WAKA KOTAHI
NZ TRANSPORT AGENCY

VARIABLE MESSAGE SIGNS – FIXED

ITS Delivery Specification

23 OCTOBER 2020
2.0

New Zealand Government

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More information
If you have further queries, contact the ITS S&S Coordinator via email: itsspec@nzta.govt.nz

More information about intelligent transport systems (ITS) is available on the Waka Kotahi website at https://www.nzta.govt.nz/its

This document is available on the Waka Kotahi website at https://www.nzta.govt.nz/itsspecs

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Contents

1 DOCUMENT CONTROL

1.1 Document information

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1.2 Document owner

Role ITS Document Review Panel

Organisation Waka Kotahi

1.3 Document approvers

This table shows a record of the approvers for this document.

Approval date	Approver	Role	Organisation
		Design Engineer	Waka Kotahi
		Product Manager	Waka Kotahi
		Asset Manager	Waka Kotahi
		Safety Engineer	Waka Kotahi
		Security Specialist	Waka Kotahi
		Procurement Advisor	Waka Kotahi
		Manager, Technical Specialists (Technology Operations)	Waka Kotahi
		Senior Manager, Journey Management (Transport Operations)	Waka Kotahi

1.4 Version history

This table shows a record of all changes to this document:

Version	Date	Author	Role and organisation	Reason
1.0	25/02/2020	Kirill Yushenko Peter Bathgate	Consultant, Resolve Group Consultant, Resolve Group	Rewrite to capture colour VMS
1.1	26/02/2020	Karen Watson	Senior Product Analyst, Waka Kotahi	Transferring to the new ITS delivery specification template
1.2	07/07/2020	Peter Bathgate	Consultant, Resolve Group	Border updates including width calculations and maintaining visibility requirements for the smaller border
1.3	18/08/2020	Russell Pinchen Karen Watson	Design Engineer, Waka Kotahi Senior Product Analyst, Waka Kotahi	Mapping existing content into the new sections Addition of a VMS dimensions diagram Addition of the requirement for a service socket
1.4	25/08/2020	ITS Document Review Panel Kirill Yushenko Peter Bathgate	Waka Kotahi Consultant, Resolve Group Consultant, Resolve Group	Review of the changes to the document
2.0	23/10/2020	ITS Document Review Panel	Waka Kotahi	Reviewed internally and version 2.0 finalised

2 TERMINOLOGY USED IN THIS DOCUMENT

Term	Definition
DRAFT	The document is being written and cannot be used outside of Waka Kotahi
PENDING	The document has been approved and is pending ratification by Waka Kotahi. It can be used for procurement at this status
RATIFIED	The document is an official Waka Kotahi document. Road controlling authorities are obliged to follow a document with this status
RETIRED	The document is obsolete, and/or superseded
AC	Alternating current
API	Application programming interface
AS/NZS	Australian/New Zealand standard
ATMS	Advanced traffic management system
Border	Border surrounding an active display matrix on an electronic sign or signal
Cantilever support	Support system with a single post and a cantilever arm supporting the VMS over the traffic lane(s)
CCM	Code compliance met
CCTV	Closed-circuit television
cd	Candela
Continuous VMS	Has a bi-stable display matrix which can maintain the display message even after power has been removed
Display matrix	Visible part of an electronic sign or signal that contains the pixels that can be activated to display the message
EJT	Estimated journey time
EN	European standard
Enclosure	Housing for electronics systems to protect against environmental conditions
FAT	Factory acceptance testing
Front screen	Screen protecting the display matrix or the parts of it against dust, water etc. See Display matrix
Gantry	Support structure spanning a carriageway for the purpose of supporting electronic signs and signals
IEC	International Electrotechnical Commission standard
IP Code	International Protection Marking (sometimes interpreted as Ingress Protection) classifies the degree of protection provided by mechanical casings and electrical enclosures against intrusion, dust, accidental contact and water [IEC 60529:1989/AMD2:2013 Amendment 2 – Degrees of protection provided by enclosures (IP Code) (IEC 60529)]
LED	Light-emitting diode

Term	Definition
LoS	Level of service
LR	Luminance ratio
Message	Configuration consisting of symbols and/or text
MIB	Message information block
MTBF	Mean time between failure
MULTI	Mark-up language for transportation information
NTCIP	National Transportation Communications for Intelligent Transport Systems (ITS) Protocol
NTP	Network Time Protocol
Pixel	Smallest controllable element of a display matrix for an electronic sign or signal
Pixel pitch	Distance between centres of adjacent pixels
RAM	Random-access memory
RCA	Road controlling authority
SAT	Site acceptance testing
SCADA	Supervisory control and data acquisition
SNMP	Simple Network Management Protocol
TCDM	Traffic control devices manual
TCP/IP	Transmission Control Protocol/Internet Protocol
TMS	Traffic management system
TOC	Traffic operations centre
UTC	Coordinated Universal Time
VMS	Variable message sign
WLAN	Wireless local area network

3 OVERVIEW AND OUTCOMES

This section defines the purpose of the equipment within the operational system.

