 8
 - 7.2 Solar panel array and charger assembly 8
 - 7.3 Batteries and capacitors 9
 - 7.4 Solar panel array, battery bank and sign display extension capability 9
- 8 Telecommunications requirements 10**
 - 8.1 Local site communications..... 10
 - 8.1.1 *Between CU and LED display* 10
 - 8.1.2 *Between configuration software (locally, e.g. on laptop) and CU* 10
 - 8.1.3 *Between CU(s) and hand-held SRD(s)* 10
 - 8.2 Remote site communications..... 10
 - 8.2.1 *Between CU and RSCS* 11
 - 8.2.2 *CU and SMS notification system*..... 11
 - 8.3 Communications timeout 11
 - 8.4 CU communications ports..... 11

8.4.1	<i>Maintenance communication port</i>	11
8.4.2	<i>Control communications port</i>	12
8.5	Labelling and identification	12
8.5.1	<i>CU ID</i>	12
8.5.2	<i>SRD ID</i>	12
9	Control Unit (CU) requirements	13
9.1	General	13
9.2	Permissible message types	14
9.3	Message display time	14
9.4	Watchdog.....	14
9.5	Global Positioning System (GPS).....	14
9.6	Directional compass capability	14
9.7	Hand-held Short Range Device (SRD).....	14
9.8	Local Facility Switch (LFS)	15
9.8.1	<i>Blank / maintenance mode</i>	15
9.8.2	<i>NORMAL mode</i>	16
9.8.3	<i>Three message modes</i>	16
9.9	Hardwired inputs.....	16
9.10	Communication protocol	16
9.11	Bus arbitration.....	16
9.12	Message hierarchy	16
9.13	Sign monitoring and logs	16
9.13.1	<i>Turning motion sensor</i>	17
9.13.2	<i>Power system monitoring</i>	17
9.13.3	<i>LED intensity control</i>	18
9.13.4	<i>Temperature control</i>	18
9.14	Critical faults	18
9.15	Alarms.....	18
10	Software requirements	19
10.1	General software user interface and access security.....	19
10.2	Remote Sign Control System (RSCS) software	19
10.3	TVMS configuration software.....	20
10.4	Control / diagnostics software.....	20
10.5	Configuration management	20
10.5.1	<i>CU configuration</i>	20
10.5.2	<i>Software program configuration</i>	21
11	Variable message display requirements	21
11.1	General	21
11.2	Failures	21
11.3	LED output.....	21
11.4	Character and graphical display formats	22
11.4.1	<i>Text Display Unit (TDU)</i>	22
11.4.2	<i>Graphics Display Unit (GDU)</i>	22
11.5	Display fonts	22

- 11.6 Display changes..... 22
- 11.7 Fallback displays 22
- 11.8 Optical performance 22
 - 11.8.1 Luminance 23
 - 11.8.2 Chromaticity..... 23
 - 11.8.3 LED dimming 23
 - 11.8.4 Luminance intensity half angle 23
 - 11.8.5 Luminance intensity uniformity 23
 - 11.8.6 Sun phantom 24
- 12 Documentation requirements..... 24**
- 12.1 Operations and maintenance manual..... 24
- 13 Testing, commissioning and configuration requirements 24**
- 14 Training requirements 24**
- 15 Maintenance requirements 25**
- 16 Handover requirements 25**
- Appendix A—Referenced variables and default settings 26**

1 Introduction

This Technical Specification defines the design, supply, installation, testing and commissioning, performance, documentation, training, maintenance and handover requirements for Transportable Variable Message sign (TVMS) and their associated control systems.

A TVMS defined in this Technical Specification is used for traffic management and/or driver information applications.

Portable variable message signs intended to advertise products and services to road users are not included within the scope of this Technical Specification.

A TVMS used for road operations as specified in this Technical Specification is different to digital advertisement signs used for the display of messages not related to road safety.

This Technical Specification shall be read in conjunction with MRTS201 *General Equipment Requirements*, MRTS202 *Variable Message Signs*, MRTS01 *Introduction to Technical Specifications*, MRTS50 *Specific Quality System Requirements*, *Traffic and Road Use Management Manual (TRUM)* Volume 1, Part 10 and other Technical Specifications as appropriate.

The key differences between a VMS sign covered under MRTS202 *Variable Message Signs* and a TVMS covered under this Technical Specification are in relation to the:

- a) TVMS operation is through the use of a hand-held Short Range Device (SRD) in addition to a remote sign control system (RSCS)
- b) TVMS is battery powered and, where necessary, the batteries are recharged via solar panels, and
- c) TVMS are mounted on a vehicle, trailer or a portable concrete block so that they can be relocated when required for traffic control staging.

TVMS complying with this Technical Specification shall only be used in accordance with the operational requirements of the *Traffic and Road Use Management Manual (TRUM)* Volume 1, Part 10. Vehicle Mounted TVMS shall, in addition, comply with the MUTCD Part 3.

This Technical Specification forms part of the Transport and Main Roads Specifications Manual.

2 Definition of terms

The terms defined in MRTS201 *General Equipment Requirements* apply to this Technical Specification. Additional terminology relevant under this Technical Specification are defined below.

Table 2 – Definitions

Term	Definition
ACMA	Australian Communications and Media Authority
CAT	Customer Acceptance Test (see MRTS201)
Configuration Software	Control / diagnostic software that runs on a laptop and can control, interrogate and program the CU
CT	Commissioning Test (see MRTS201)

Term	Definition
CU	The internal control processing unit hardware within the TVMS sign unit which undertakes all communication and internal processing tasks required for operation
DOD	Depth of Discharge
Event	Sign status change, message change, occurrence of a fault in CU or sign
FAT	Factory Acceptance Test (see MRTS201)
FP	Field Processor
GDU	Graphical Display Unit
GPS	Global Positioning System
IAT	Installation Acceptance Test (see MRTS201)
IP	Ingress Protection
LFS	Local Facility Switch – a key operated device used to manually control operation of the CU
Message	Any stable state displayed by a TVMS on its display at any one instance of time that is preceded and followed by a change of state
NATA	National Association of Testing Authorities
Pixel	The smallest discreetly controlled light emitting component of the sign dot matrix display
Replay Attack	Unauthorised access of keyless entry systems without Code Hopping or Rolling code communications algorithms
RPEQ	Registered Professional Engineer of Queensland
RSCS software	Remote Sign Control System Software – this is the software system used to remotely operate and monitor the TVMS signs for example, from a Traffic Control Company's Premises
SRD	Short Range Device – These are the (hand-held) remotes which can set a TVMS Sign to display a permitted message frame
STREAMS	The Principal's traffic management system and primary user interface to ITS field devices
TDU	Text Display Unit
TVMS	Temporary Variable Message Signs
UHF	Ultra High Frequency – 300 – 3000 MHz radio frequency spectrum band. See the ACMA website for further information.
VMS	Variable Message Sign
VPN	Virtual Private Network
WH&S	Workplace Health and Safety

3 Reference documents

The requirements of the referenced documents listed in Table 3 of MRTS201 *General Equipment Requirements* and Table 3 below apply to this Technical Specification. Where there are inconsistencies between this Technical Specification and referenced MRTS documents, the requirements specified in this Technical Specification take precedence.