3.1 ITS delivery specification definition

Delivery assurance is managed through a series of delivery specifications which support procurement and systems integration. The key risks that specifications address are ensuring the correct equipment is being procured, that it will integrate with operational systems and will deliver the correct functionality and performance requirements.

3.2 Overview

The purpose of this document is to specify the minimum requirements for the procurement of variable message signs (VMS) by Waka Kotahi. In addition, this specification details system integration requirements (such as protocols, interfaces, data standards etc) to ensure compliance with Waka Kotahi operational and asset management systems.

The outcomes of the specification are to provide guidance in order to procure high quality, energy efficient and long-lasting VMS which have a proven track record in a similar operating environment to New Zealand. Additional requirements to support other applications will be added over time.

The specification does not describe the detailed form and message configuration/limitations of a VMS; the pixels are detailed in the latest version of ITS design standard: VMS – Fixed.

3.2.1 Definition

A VMS is an electronic traffic sign used on roadways to give travellers information about special events. They warn of traffic congestion, accidents, adverse weather conditions and incidents. They may also ask vehicles to take alternative routes, limit travel speed, warn of duration and location of incidents, or just inform of traffic conditions.

3.2.2 Class

001 Signs.

3.3 Scope

This document specifies procurement requirements for fixed VMS:

Sign types	Motorway/expressway	Regional types A and C	Urban type D (EJT)

This delivery specification applies only to standard dimension, fixed location, VMS, ie those on which messages can be created because the finest individual pixels can be in multiple states (off or any available colour).

Continuous signs, which are similar to fixed signs, are not covered by this specification. Note that the only difference between a fixed sign and a continuous VMS is the ability of the latter to show messages by some electro and/or mechanical means, eg rotating prisms.

This document does not cover any other form of electronic roadside signage such as relocatable (mobile) VMS, lane control signals, school zone signs, speed-activated warning signs and advanced warning signs (regional intersection or ramp signal types A and B).

VMS types used exclusively by territorial local authorities are outside the scope of this specification. Design and installation of fixed VMS sites is covered in the latest version of ITS design standard: VMS – Fixed.

3.4 Applicable legislation

All ITS equipment must be capable of being installed and maintained in accordance with the Health and Safety at Work Act 2015.

3.5 Outcomes

3.5.1 Operational

The intended operational outcomes of this Waka Kotahi specification are to:

- increase road user acceptance of the information by improving the quality of information and images on VMS in normal and adverse conditions
- improve quality of transport operations centres' (TOCs') operational activities around VMS (VMS status condition and fault logging)
- minimise maintenance costs
- improve renewal cycles.

By developing this specification, Waka Kotahi is to achieve the following strategic outcomes specifically to ensure and enhance the Waka Kotahi dynamic, in-trip messaging capability including (but not limited to):

- enhancing road user notification in normal and adverse conditions
- increasing road user awareness of traffic conditions to assist with improved safety, to provide journey options and to reduce congestion
- improving whole-of-life ITS-related costs by supplying quality VMS assets, including reducing the Waka Kotahi environmental footprint through reduced energy consumption
- minimising constraints associated with power and energy requirements to drive assets in rural applications.

This specification for VMS contributes to the Waka Kotahi strategic fit, operational services, safety, efficiency and value for money.

VMS must provide a guaranteed delivery level of service (LoS) (ie a mechanism to communicate to road users by the nature of VMS being positioned adjacent to, or above, traffic lanes) for messaging Waka Kotahi users.

These are the requirements. The VMS must:

- be able to display and maintain highly visible and legible messages to road users under all conditions
- be positioned in locations which maximise visibility both optically (optimising height and viewing angles) and logically (preceding important journey decision points). These aspects are covered in the latest version of ITS design standard: VMS – Fixed
- not constrain the ability to deliver required messages (noting message configuration will change with operations requirements)
- provide operational status feedback to confirm that VMS are displaying the required message.

3.5.2 For users of the Waka Kotahi transport network

VMS are intended to provide a mechanism to advise users of road conditions, route availability and journey time estimates. The desired outcome is to keep users well informed at all times and in all weather conditions, receiving timely information which will help them undertake their journeys safely and efficiently.

VMS infrastructure is used to advise of adverse weather conditions, road closures and detours, and traffic conditions in real time, and to warn of advance works or events which may adversely affect users' journeys.

3.5.3 For road controlling authorities

VMS must be effective, reliable and durable as they are deployed in harsh outdoor environments and exposed to extremes of temperature and weather, as required in section 5 Performance requirements. Trouble-free operation for many years is expected (section 5.1 Resistance to the effects of external conditions). VMS are tools that enable road controlling authorities (RCAs) to actively manage incidents and roadworks.

4 FUNCTIONAL REQUIREMENTS

This section outlines what the equipment and systems need to do (functional), and how they need to do it (non-functional).

4.1 Full-colour display matrix

Full-colour VMS must be able to display text and graphics as defined in section 5.4.1 LED colour palette.

4.2 Display uniformity

The display of the VMS must appear to be uniform and consistent across the display board and in the following areas.

4.2.1 Luminous intensity (brightness)

There must be no visible variation in brightness across the display. The luminous intensity of VMS must be capable of automatically adjusting to align with ambient lighting conditions.

4.2.2 Colour

Optically there must be no visible variation in the colour of the light produced across the display.

4.3 Contrast ratio

The primary means of maintaining a legible and visible message is by controlling the contrast ratio. Visibility relies on the ratio between the illuminated pixels and the reflected light from the non-illuminated background, as specified in section 5.2 Display matrix finish.

The VMS must support the ability to automatically increase or decrease the luminous intensity (brightness) in response to ambient conditions to maintain the contrast ratio under all operating conditions.

The contrast ratio must ensure that all images displayed on the VMS are clearly legible under all conditions.

4.3.1 Border sizing to support the contrast ratio

A border is required around the display matrix to support the contrast between the displayed message and ambient lighting conditions. The width must measure between 5% and 15% of whichever measurement is smaller and must be the same width on all sides. Refer to Appendix A – Waka Kotahi VMS types.

For a fixed frame size the border width can be reduced to maximise the usable space available on the display matrix area (subject to section 5.2 Display matrix finish). This enhances the operational capability to increase the font size and enhance the readability of messages. Refer to Appendix B – VMS dimensions.

4.4 Display matrix pixel control

Each individual pixel must be able to be addressed and controlled separately. In effect the VMS is full colour and graphics capable – it is not constrained to use alphanumeric characters or predefined symbols.

The use of fully configurable displays allows flexibility to introduce new graphic symbols in the future should the (currently unforeseen) operational need arise. Note: The development of new graphic symbols must be in accordance with the Waka Kotahi Traffic control devices manual (TCDM).

Refer to Appendix A – Waka Kotahi VMS types which notes the minimum message display dimensions required by Waka Kotahi.

4.5 Display matrix parameters

The VMS display must consist of a full matrix and be capable of displaying a single steady screen and two alternating screens depending on message length.

4.6 Visible flicker – machine readability

During testing there shall be no visible light flicker, whether the LEDs of a VMS are operating at full intensity or are dimmed. Further, VMS messages must be machine readable, eg by CCTV cameras.

4.6.1 Frequency

The LCS must meet the frequency requirement of 100Hz or greater.

4.7 Sign controller

4.7.1 Status reporting

Retain fault logs locally until retrieved by the Waka Kotahi-authorised asset manager or logging system report VMS fault conditions to the central control system as soon as the communication network is available

4.7.1.1 Retention period

Minimum of 24 months.

4.7.2 Fault reporting

The sign controller must monitor the operation and health of the VMS and communicate status with the control room. Alerts on operators' workstations indicate whenever a problem occurs which will prevent correct display of messages on the VMS.

There are several conditions which must be drawn to operators' attention which must be provided by the VMS supplier. There are three levels of criticality:

- Critical: detected fault results in unit outage or may have safety implications.
- Urgent: detected fault prevents designed operation to support outcomes.
- Routine: detected fault has no impact on operation to support outcomes.

4.7.2.1 Fault reporting error types

The minimum error types are:

Error type	Definition
Pixel	Pixels can fail from time to time. A pixel error will be raised when pixels fail. Should multiple failures occur on an individual board, this may affect message interpretation in which case the VMS will generate a pixel error and all LEDs will be turned off (the sign will blank). The percentage of pixels or colour channels failing that will raise an error must be configurable in software and hardware and be capable of identifying the position of individual pixel faults. The configuration of display alarms is to be discussed post contract award with the successful supplier. The display module(s) where faults have occurred must have a visible fault indicator to facilitate efficient maintenance removal and replacement.
Message	The sign is not able to display any message either because of internal device failure(s) or because the VMS is unable to resolve a message in the format in which it is presented (eg if the characters contained exceed the maximum message length).
Power	This error is raised when one or more power supplies becomes faulty or the mains power supply fails.
Temperature	If the internal temperature inside the enclosure exceeds a threshold level, the sign must be turned off to protect the sensitive electronic components from damage.
Photocell	A pair of photocells are used to measure the ambient light at the sign and adjust the brightness of the LEDs to suit. If a photocell fails, the sign could become either too dim or too bright to be legible.
Internal communication	This error advises a communication failure within the VMS unit.