Table 3 – Referenced documents

Document ID	Document name / description
AS 1170.1	<i>Structural Design Actions, Permanent, imposed and other actions</i>
AS 1170.2	<i>Structural Design Actions, Wind Actions</i>
AS 1664	<i>Aluminium structures</i>
AS 1665	<i>Welding of aluminium structures</i>
AS 1744	<i>Forms of letters and numerals for road signs</i>
AS 1906	<i>Retroreflective materials and devices for road traffic control purposes</i>
AS 3000	<i>Electrical installation - building structure and premises (Wiring Rules)</i>
AS 3011.2	<i>Electrical installations - Secondary batteries installed in buildings - Sealed cells</i>
AS 3012	<i>Electrical installations - Construction and demolition sites</i>
AS 3100	<i>Approval and test – General requirements for electrical equipment</i>
AS 4086.1	<i>Secondary batteries for use with stand-alone power systems - General requirements</i>
AS 4086.2	<i>Secondary batteries for use with stand-alone power systems - Installation and maintenance</i>
AS 4509.1	<i>Stand-alone power systems - Safety and installation</i>
AS 4509.2	<i>Stand-alone power systems - System design</i>
AS 4852.2	<i>Variable Message Signs (Part 2: Portable Signs)</i>
AS 5033	<i>Installation and safety requirements for photovoltaic (PV) arrays</i>
AS 60529	<i>Degrees of protection provided by enclosures (IP Code)</i>
AS/NZS 5033	<i>Installation and safety requirements for photovoltaic (PV) arrays</i>
IS18	<i>QGCI0 Information Security Standard</i>
IP65	Not a standard (IP = Ingress Protection)
IP67	Not a standard (IP = Ingress Protection)
MRTS01	<i>Introduction to Technical Specifications</i>
MRTS02	<i>Provision for Traffic</i>
MRTS232	<i>Provision of Field Processors</i>
MRTS50	<i>Specific Quality System Requirements</i>
MRTS61	<i>Mounting Structures for ITS devices</i>
MRTS201	<i>General Equipment Requirements</i>
MRTS202	<i>Variable Message Signs</i>
MRTS226	<i>Telecommunications Field Cabinets</i>
MUTCD	<i>Queensland Manual of Uniform Traffic Control Devices</i>
TRUM Volume 1, Part 10	<i>Traffic and Road Use Management Manual Part 10 Traffic Control and Communication Devices</i>

4 Quality system requirements

The quality system requirements defined in MRTS201 *General Equipment Requirements* and apply to this Technical Specification. Additional quality system requirements relevant under this Technical Specification are defined in Table 4. There are no Milestones defined.

Table 4 – Hold Points, Witness Points and Milestones

Clause	Hold Point	Witness Point	Milestone
4.1	1. Detailed design documentation to be provided prior to manufacture 2. Optical performance certification		
5.4	3. Safety requirements		
6.3.1	4. Vehicle, Trailer and/or concrete block support structure design documentation		
7.1	5. Detailed design documentation of the electrical wiring including solar and charging assembly and calculations, signed by RPEQ.		
11.8		1. Optical Performance Test	
13		2. Factory Acceptance Test	

4.1 Samples for acceptance

The requirements of MRTS201 apply to this Technical Specification. Detailed designs of the sign layout, fabrication and assembly drawings, calculations, specifications and certifications of the TVMS components (signed by the Contractor's RPEQ) shall be submitted to the Principal via the Administrator for verification prior to manufacture. These components include the TVMS controller, sign face, LEDs, LED matrix boards, pixel arrangements showing horizontal and vertical pitch and total number of pixels, power supply (including solar power, surge protection and back-up batteries), communication ports, cable termination, enclosure and mounting accessories. **Hold Point 1**

Optical performance test methodology and NATA certification confirming the TVMS performance requirements specified in this Technical Specification must be submitted before delivery to Site.

Hold Point 2

4.2 Warranty

The Contractor installing the TVMS shall warrant the installation against defects for a minimum of five years in accordance with the requirements of MRTS201.

Minimum five year warranty provision is required for electronic signage, including TVMS, as they fall under a category of products which are either high cost, safety critical or high quantities.

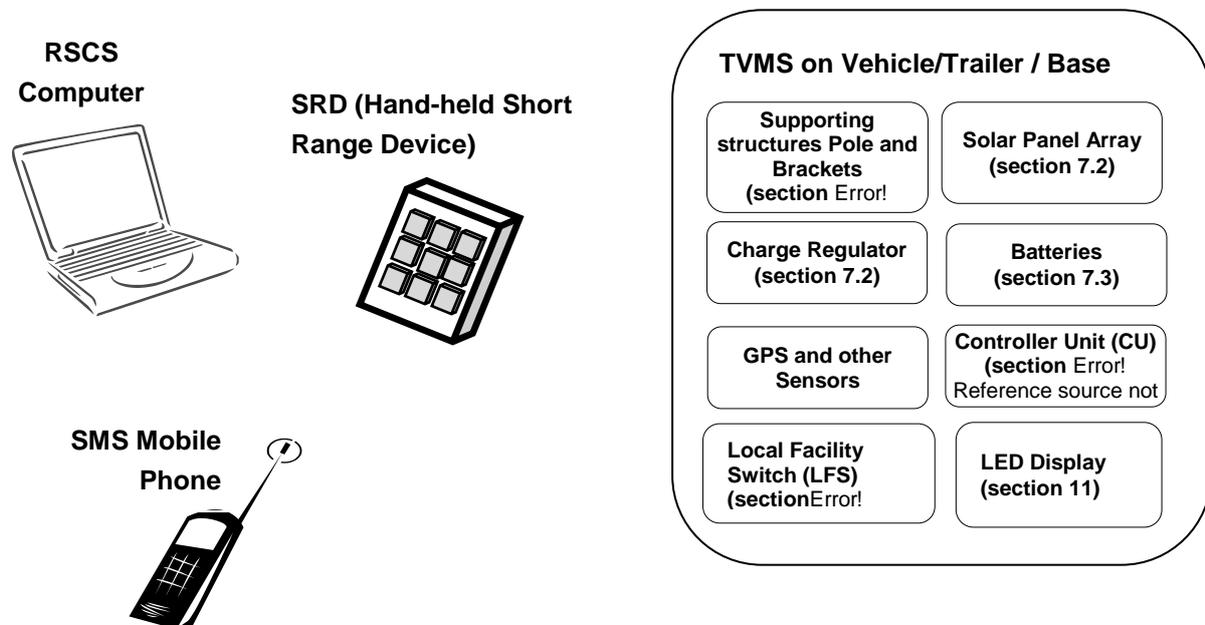
5 Operational requirements

5.1 Key TVMS components and function

The following figure shows the key components associated with TVMS.