4.7.3 Error handling

Incorporate an error handler to detect out-of-program conditions and reset the controller.

The error handler must put the VMS into a known state, eg clear the message automatically and immediately in the event of internal or external critical failures such as a communications failure.

All errors must be logged.

The VMS must take appropriate action when faults arise. Under no circumstances can the VMS display to road users:

- brightness levels which are inconsistent with ambient lighting or are not uniform across the display
- partial, incomplete or otherwise potentially unintelligible messages.

4.7.4 Configuration and administration

The sign controller must:

- provide an interface in the VMS for a device to be connected to upload and download graphics and facilitate diagnostic testing. The VMS must support both local and remote access for manufacturer's proprietary software. Associated software must be provided by the manufacturer for use by Waka Kotahi or their agents
- store 150 text-based messages or graphic images for immediate display
- have sufficient RAM memory to upload and download messages as defined above

4.7.5 Command and control

The sign controller must:

- be able to operate the VMS in both local-control mode (ie no external communications) and remote-control mode (ie communicating with an external central control system)
- in both local and remote modes, support technician/operator selection of all NTCIP 1203 v03 National Transportation Communications for ITS Protocol – Object Definitions for Dynamic Message Signs (DMS) (NTCIP 1203) functions (such as manually changing dimming level, commanding display of pre-stored messages, and running diagnostic routines capable of testing full VMS operation)

4.8 Message sources

The VMS must be able to display graphic symbols (which resemble alphanumeric characters or pictograms) requested from approved external sources (such as TOCs) or as part of a local response (such as from a remote tunnel SCADA system).

4.9 Remote configuration

The VMS must support remote configuration by RCAs or their appointed agents such that text and graphics can be uploaded into the onboard library, and modifications can be made to font files and other configurable objects.

4.10 Status information

The VMS must be able to communicate status including faults, confirm receipt and read-back messages, and communicate any required performance parameters to the approved external source(s).

4.10.1 Status update in real time

Status information must be updated in real time (less than two seconds).

4.11 Storage of text and graphics

The VMS must be able to display alphanumeric messages and graphics from an onboard library which can be commanded without sending the full content of the message, eg a complex message could be stored with the label ‘Message1’; receiving a properly formatted request to display Message1 would display the complex message.

4.12 Internal logging requirement

The VMS must maintain logs and retain performance parameters including fault conditions until they are retrieved (and removed) during the prevailing periodic maintenance cycle for resolution.

4.12.1 Internal logging retention period

Logs and performance parameters captured by the VMS must be retained for a minimum two-year period.

4.13 Message currency

The VMS must ensure that messages are kept up to date by maintaining regular contact with the message source. The VMS must continue to display the current message if regular communication is lost.

4.13.1 Configurable communication loss period

The period of time of no communications between the VMS and its message source after which the VMS assumes that a communication fault has occurred is required to be configurable with a default setting of 12 minutes.

4.13.2 Settings

- The default setting is 12 minutes.
- Must be confirmed with Waka Kotahi Transport Operations in line with the application of the VMS.

4.14 Prompt message display

The time difference between receipt and display of all messages must be compliant with section 5 Performance requirements such that there is no discernible lag between one device updating and updating of the adjacent VMS.

4.14.1 Display update time

For VMS in a group or pair, the maximum lag between sequential VMS updating is one second.

4.15 Message queuing and prioritisation

Message prioritisation (contention) must be resolved solely on NTCIP 1203 parameters.

The VMS must be able to order incoming messages based on the priority of the message received and against the current run time message priority. The message with the highest priority must be displayed on the VMS.

Incoming messages must be stored and queued in priority order, pending display.

4.16 Compliance with Waka Kotahi protocols and other control interfaces

The VMS must be configured to comply with prevailing Waka Kotahi protocols, and other control interfaces as specifically requested in the procurement documentation.

4.17 Integration with existing Waka Kotahi traffic management system

VMS procured using this specification must be able to interface seamlessly with the Waka Kotahi current advanced traffic management system (ATMS).

4.18 Testing and compliance

The test plan for VMS is being confirmed and an interim version is available on request by emailing Waka Kotahi at itsspec@nzta.govt.nz

5 PERFORMANCE REQUIREMENTS

This section outlines the reliability and availability requirements of equipment which may require independent certification and/or declarations of conformity.