Figure 5.1 – Key TVMS components

The following figure shows the key components associated with TVMS.



Note: Control of vehicle mounted TVMS shall conform to the requirements of the MUTCD Part 3 and require no remote access.

5.2 General operation

The use of the TVMS shall be in accordance with Volume 1, Part 10 of the TRUM Manual, Variable Message Signs Use and Operation, and the MUTCD and have the capability of operating as follows.

5.3 Control methods

The TVMS shall be operated by selecting the following methods via the TVMS controller:

- a) Locally, when the TVMS controller has been selected for BLANK / MAINTENANCE operation using a local facility switch. This would enable operation of the TVMS through the TVMS configuration software and/or hardwired inputs to select one of a number of pre-determined messages.
- b) Remotely, when the TVMS controller has been selected for NORMAL operation. This will enable operation through a hand-held Short Range Device (SRD) and/or Remote Sign Control System (RSCS), which may be compatible with an existing Transport and Main Roads system, such as STREAMS.

The TVMS controller shall provide the operational interface with the SRD and RSCS.

The local TVMS operating system executing on the CU shall have a minimum of 99.9% operating reliability.

5.4 Safety requirements

All vehicle-mounted and trailer / concrete block mounted TVMS used in safety-related applications shall only be deployed following the appropriate risk analysis undertaken to ensure safety in the event of sign failure. Example of risk mitigation could include video monitoring of the sign face. **Hold Point 3**

6 Mechanical, physical, enclosure and mounting requirements

6.1 General

The mechanical and physical requirements defined in MRTS201 and MRTS61 apply to work provided under this Technical Specification. Additional mechanical and physical requirements for equipment provided under this Technical Specification are described below.

6.2 Design life

Unless otherwise specified, the design life of the TVMS components shall be as follows:

- a) structures: a minimum of 40 years
- b) enclosures: a minimum of 20 years
- c) LEDs / pixels: a minimum of five years, and
- d) electronics: a minimum of 10 years.

6.3 Mounting

6.3.1 General mounting requirements

The display enclosure shall be capable of being mounted on a vehicle, a trailer or a concrete block support structure in a location consistent with Volume 1, Part 10 of the TRUM manual. The mounting structures supporting the TVMS shall be designed for the site conditions in which they are intended to be used.

The structure shall be designed in accordance with MRTS61, AS 1170.1 and AS 1170.2 when installed with all supporting hardware and accessories used to operate the signs, including the solar panels, where fitted.

Vehicle, trailer and / or concrete block support structure design documentation showing compliance with this standard and certified by a RPEQ, shall be submitted to the Principal's representative for acceptance. **Hold Point 4**

6.3.2 Vehicle mounts

The vehicle on which the TVMS is mounted shall conform to the requirements of the host vehicle specified in the MUTCD Part 3 and this Technical Specification. Where there is discrepancy between the MUTCD Part 3 and this Technical Specification, regarding the host vehicle, the MUTCD Part 3 takes precedence. If required, vehicle mounted VMS shall be fitted with solar panels.

6.3.3 Trailer mounts

Where the TVMS is mounted on a trailer, the sign and solar panel array shall have a mechanical system which allows the sign and solar panel be safely secured to the trailer for transportation.

The mechanical system shall also allow for the sign and solar panel to be safely erected on site to ensure the sign is clearly visible to motorists and that the solar panels can be automatically adjusted to ensure optimum solar exposure and maximum energy generation anywhere in Queensland.

The mechanical systems shall ensure that the sign cannot rotate due to wind gusts up to the ultimate wind speed the structure is designed.

The trailer shall comply with the applicable Australian Design Rules and shall be suitable for registration in accordance with the statutory requirements of the State of Queensland.

6.3.4 Concrete block mounts

The final design documentation of concrete block mounts shall include the location and type of mounting structure to be provided to mount each TVMS and the Contractor shall not commence fabrication of the footing and support structure until that final design documentation has been accepted by the Principal or their delegate.

6.4 Exterior finish and surfaces

A non-reflective finish is required to all painted surfaces of the TVMS. Surface colours shall be:

- a) front face surrounding the active display and bottom external face: matte black or APO Grey
- b) remainder of external surfaces: APO grey, and
- c) interior: matte black or natural finish with internal black backing board.

Where an internal backing board is used, this shall allow easy removal to access the variable message display.

6.5 Front cover

6.5.1 Material

A protective front cover shall be fitted to the display enclosure to form a viewing window. The front cover material shall be a single, clear Lexan® sheet, or equivalent, with a non-reflective finish. The sheeting shall be manufactured from sign-grade material SG300 with a thickness at least equal to that recommended by the manufacturer, and in all cases, at least 4.5 mm. The viewing window shall be such that when installed, the sides and bottom edges of the display face are fully visible at viewing angles of $\pm 45^\circ$ (horizontal) and $\pm 30^\circ$ (vertical) to the axis perpendicular to the front plane of the display.

6.5.2 Retention method

The front cover shall be able to be removed from outside the TVMS for maintenance without requiring removal of internal components. Fasteners and retaining cover strips shall be easily accessible.

The front cover retention and seal design shall allow for thermal expansion properties of the front cover material. The front cover surrounding framework and cover strips shall provide the required weather proofing and strength for both positive and negative wind pressures.

6.6 Condensation prevention

A mechanism shall be provided to prevent condensation on the inside surface of the front cover. One way this could be done is by using a demister or other dehumidifying devices.

6.7 Enclosures

All telecommunications equipment, including the FP and the TVMS controller associated with the TVMS, may be installed in a suitable roadside enclosure, being either:

- a) a ground mounted field cabinet complying with requirements of MRTS226

- b) a traffic signal controller, or
- c) an integral enclosure, or display enclosure, complying with the requirements of MRTS201 installed on the TVMS mounting structure.

6.7.1 Display enclosure

The sign enclosure shall house the TDU, GDU and associated control electronics, and comply with the requirements of MRTS201 *General Equipment Requirements*. Where installed in a tunnel, the enclosure shall be made of Marine Grade Aluminium.

The display enclosure shall provide a degree of protection of not less than that required for the classification of IP65 in accordance with AS 60529 in normal service.

Access shall be provided to allow TVMS maintenance and configuration. The door arrangement shall be compatible with the mounting structure members. The mounting structure shall comply with the requirements of MRTS201 and MRTS61.

7 Electrical requirements

7.1 General

The requirements of MRTS201, Section 10.5.1 and Section 10.5.2 apply to this Technical Specification.

All TVMS shall be powered from batteries chargeable from solar panels. Trailer mounted TVMS shall be powered from batteries which are recharged from solar panels. Concrete block mounted TVMS shall have the option of being mains powered. Where the TVMS are mains powered, the electrical system shall comply with AS 3012.

Electrical protection, switching and isolation and lightning protection shall be provided in accordance with AS 4509.2. High Rupture Capacity (HRC) fuses shall be used for circuit protection. The switchboard shall be labelled with nominal voltage and current, DC or AC, as well as the requirements of fire emergency information for PV arrays required by AS 5033.

An electrical wiring diagram shall be provided in each enclosure, with details specific to each installation.

The total warranty for the solar power system shall be at least five years.

The solar panels and battery configuration shall be designed to provide seven days of continuous operation without charge throughout the entire warranty period.

Detailed designs of the electrical wiring, including the solar power and charging assembly and calculations showing the standalone power system, is adequate for the intended duration of operation, including seven days autonomy, shall be reviewed and signed by a RPEQ. They shall then be submitted and approved by the Principal or their delegate for verification and acceptance.

Hold Point 5

Should a failure of the solar panels occur, there will be sufficient backup charge stored in the battery compartment to ensure continued operation for a week.

7.2 Solar panel array and charger assembly

The selection, configuration, installation and testing of solar panel modules shall be consistent with AS 4509.1, AS 4509.2 and AS/NZS 5033.

All solar panel module fittings and adjustments shall be designed, manufactured and tested with appropriate theft prevention methods.

The solar panel size shall not exceed the trailer footprint intended for TVMS mounting.

The solar panel system shall utilise a voltage of 12 or 24 Volts.

All battery chargers shall be connected to the battery bank by fixed wiring via the main battery fuse or circuit breaker. If the main battery fuse or circuit breaker will not provide overcurrent protection for the battery charger output wiring, the battery charger output cabling shall be protected from overcurrent by separate HRC fusing or a d.c. rated circuit breaker adjacent to the main battery fuse or circuit breaker. The battery charger shall be fitted with a fuse or circuit breaker to provide an isolating point and battery charger overcurrent protection.

7.3 Batteries and capacitors

The function of the battery bank is to provide sufficient storage for the continuous operation of the TVMS sign during periods of limited sunlight or due to failure of the charging circuitry.

The selection of the batteries shall be consistent with AS 3011.2, AS 4086.1 and AS 4086.2 and subject to the following additional conditions:

- a) the battery technology shall have a high cycle life (> 2000) and of a low maintenance type
- b) the battery shall be of the type suitable for charging by Photovoltaic (PV) Cells
- c) limiting the depth of discharge for batteries to about 50%. (e.g. meaning the deep cycle batteries will be at 50% capacity or better)
- d) batteries with liquid electrolytes shall NOT be used, and
- e) batteries (and capacitors) shall be installed to minimise risk of:
 - i. impact by a motor vehicle
 - ii. theft or vandalism, and
 - iii. explosion.

7.4 Solar panel array, battery bank and sign display extension capability

The solar panel assembly, battery bank and sign display components shall also be able to be physically separated from the TVMS trailer / concrete block and placed at a maximum of 10 m on suitable support structures. The support structures will be designed and certified by a structural RPEQ.

The electrical cable adjoining the solar panel array, battery bank and sign display components shall be able to be housed within suitably sized corrugated steel conduit and the size of cable be selected such that any voltage drop is < 2.5% of the solar panel array output voltage. The cable shall be terminated with Utilux type or corrosion resistant IP67 rated connector that allows for a robust quick release connection.

Ideally, the TVMS should be located at the best vantage point with a good solar exposure. As this may not always be the case, the solar panel array, battery bank and sign display components may be positioned at some 10 m from the trailer / concrete block via respective cabling. This will allow these components to be outside the clearance zone.

8 Telecommunications requirements

The telecommunications requirements defined in MRTS201 apply to work provided under this Technical Specification. Vehicles used for mounting TVMS shall comply with the communication requirements of the host vehicle specified in the MUTCD Part 3 and this Technical Specification in order of preference.

8.1 Local site communications

8.1.1 Between CU and LED display

Communication between the local CU and LED sign display shall be via a direct wired connection. The communications system shall be secure tamper proof and fully enclosed. Messages transmitted from the CU to the LED display shall be displayed within 50 ms of being sent.

8.1.2 Between configuration software (locally, e.g. on laptop) and CU

Refer to Clause 8.4.

8.1.3 Between CU(s) and hand-held SRD(s)

Provision shall be made for communication between the CU(s) and SRD(s) via a wired or wireless connection.

For wired connection between the CU and the SRD, the connecting lead shall be at least 15 m.

Wireless connection between the CU and the SRD shall utilise local encrypted wireless communication technology, such as Ultra-High Frequency (UHF) radio band or other reliable wireless technology. The wireless SRD shall be as specified in Clause 9.7 below.

The SRD and CU shall communicate reliably over wireless point to point ranges of at least 150 m.

Where a SRD has requested a change of message on a TVMS sign CU, the message change shall be completed within 250 ms of the request—i.e. the respective CU's display shall energise the requested message LED pixels.

Any radio frequency communications antennas shall be positioned at the highest point on the TVMS sign to make effective use of available signal gain and avoid line of sight signal attenuation by objects such as concrete barriers and shrubs.

Communications shall be in accordance with Australian Communications and Media Authority (ACMA) requirements.

8.2 Remote site communications

The requirement for remote site communications may not be applicable to vehicle mounted TVMS that comply with MUTCD Part 3. The following apply to trailer mount and concrete block mount TVMS.

8.2.1 Between CU and RSCS

Communication between the CU and the RSCS software shall be via a secure wireless connection using a third party 3G / 4G mobile service provider using secure interface and access protocols as detailed in Clause 10.1 below. All communication over third party communications network shall provide adequate privacy and integrity of data to the satisfaction of the Principal.

The carrier selected shall have sufficient and reliable coverage at the project Site.

Setup and ongoing provision of the mobile service required is the responsibility of the Contractor who owns the TVMS sign.

All messages transmitted from the RSCS software to the CU embedded firmware shall not exceed 4.0 seconds.

All messages transmitted from the CU to the RSCS software shall also not exceed 4.0 seconds.

8.2.2 CU and SMS notification system

Communication between the unit controller and a mobile phone for the purposes of the transmission of critical alert SMS notifications as defined in Clause 9.15 below shall be via a third party SMS mobile service provider. The telecommunications carrier selected shall have sufficient and reliable coverage at the project Site.

8.3 Communications timeout

For any SRD or RSCS to CU communications, periodic timeout check shall be ignored and the display shall remain on indefinitely until requested otherwise.

For Blank / Maintenance mode, if the configuration software remains inactive for a period as defined in Appendix A, then the user session will be terminated, the sign display blanked and the user will need to re logon and establish another session.

All time-out periods shall be software configurable with ranges and default values stated in Appendix A.

8.4 CU communications ports

8.4.1 Maintenance communication port

It shall be possible to control and interrogate the TVMS via an EIA / RS-232 maintenance communications port via the TVMS controller. The RS-232 port shall allow local and remote communications via a laptop computer containing TVMS messaging and diagnostics software to be provided by the supplier. The maintenance communications port shall also allow remote connection of a similar computer via a modem.