5.1 Resistance to the effects of external conditions

The operating environment of VMS can be relatively harsh. Equipment that is deemed fit for purpose is expected to continue to operate effectively exposed to the New Zealand environment (as per NIWA) for a minimum of 15 years. It is essential that materials and manufacturing processes take this into account.

VMS must be resistant to a wide range of challenging conditions including strong direct sunlight, high ultraviolet (UV) light levels, extremes of temperature, severe winds (gusts up to 250km/h), marine conditions (sea salt exposure), rainfall (up to 18m annually), snow and ice.

VMS shall be capable of continuous, normal operation (24/7 day and night) and maintaining performance criteria in the conditions described below:

- installed and operated in direct sunlight
- ambient temperature range between –25ºC and +55ºC (class T2 as per EN 12966:2014+A1:2018 Road vertical signs – Variable message traffic signs [EN 12966])
- enclosure air temperature between –20°C and +75°C
- maximum wind conditions likely to occur at the installation site as per AS/NZS 1170.2:2011 Structural design actions – Part 2: Wind actions
- solar radiation with value of up to 5000W/m² at direct sunlight, incident at an angle of 30° from the vertical
- varied light intensity due to shadows
- altitude up to 1000m
- humidity between 10% to 95% non-condensing
- conditions, both permanent and temporary, that may be unique to the specified location, eg instances of thick smoke and electromagnetic interference
- vibrations expected in the installed location
- marine environment
- road surface reflection
- seismic shock resistance to magnitude 8.5.

VMS operation shall cause no adverse effect to the surrounding environment in which it is installed. Conversely, VMS shall not be affected by adverse environmental conditions expected at the intended installation location.

5.2 Display matrix finish

The finish of all VMS surfaces should not result in specular (mirror) reflection that distracts road users.

5.2.1 Display board surfaces

The display board must:

- not reflect light back to the user in order to support contrast of the message being displayed
- be finished in matt black
- be powder-coated
- not use smooth, monolithic front screens (such as polycarbonate panels).

5.2.2 Frame surfaces

Frame surfaces must be powder-coated.

The colour of the frame coating is to be BS381 693 Aircraft grey.

The coating must facilitate the removal of graffiti.

5.3 Mechanical

VMS shall be designed to ensure reliable transfer of all static and dynamic forces to the fixing and mounting structures.

VMS must meet class WL9 as per EN 12966 for wind loading, class DSL4 as per EN 12966 for dynamic snow loading, class TBD6 as per EN 12966 for temporary bending deflection. See EN 12966 section 4.5.2.5 Mechanical performance requirements.

5.3.1 Resistance of electrical/electronic components to the effects of pollution

The manufacturer shall declare the degree of resistance in accordance with EN 12966 section 4.5.2.2 Resistance of electrical/electronic components to the effects of pollution.

5.3.2 Resistance of VMS to surface corrosion

The surface protection of VMS enclosures against corrosion shall be class SP2 as per EN 12966 and meet the requirements of EN 12966 section 4.5.2.3.2 Resistance to corrosion of discontinuous VMS.

5.3.3 Enclosure: ingress protection against water and dust

VMS enclosures shall be protected against water and dust ingress in accordance with EN 12966 section 4.5.2.4 Ingress protection against water and dust (IP) provided by enclosure. All VMS enclosures must meet a minimum IP rating of IP56 (P3 as per EN 12966).

5.3.4 Enclosure: protection against external mechanical impacts

The sensitive electrical equipment inside VMS shall be given adequate protection against mechanical impacts such that the enclosure does not deform, delaminate, lose its structural integrity, or suffer a reduction in ingress protection if struck. The VMS must meet a rating of IK10.

5.3.5 Service replacement

VMS shall be:

- designed to be installed and maintained by local technicians following manufacturer's supplied documentation
- accessible for replacement in the field.

5.4 Visual performance

5.4.1 LED colour palette

When observing the whole VMS front screen from all viewing angles within the specified beam width, colours shall not be discernible as individual red, green and blue light sources.

Each individual red, green and blue LED must be capable of displaying 256 shades of corresponding colours equating to 255 x 255 x 255 colour (>16 million colours).

5.4.2 Colour

All VMS must meet colour class C2 as per EN 12966.

The chromaticity coordinates of the required colour parameters are defined in table 3 and figure 1 of EN 12966 section 4.4.2 Colour.

5.4.3 Luminance

All VMS must meet luminance levels to class L3 as per tables 4 to 9 of EN 12966 section 4.4.3 Luminance.

5.4.4 Luminance ratio

All VMS must meet luminance ratio (LR) class R3 as per table 10 of EN 12966 section 4.4.4 Luminance ratio.

5.4.5 Beam width

High-speed roads with two or more running lanes typically use beam width B5 as per EN 12966 section 4.4.5 Beam width. All other roads typically use beam width B6. It is the designer's responsibility to select the correct beam width and this should be reflected in procurement documentation.

Selecting beam widths that are too wide for the location costs money, wastes energy and creates light pollution. Further guidance on beam width selection based on road topology (eg steep gradients) can be found in the latest version of ITS design standard: VMX – Fixed.

5.4.6 Uniformity of luminous intensity

There are two requirements around luminous intensity for which each colour (as specified in section 5.4.2 Colour) must be tested, as follows:

Luminous intensity		Ratio of output
Highest 12%	Lowest 12%	3:1
Highest 4%	Lowest 4%	5:1

5.4.7 Visible flicker – machine readability

The VMS must meet the frequency requirement of 100Hz or greater.

5.4.8 Design life

The specified design life (operational service life) of the VMS is 15 years.

5.4.9 Degradation of visual performance

VMS design solutions must consider the impact to visual performance (ie colour, luminance and LR) caused by ageing effects. The visual performance requirements are minimum requirements and must be achieved during the entire operational lifetime of the VMS (see section 6 Technical requirements).

6 TECHNICAL REQUIREMENTS

This section outlines specific technical and technology constraints for the equipment.

6.1 Electrical safety

All ITS equipment must comply with and be installed in accordance with the Electricity (Safety) Regulations 2010 (SR 2010/36).

VMS shall conform to:

- AS/NZS 3000:2018 Electrical installations – known as the Australian/New Zealand Wiring Rules
- EN 12966 section 4.5.3.2 Electrical safety.

All serviceable components should be secured with fastening made from non-conductive materials.

The VMS enclosure must not have any exposed electrical contacts.

6.2 Electrical

6.2.1 Power supply

The following methods of supplying power to a VMS are acceptable:

- reticulated mains – 230V AC
- via solar panel
- other renewable energy sources, eg wind turbine.

The VMS shall have the necessary termination equipment to cater for reticulated mains power supply or other type(s) (specified during the procurement).

The VMS enclosure must not contain UPS or batteries. If required, an alternative power source should be housed separately near to the enclosure.

6.2.2 Power consumption

Power consumption can be a significant operational cost factor.

Waka Kotahi wishes to act sustainably and responsibly, minimising power usage and carbon footprint. Value for money, total cost of ownership and quality are important factors in the procurement of VMS:

- Manufacturers must state typical and maximum power consumption figures throughout the expected design life for consideration in procurement evaluation.
- The maximum power consumption for VMS with all LEDs illuminated at maximum brightness must not exceed the ratings listed in Appendix A – Waka Kotahi VMS types.

6.2.3 Nominal voltages

The standard nominal voltage for connection to the public supply shall be taken to be 230V AC RMS single phase.

6.2.4 AC operating voltage range

Variations in the nominal supply voltage defined in EN 12966 section 4.5.3.1.3 Operating voltage range shall not affect the VMS functions. This shall be tested in accordance with tables 16 and 17 of EN 12966 section 5.4.2 Electrical tests, and shall meet the requirements given therein.

6.2.5 Mains frequency

Variations within the frequency range of 50 ± 1 Hz shall not affect the VMS functions.

6.2.6 Power-up activation

The VMS shall be ready for activation when the supply voltage reaches a value within its operating voltage range. At no time during power-up activation shall partial, incomplete or false messages be displayed.

6.2.7 Low voltage – switch-off voltage response

A drop in the nominal voltage of more than 13% shall not cause partial, incomplete or false messages to be displayed or cause damage to the VMS.

6.2.8 Low voltage – voltage interruption

The effect of voltage interruption shall be as per EN 12966 section 4.5.3.1.6.2 Voltage interruption.

6.2.9 Low voltage – temporary over-voltage

When protection for temporary (not transient) over-voltage is incorporated, the operating voltage range of the protective device shall be stated and shall be tested in accordance with table 16 of EN 12966 and shall meet the requirements given therein.

6.2.10 Electromagnetic emission and immunity

For all types of environment, the VMS shall conform to EN 50293:2012 Road traffic signal systems. Electromagnetic compatibility.

The performance of any external equipment must not be interrupted by any radio frequency or electromagnetic interference generated by the VMS or vice versa.

6.2.11 Electrical surge protection

All equipment shall be internally protected against damage resulting from:

- lightning strikes near the VMS or gantry
- electrical transients on power cabling

- electrical transients on internal and external signal wiring
- electromagnetic interference
- static electrical discharge.