A physical change of connection between remote and local operation shall not require further interaction from the user, nor in anyway interrupt operation or require rebooting of TVMS control system or computer / software. The hardware handshaking lines of the EIA / RS-232 interface shall be used such that connection/ disconnection of the maintenance PC (either locally or by modem) results in the immediate initiation/ termination of the maintenance port communications session with the TVMS.

The TVMS control and diagnostics software shall be capable of operating at all possible modem connection and serial port speeds.

8.4.2 Control communications port

It shall be possible to control and interrogate the TVMS via either of two EIA / RS-232 control communications ports. The control communications port shall allow local connection of a field processor / modem for communications with STREAMS.

While a PC / laptop computer is connected to the TVMS via the maintenance communications port, control of the TVMS via the control ports shall be inhibited. However, status and diagnostic interrogation by STREAMS via the control ports shall be maintained.

Complete control and monitoring by STREAMS shall be maintained through either, and / or both control communications ports as determined by telecommunications infrastructure provided at each Site.

Where communications equipment is connected to both control communications ports, the primary port shall be used for control commands to / from the TVMS, and the secondary port shall be used for status-only communications with the TVMS.

Where communications equipment is connected to only one control communications port (or in the case of failure of either communications port or attached equipment), the TVMS shall automatically revert to full control and status communications through the active port.

TVMS communications software shall be capable of operating at all possible modem connection and / or serial port speeds.

8.5 Labelling and identification

The SRD and CU shall each have a configurable unique communications ID—e.g. a three-digit integer between 001 and 255.

Communications messages between the CU and SRD shall include a checksum unique to each TVMS site and shall be computed based on the message information exchanged to ensure integrity of the communication is upheld.

The checksum shall be available for confirmation by the RSCS that the message frames at each TVMS site are the same as those stored within the RSCS software. The checksum shall be verified periodically and recomputed each time the message frames is changed and/or that the CU is reset/rebooted.

8.5.1 CU ID

A TVMS CU unique ID shall be configured through RSCS or configuration software.

Any communications messages transmitted by a CU shall embed the CU's respective ID.

A physical label displaying this ID must be clearly visible on the TVMS.

8.5.2 SRD ID

A unique SRD ID shall be configured on a SRD through a settable dipswitch or electronically configured using the RSCS or configuration software.

9 Control Unit (CU) requirements

9.1 General

The control system requirements defined in MRTS201 apply to this Technical Specification. Vehicles used for mounting TVMS shall comply with the control requirements of the host vehicle specified in the MUTCD Part 3 and this Technical Specification in order of preference.

Additional control system requirements for equipment provided under this Technical Specification are described below.

Each TVMS shall be controlled by a CU that is operated in the following order of priority:

1. local facility switch
2. hardwired input(s)
3. maintenance communications port, and
4. control communications ports.

Software shall be provided in accordance with Clause 10.

The TDU and the GDU shall be able to be controlled individually or simultaneously.

The CU of each TVMS shall:

- a) conduct all processing associated with the communications support for paired signs
- b) ensure that the requested messages are immediately displayed on the TVMS sign LED display and carries out all associated processing and monitoring functions
- c) monitor, log and report the operation of each connected sign display individually
- d) monitor, log and report events crucial for the operation of the sign
- e) allow the TVMS to be controlled individually or as part of a pair
- f) be capable of storing all recommended message frames in its non-volatile memory, refer to *Traffic and Road Use Management Manual* (TRUM) Volume 1, Part 10 for the recommended messages
- g) command signs to display only the allowable messages for that respective site as defined by the *Traffic and Road Use Management Manual* (TRUM) Volume 1, Part 10
- h) allow local automatic reset of sign displays and the CU itself, such as via watchdog(s)
- i) be capable of automatically dimming connected signs based on the average of the light sensor outputs. Automatic dimming of the sign occurs to increase ambiance. Automatic dimming is not permitted for the sole purpose of extending the battery life
- j) accept / reject valid or invalid commands made by the SRD, RSCS, configuration software
- k) allow a unique electronic identification for each site to be configured
- l) electronically verify with the connected sign display that the displayed message is consistent with the message originally requested and permitted
- m) accept an analogue input from a Local Facility Switch (LFS), and

- n) Additional information and functionality of the CU required is described in the following sections.

9.2 Permissible message types

Each TVMS CU shall be configured to store only those message types permitted to be displayed as defined in the *Traffic and Road Use Management Manual (TRUM)* Volume 1, Part 10 for the site in which they are operating. This will be achieved through the RSCS or configuration software referred to in this specification. The CU shall ensure that only messages permitted for that site are displayed on its respective signs.

The CU shall allow:

- a) the configuration software to read and write its permitted messages / message combinations
- b) the RSCS to read its stored messages, and
- c) stored messages to be downloaded to the sign(s) only when required to be displayed.

The permissible messages for each site shall be confirmed with the Principal.

9.3 Message display time

The minimum display duration of each message frame shall be configurable and accessible via the TVMS configuration software. The time range and factory default settings are shown in Appendix A.

9.4 Watchdog

The TVMS display and CU must each monitor the state of its respective processor and blank the respective display(s) if processor failure occurs.

The CU shall generate an alarm and blank all signs if the integrity of the firmware or configuration is compromised.

9.5 Global Positioning System (GPS)

Each TVMS sign shall be fitted with a GPS receiver. The on board GPS receiver shall monitor the location in three dimensions (latitude, longitude and altitude) of each sign and also synchronise the TVMS CU internal clock. The CU shall provide an alarm if a sign is moved beyond a 30 m radius of its installed position. This may be achieved using a virtual perimeter or “geo-fence”.

Vehicles that mount TVMS, and which are compliant with MUTCD Part 3, may not require GPS.

9.6 Directional compass capability

Each TVMS may have the ability to discern the installed directional orientation and whether any subsequent change in direction has been detected through the use of a Magnetometer or Inertial type sensor.

9.7 Hand-held Short Range Device (SRD)

The local method of control is via a hand-held SRD communications device. The following requirements shall apply to the use of the SRD:

- a) have a unique ID (refer to Clause 8.5 above) that is transmitted with each message change request

- b) should a RSCS message change request occur at the same time as the message change request from a SRD, the SRD request shall have priority and the RSCS request shall be ignored
- c) for wireless SRD, use “code hopping” or “rolling code” technology, to prevent unauthorised use of the signs through “replay attacks”
- d) for wired SRD, the leads shall preferably be securely terminated in the RS-232 port of the TVMS sign or any other secure termination resulting in 15 m lead
- e) the CU shall have the ability to deactivate a SRD from controlling the TVMS sign (e.g. due to lost or damaged SRDs) through the TVMS configuration or RSCS software
- f) only when a SRD message activation button is pressed and held for two seconds shall a control message be transmitted.

To guard against accidental activation of a TVMS frame from the SRD, buttons must be pressed and held for two seconds before any TVMS message frame will be changed.

Note: If the above requirements are not met, the manufacturer/supplier must demonstrate (to the satisfaction of the department) how they will limit the remote control request to an individual CU and prevent unauthorised use of the signs.

9.8 Local Facility Switch (LFS)

A five-position key operated facility switch that complies with MRTS201 shall be provided to enable selection of the following five display functions for each of the text display and the graphics display:

- 1. Blank / Maintenance, or
- 2. NORMAL
- 3. Three message modes.

9.8.1 Blank / maintenance mode

Where Blank / Maintenance mode is selected on a LFS, the following requirement shall apply:

- a) the hardwired sign display of that TVMS sign shall be blanked
- b) whilst this mode is selected at the particular TVMS sign, any subsequent display requests from a RSCS software session or SRD shall be ignored
- c) the TVMS sign shall remain powered
- d) where two signs have been configured as one pair, selecting the LFS to “BLANK” on one TVMS sign shall not blank the other paired TVMS sign unit
- e) a locally connected PC / laptop running the configuration software shall be permitted to perform all status, maintenance and diagnostic functions on the respective TVMS sign
- f) the LFS shall be designed as fail-safe operation and, as such, should it fail or be disconnected, Blank/Maintenance mode will be activated.

The purpose of a LFS is to provide manual local override and blank the sign display or perform local maintenance and diagnostic functions, if required.

9.8.2 NORMAL mode

Where NORMAL mode is selected on the LFS, the displayed message is selected via the maintenance communications port and / or the control communications port. The followings shall apply:

- a) the hardwired sign display of that TVMS is active
- b) the CU shall accept remote control communications from a remotely connected PC / laptop running the RSCS software
- c) the CU shall accept remote control communications from a designated local hand-held SRD.

9.8.3 Three message modes

Three modes labelled Message 1, Message 2, and Message 3 display either Message 1, 2 or 3. The messages shall be in accordance with TRUM Volume 1, Part 10.

Control via all communications ports inhibited; status and diagnostic commands via all communications ports remain functional.

9.9 Hardwired inputs

Where required, the TVMS controller shall have the ability to display a predefined message when it receives a voltage free contact closure or similar input from an external device such as a loop detector or vehicle over-height detector.

Unless otherwise specified, the TVMS controller shall be capable of accepting a minimum of six hardwired inputs.

9.10 Communication protocol

Where connection to STREAMS is required, the communication between the Field Processor and the TVMS CU shall comply with TSI-SP-003, MRTS232 and MRTS201.

9.11 Bus arbitration

Each TVMS shall act as a slave on the EIA RS-422A / modem bus.

9.12 Message hierarchy

Each TVMS controller shall provide a user-configurable message hierarchy for message selection commands and hardwired inputs.

9.13 Sign monitoring and logs

The CU shall monitor and log the following items, which shall be configurable to raise an alarm:

- a) any SRD message requests of the CU, including the unique Identifier of the SRD requesting message change
- b) all RSCS software requests of the CU, including the RSCS username under which the request was made
- c) all unauthorised RSCS software requests of the CU, including the RSCS username under which the request was made
- d) loss of communications with the sign (noting the type of communication for example, SRD, RSCS, etc.)

- e) high internal sign enclosure temperature
- f) movement of the sign from its installed position
- g) LED faults (pixel failures for Annulus, Strobes and Speed)
- h) initialisation of TVMS (power up)
- i) when an SMS critical alert request has been transmitted by the CU
- j) changed state of LFS (i.e. NORMAL or Blank / Maintenance)
- k) Low Battery Voltage (e.g. where the voltage of the power supply battery drops to a level that would prevent the battery from being recharged by the charging system)
- l) loss of solar charge current / voltage
- m) loss of load current
- n) internal component faults (GPS and other modular hardware components), and
- o) all configuration changes (e.g. made through configuration or RSCS software).

The log shall identify the sign (through its respective sign ID) and its fault. The log shall include the date and time stamp for all entries and may be exported in a readily acceptable format, such as comma delimited text file (.csv), Microsoft Excel (.xls) or other formats as agreed with the project representative.

The log shall also report when the fault condition has cleared and subsequently returns to normal operation.

The log file storage for the event log shall be sufficient to allow at least eight days of continuous logging without overwriting. The oldest event record shall be overwritten first when the log file storage capacity has been exceeded.

For critical faults defined in Clause 9.14 below, the log shall include the RSCS or configuration software username ID which performed the acknowledgement and clearing of the fault.

Where a RSCS connection is in session, the RSCS software shall be synchronised and receive updates dynamically from the respective CU.

9.13.1 Turning motion sensor

Each TVMS may have the ability to detect whether the unit's position has been altered from the installed position through the use of Gyroscope.

The GPS receiver, Directional Compass and Gyroscope facility will allow greater visibility of how the site layout is set out and whether any subsequent changes have occurred due to any number of scenarios. This type of technology is now commonplace within most modern mobile phone devices.

9.13.2 Power system monitoring

The power system log is used for discerning the proper operation of the power system. The CU shall log the electrical parameters (referred to in Clause 9.15) for each connected sign within the roadwork site. For solar charge current / voltage, load current and battery charge voltage, the CU will aggregate the measurements that it receives from the connected signs over a one hour period using rolling averages.

Each sign shall report no less than four measurements for each parameter per hour to the connected CU.

9.13.3 LED intensity control

The LED intensity shall be controlled to provide constant apparent brightness, and maximum legibility distance, for the complete range of ambient light under which the TVMS shall operate.

Each TVMS shall support automatic brightness variation, where the TVMS determines the LED brightness level using a light sensor reading and a predefined set of light sensor values.

Each TVMS shall be provided with at least two light sensors to detect ambient light levels. These sensors shall be located as follows:

- a) one sensor facing forward perpendicular to the sign face, and
- b) one sensor facing backward perpendicular to the sign face.

9.13.4 Temperature control

Each TVMS shall be provided with at least one temperature sensor to measure the temperature inside the display enclosure near the top centre. The sensor shall not be mounted directly against the top face of the display enclosure. The temperature reading shall be available through the use of a protocol message via STREAMS. The temperature shall be in units of degrees centigrade.

9.14 Critical faults

Critical faults shall also include the following:

- a) Movement of the sign after installation – This is required to ensure the sign location has not been altered after installation due to unauthorised tampering, vehicular incident, wind and other reasons. A number of sensors will be utilised to determine whether the sign has been moved.
- b) LED pixel faults - e.g. which cause the display to be blanked (see Clause 11.2).
- c) Low battery voltage level alarm - when the battery level falls to below 25% of full capacity (e.g. indicating insufficient charge or problem with solar charging circuit).
- d) Charging voltage too high - when the battery charge voltage exceeds the maximum charge voltage for the selected battery (e.g. indicating a possible battery charge regulator problem).
- e) Loss of solar module - e.g. open circuit detected on solar power charging circuit, and
- f) Loss of load - e.g. possible disconnection of extension cable between trailer / concrete block and sign display.