Surge protection shall be provided on the incoming power circuits and communications circuits.

6.2.12 Service socket

All enclosures shall be fitted with a single-phase switched 10A-rated power outlet socket, in accordance with AS/NZS 3112:2017 Approval and test specification – Plugs and socket-outlets.

6.3 Sign controller

The embedded controller must:

- support a fully featured, industry standard, embedded operating system
- be able to support various industry standard protocols such as RS485/RS422, Ethernet IP and WLAN.

The controller must:

- support NTCIP 1203 including MULTI and, as a minimum, support MIB elements defined in the test plan (available by emailing Waka Kotahi at itsspec@nzta.govt.nz)
- comply with Waka Kotahi or local authority (if applicable) security requirements
- control the display of messages on the VMS
- receive direct manual instruction from vendor proprietary software (local or remote)
- provide an interface for a laptop computer running Microsoft Windows operating system for configuration, uploading and downloading messages, and diagnostic testing
- display the message within an elapsed time of less than one second of receiving the command
- support time synchronisation from an external clock, eg UTC, NTP.

6.4 Physical characteristics

6.4.1 Front panels

VMS front panels should be designed in such a way that no part of the message displayed is obscured when observed from the required viewing positions. They should be designed in such a way as to minimise the effects of ice and snow.

6.4.2 Front screens

Front screens adversely impact the intensity of light being transmitted from the VMS and can be prone to degradation caused by weathering and exposure to intense direct sunlight. Consequently, monolithic screens such as polycarbonate panels or louvres are not permitted.

VMS which allow portions of the front screen to be removed (modular) may risk weather tightness of the enclosure and are not permitted.

6.4.3 Display matrix

6.4.3.1 Physical layout

The display must be formed using a regular matrix, ie the spacing between individual light sources in both the x and y axes is uniform.

The display area (height x width) is specified in Appendix A – Waka Kotahi VMS types, for different VMS types (based on road operating speed, location).

6.4.3.2 Display technology options

LED technologies are the default choice for the displays for all VMS applications. This technology provides good visibility under most viewing conditions, high reliability and low optical degradation, and has low maintenance requirements.

6.4.3.3 Pixel pitch

The pixel pitch defines the resolution of the VMS. For legibility and particularly for accurate representation of graphical images, the higher the resolution, the more an image matches a fixed sign.

On large VMS installed above or alongside state highways, the maximum pixel pitch must be 20mm. For smaller VMS used on local roads, the maximum pixel pitch must be 16mm.

6.4.3.4 Beam width

Depending on application, the minimum beam width shall be in accordance with EN 12966 section 4.4.5 Beam width. The following table provides additional information.

Beam width class	Beam angles				Typical	
	Horizontal			Vertical	Application	Character height
B1	–5°	0°	+5°	0° 0° –5°	High-speed road, two running lanes plus one safety lane. VMS gantry-mounted centrally over running lanes.	300mm 400mm
B2	–7°	0°	+7°	0° 0° –5°	High-speed road, three running lanes plus one safety lane. VMS gantry-mounted centrally over running lanes.	300mm 400mm
B3	–10°	0°	+10°	0° 0° –5°	High-speed road, four running lanes plus one safety lane. VMS gantry-mounted centrally over running lanes or at side of road, requiring a wider beam to cover up to two lanes.	300mm 400mm
B4	–10°	0°	+10°	0° 0° –10°	As B3 above. VMS mounted at height of 6m or more.	300mm 400mm
B5	–15°	0°	+15°	0° 0° –5°	As B3 above, but extra-wide VMS covering more than two lanes.	200mm 300mm 400mm
B6	–15°	0°	+15°	0° 0° –10°	As B5 above. VMS mounted at height of 6m or more.	200mm 300mm 400mm
B7	–30°	0°	+30°	0° 0° –20°	For special applications, where very wide horizontal and vertical beam widths are required. In urban areas B7 could be suitable for cyclist and pedestrian audiences.	Not specified, however 200mm character height is minimum for urban roads in NZ.

6.4.3.5 LEDs

VMS suppliers are required to provide evidence that LEDs supplied as part of any VMS meet the quality, luminous intensity ratings, batch requirements and life expectancy (refer to section 5.4.8 Design life).

Details of the current rating of the proposed LEDs to be used, and what actual current they will be driven at to meet the luminous intensity requirements, must be provided.

LEDs must be sourced from the same batch/bin in order to mitigate the risk of minor variations in colour output.