9.15 Alarms

Each sign shall be fitted with an SMS mobile phone alert system (referred to in Clause 8.2.2).

Where critical faults occur:

- a) an SMS notification will be sent from the respective CU to pre-specified phone numbers with a clear description of the site ID and a description of the fault, and
- b) if the sign is connected to the RSCS, an alarm shall also be generated on the user alarm monitoring interface

- c) the respective TVMS sign display shall be blanked only.

10 Software requirements

The requirements defined in MRTS201 *General Equipment Requirements* apply to this Technical Specification. Additional requirements are provided under this Technical Specification are described below.

10.1 General software user interface and access security

The software user interface shall be such that user access is controlled through username and password logon credentials. The following types of user accounts shall be provisioned for in the software user interface:

- a) Administrator – for user access management and full access to all features of the TVMS RSCS software user interface, and
- b) Standard user – for conducting general operating functions as defined by the Administrator account (clearing alarms, blanking the sign and other administrator authorised functions).

The factory default user credentials shall not be used and these shall be changed prior to any operation of the TVMS sign(s). Passwords shall be generally in accordance with the Transport and Main Roads ICT policy and comply with the following:

- a) minimum length of six alpha numeric characters
- b) be only allowed to be incorrectly entered up to three times after which the user account will be led and an Administrator-enabled account will then need to be accessed to reset the disabled user account password
- c) the logon interface shall ensure that any programmatic script execution capability does not compromise the integrity of the logon process - e.g. SQL injection attacks, and
- d) the logon interface shall ensure that any logon error messages are generic in nature to protect from user access information leakage - e.g. prevent brute-force attacks and the exposure of valid usernames.

All insecure management protocols services, such as telnet, HTTP, etc., shall be disabled to prevent any unauthorised communications terminal access to the local CU.

Should maintenance and diagnostic functions be required to be undertaken on the CU, then secure communication protocols such as SSH, HTTPS shall be used.

The software shall be web-based and display the location of the managed TVMS signs on a GIS layer which has up-to-date maps and associated geographic or spatial information.

The software shall allow the default message of a TVMS sign to be set.

All software updates shall be fully backwards compatible with any previous versions.

10.2 Remote Sign Control System (RSCS) software

The RSCS may be used on site or via a location which is remote to the roadwork site such as a Traffic Controller Agency's Business Premises.

RSCS software shall provide the functionality similar to TVSL as detailed in the TRUM Volume 1, Part 10, Section 6 which includes general security requirements, which are in addition to the requirements specified within this specification.

The RSCS shall be hosted on a Microsoft Windows® operating system environment, from Windows 7 to the industry standard which current at the time of use. Any software provided must be capable of operating on all such operating systems.

10.3 TVMS configuration software

The TVMS sign shall be able to be initially programmed through the use of configuration software. Prior to any configuration of a TVMS sign's CU, the respective LFS switch shall have the "Blank / Maintenance" mode selected.

The primary functions of this software will be, but not limited to:

- a) Allow the required initial setup of a TVMS sign (including, but not limited to, configuration of messages, SRD administration functions, such as removing lost SRD units and replacing with other SRD via SRD IDs).
- b) Perform any periodic maintenance and diagnostic functions required during the life of the product (including, but not limited to, reporting and extraction of fault / event logs, internal health statuses of internal TVMS sign components, such as battery, solar panel, other I/O statuses, connection states for, SRD / CU, RSCS / CU communications).

10.4 Control / diagnostics software

The TVMS CU shall fully implement all TVMS functions as required by Clause 9 for all communications ports.

The computers may use Microsoft Windows® operating systems from XP to those industry standards current at the time of use. Any software provided shall be capable of operating on all such operating systems.

The software shall report the selected position of the facility switch.

10.5 Configuration management

10.5.1 CU configuration

All settings in the CU, including settings included in Appendix A, the permissible messages and / or combinations of messages, shall be accessible using the configuration software. The configuration shall be Site-specific and must ensure that only the CU with the correct configuration for the respective TVMS site is allowed to control its respective TVMS site.

The site-specific permitted messages, and / or combinations of messages and other user configurable settings, shall be stored in non-volatile memory such that they can be altered and downloaded from the configuration or RSCS without requiring any change to the CU firmware.

All firmware or software required for the TVMS sign, SRD or RSCS shall be fully backwards compatible with any previous versions.

Backward compatibility becomes significant particularly if Transport and Main Roads has legacy system associated with a product and a new version of the product emerges.

10.5.2 Software program configuration

All software configuration changes shall be date and time stamp logged and include with the username of the software user who made the configuration setting change.

Prior to the application of any software configuration change, a backup of the existing configuration shall be copied and stored in non-volatile memory.

All associated TVMS software shall allow the saving of existing configuration settings for backup. The saved backup settings file shall be able to be used to restore previously saved configuration should this be required.

11 Variable message display requirements

11.1 General

The variable message display technology shall be light emitting diode (LED). The display pixels may be formed by arranging one or more LEDs in a cluster to achieve the required luminance levels.

The displays shall utilise a series of pixels forming a dot matrix display system. A “full matrix” configuration shall be used to allow the display of graphics as well as alphanumeric characters. The horizontal and vertical pitch of the pixels in the matrix shall be in accordance with AS 4852.2:2009.

The variable message display pixels shall be in modules of a size capable of being removed and installed by hand via access door(s) or screen.

The permissible TVMS message types shall be as described in Clause 9.2.

11.2 Failures

Facilities shall be included to detect failures within the display control system. The TDU and GDU shall blank the display in the event of a sign processor fault. Time to blank shall be a configurable setting.

The DU shall monitor communications with the TVMS controller and blank the displays if loss of communication experienced. The communications timeout period shall be configurable setting.

The TVMS controller shall be able to detect LED failure even if the LEDs is required to be ‘off’ at the time of the periodic check. The display shall be blanked upon failure of 2% of contiguous pixels for each displayed image or failure of more than 20% of LEDs.

On power restoration after loss of power, the TVMS shall become available for activation and remain blank until commanded by the TVMS controller or STREAMS. The power recovery delay time shall be configurable. At no time shall partial or incomplete messages be displayed.

The TVMS controller shall allow the sign’s display to remain blank for a minimum time once the display has been blanked irrespective of the cause. This minimum blank time shall be configurable. Refer to Appendix A.

Single LED failure, provided that the cumulative LED loss remains below the 2% and/or 20% thresholds described above or TVMS light sensor failure, should not result in blanking of the display.

11.3 LED output

Each individual LED shall be driven with a continuous current with no peak and/or magnitudes exceeding 70% of the LED manufacturer's maximum continuous rating. For LEDs in a 5 mm or smaller diameter package, peak magnitudes of the LED current shall not exceed 20 mA.

11.4 Character and graphical display formats

The TVMS sign shall be capable of displaying:

- a) text
- b) graphics, or
- c) a combination of text and graphics.

All signs shall display their colours against a matte black background.

11.4.1 Text Display Unit (TDU)

Where text only signs are required, each alphanumeric character in the TDU shall be formed by a matrix arrangement of horizontal and vertical pixels. The display colour for the TDU shall be yellow as defined by the colour coordinates in AS 4852.2:2009.

The display resolution, minimum legibility (sight) distance, character height, character spacing and line spacing requirements shall be as defined in AS 4852.2:2009. The type of TVMS proposed for each location shall comply with the requirements of the TRUM Volume 1, Part 10 and MUTCD Part 3, and shall be specified on the design documentation.

11.4.2 Graphics Display Unit (GDU)

The GDU shall be formed by a matrix arrangement of a minimum of 64 horizontal pixels and a minimum of 64 vertical pixels. The pixels in the GDU shall be evenly spaced to match the overall vertical dimension of the TDU.

The display colour for the GDU shall be as defined in Clause 11.8.2.

11.5 Display fonts

As a minimum, the variable message display shall generate single stroke alphanumeric character fonts generally to the requirements of AS 1744. The characters shall be arranged so as to have a minimum of two pixels between characters and two pixels between lines.

11.6 Display changes

Variable message display changes shall be in accordance with the TVMS Use and Operations Guidelines. All display changes shall be effected by first blanking the respective TDU and / or GDU, and then activating all required pixels of the respective display simultaneously (as apparent to the eye).

11.7 Fallback displays

Facilities shall be included to detect failures within the variable message display(s) and the display control system(s). On detection of a failure, the relevant display(s) shall be blanked to prevent confusing displays to the motorist. Loss of communications with STREAMS shall also be considered a TVMS failure and shall result in the display(s) being blanked after a pre-set time period. This time period shall be a variable, able to be set by STREAMS, with a range of 60 seconds to 600 seconds.

11.8 Optical performance

The performance of the TVMS displays must meet or exceed the optical characteristics defined in Clauses 11.8.1 to 11.8.6. Tests shall be performed by a NATA accredited laboratory and the results submitted to the Principal. **Witness Point 1**

11.8.1 Luminance

The performance of the TVMS displays must meet or exceed the luminance and chromaticity parameters defined in AS 4852.2.

11.8.2 Chromaticity

For monochromatic signs, the colour yellow as defined by the colour coordinates in AS 4852.2:2009 Table 3.3 shall be used.

Multi-colour signs shall support display of the colours red, yellow, green and white as defined by their respective region chromaticity coordinates in AS 4852.2:2009 Table 3.3. This could be achieved by the use of a cluster of individually mounted LEDs consisting of red, yellow, green and white diodes.

Where required by Transport and Main Roads, the TVMS shall display the colour orange using individually mounted orange LEDs which shall fall within the chromaticity coordinates shown in Table 11.8.2 1 below. The orange colour shall not be generated by mixing the other LEDs.

Other colours potentially supported by the sign shall not be displayed neither shall the ability to mix pixel colours be provided.

Red, green, yellow and white pixels are required for compliance with road signage colours. RGB signs are not to be used as the blue colour is known for its poor contrast and legibility. Moreover, dimming is an inappropriate technique for RGB signs to achieve and maintain colour compliance for both green and yellow.

Table 11.8.2 1 – Chromaticity coordinates for orange

Colour		1	2	3	4
Orange	x	0.63	0.61	0.64	0.66
	y	0.37	0.37	0.34	0.34

The AS 4852.2 does not define the orange region. This coordinates defined in the table are designed to fall within the orange region for the retro-reflective fluorescent orange in AS 1906, having established that the VMS yellow region of AS 4852.2 largely falls within the retro-reflective fluorescent yellow region in AS 1906.

11.8.3 LED dimming

The dimming requirements shall be as specified in AS 4852.2.

The LED intensity shall be controlled to provide maximum legibility distances for the complete range of ambient light under which the TVMS shall operate.

11.8.4 Luminance intensity half angle

The luminance half angle for type A, B and C signs shall meet the intensity half angle parameters defined in AS 4852.2.

11.8.5 Luminance intensity uniformity

The luminous intensity uniformity requirements shall be as specified in AS 4852.2.

11.8.6 Sun phantom

The action of sunlight or other bright light sources on the optical elements shall be controlled such that inactive pixels shall not appear active.

12 Documentation requirements

12.1 Operations and maintenance manual

Each sign shall be supplied with an operations and maintenance manual detailing how to safely use the signs. As a minimum, it shall detail:

- a) safe transportation of the sign
- b) on-site installation
- c) guide on suitable locations for installation
- d) setting up of the TVMS signs for operation
- e) local configuration, remote management and administration using the RSCS Software
- f) starting up
- g) shutting down
- h) safe manual handling procedures for the batteries
- i) routine and preventative maintenance
- j) troubleshooting
- k) Workplace Health and Safety (WH&S) requirements, and
- l) specific details and calculations of the battery size, solar panel size and battery charger / regulator. This documentation shall contain all the applicable elements provided in the worked example of Appendix A of AS 4509.2. The manufacturer specification sheet of the PV array, batteries and battery charger / regulator shall be provided.

13 Testing, commissioning and configuration requirements

After the signs are first built and before being used on site, a Factory Acceptance Tests (FAT) shall be completed in accordance with the requirements of this specification. **Witness Point 2**

The testing documentation for the each sign used on site shall be provided to the Principal when submitting the Traffic Guidance Scheme (TRUM Volume 1, Part 10) in accordance with MRTS02 Clause 5.3.2.

The generic Installation Acceptance Test (IAT), Commissioning Test (CT) and Customer Acceptance Test (CAT) shall be replaced with the Contractor's configuration process. The minimum general requirements for this process are detailed in MRTS201.

14 Training requirements

The training requirements defined in MRTS201 *General Equipment Requirements* apply to this Technical Specification.

15 Maintenance requirements

The maintenance requirements defined in MRTS201 *General Equipment Requirements* apply to this Technical Specification.

16 Handover requirements

The handover requirements defined in MRTS201 *General Equipment Requirements* apply to this Technical Specification.

Appendix A—Referenced variables and default settings

Reference	Description	Range of values	Factory default	Device(s), systems affected
8.3	Local configuration software – site controller Communications Session Time-out	1–600 seconds	300 seconds	Control unit / Configuration Software
9.3	Minimum message display time	1–5 seconds	5 seconds	Control unit / sign display
11.2	Sign processor fault blank time	0.5–3 seconds	1 second	Sign display
	Communications check with sign display	0–30 seconds	Once every 5 seconds	Control unit / sign display
	Power recovery delay time	1–600 seconds	60 seconds	Control unit / sign display
	Minimum blank time	1–120 seconds	30 seconds	Control unit / sign display