The latest high-quality manufacturing techniques must be used to ensure that:

- exposure of components to mechanical or thermal stress is minimised
- manual handing of sensitive componentry is minimised
- conformal coatings are consistently applied to circuit boards to minimise exposure to condensation.

Whilst there is no standard size prescribed for the modules forming the display, they should be of a size that is easy to replace with the VMS in situ in the field and without the need to dismantle any part of the VMS. No soldering or heat-based bonding is permitted to be undertaken as part of VMS maintenance. Removal or replacement of display modules must be tool free.

6.4.4 Heating and forced ventilation

The provision of heaters and fans for supplementary environmental control within the enclosure is not permitted.

6.4.5 Doors and maintenance access

Must include physical security against unauthorised access.

All covers, doors, protective screens, plates, glands, external connectors etc shall be provided with rubber seals or equivalent materials which are maintenance free and shall remain effective for the design life of the equipment.

Where access doors are provided, they shall be fitted with a suitable retention stay to hold the door in the open position for the safety of maintenance personnel working inside the enclosure. For security, access doors and panels shall be fitted with suitable locks (one lock per door/panel), designed for outside conditions. Unless specified otherwise, all access door locks shall have an identical key and the supplier shall provide at least four copies of the key.

For regional VMS, the enclosure is located approximately 3m above the ground. The design should ensure ease of access to components for ladder-based access or facilitate the use of portable access equipment (eg scissor lift or cherry picker).

6.4.6 Cable entries

All power supply, control and communication cabling shall enter the VMS enclosure through appropriately constructed, sealed and glanded entry holes. The location of the entry points is specified on the manufacturer’s design drawings approved by Waka Kotahi. All the cable entry points must be through the bottom of the VMS frame.

6.4.7 Electrolytic compatibility

Components shall comprise materials that when assembled into the VMS are electrolytically compatible and environmentally stable.

6.4.8 Lifting eyes

The enclosure shall be provided with at least two lifting eyes which enable the VMS to remain horizontal when lifting the enclosure onto the support structure.

The lifting eyes shall be appropriately located ensuring sufficient structural strength to allow the VMS to be lifted or moved without causing any damage or deformation to any part of the VMS.

6.4.9 Mounting to support structure

The VMS must be designed to be mounted to the structure on which it will be supported. Modifications to the VMS enclosure are not permitted once it has left the place of manufacture.

The VMS enclosure mounting points must be agreed with the Design Engineer. The mounting points are specified in the site or gantry design.

Penetration through the enclosure for mounting is not permitted. Captive nuts in the VMS must be used to attach the structure to the VMS with appropriately sized fixings (bolts or screws).

6.4.10 Transportation

VMS should be shipped in containers that protect their contents from damage in transit including extreme temperature, humidity, impact/shock etc. The units must be wrapped to prevent contamination and the packaging should be fitted with a device to indicate whether the unit has been subjected to rough treatment during its journey.

6.4.11 Certification and declarations of conformity

All VMS supplied to Waka Kotahi must include:

- certification from an accredited independent testing facility demonstrating compliance with EN 12966
- a declaration of conformity from the manufacturer for each of the following industry standards:

Declarations of conformity
AS/NZS 1170.2:2011 Structural design actions – Part 2: Wind actions
SR 2010/36 Electricity (Safety) Regulations
EN 50293:2012 Road traffic signal systems. Electromagnetic compatibility
AS/NZS 3112:2017 Approval and test specification – Plugs and socket-outlets
BS381 693 Aircraft grey
AS/NZS ISO/IEC 27001:2006 Information technology – Security techniques – Information security management systems – Requirements
AS/NZS ISO/IEC 27002:2006 Information technology – Security techniques – Code of practice for information management
IEC 61508 series (for functional safety)

The supplier must provide supplementary report information from the testing facility stating all the tests performed, including, but not limited to, the LED colour(s), pixel pitch, beam width, luminance, luminance ratio and IP rating of the specific VMS type being supplied under the Waka Kotahi contract.

6.4.12 Documentation, software and licensing

6.4.12.1 Documentation

VMS vendors must supply OEM maintenance, service and operations guidelines and manuals which will include maintenance schedules and procedures, handling and storage, and spares list.

6.4.12.2 Software and licensing

VMS vendors must supply all software and licensing required to configure and manage the VMS to Waka Kotahi or their agent's use.

6.4.13 General

Item	Requirement
Availability	99.99% excluding mains power or external communications failures
Failure modes (power or communications failures)	• Display or enter default mode • Shutdown in safe manner where specified. • Automatic restart in safe manner upon restoration of power or communications
Privacy/security of data	Comply with AS/NZS ISO/IEC 27002:2006 Information technology – Security techniques – Code of practice for information management and AS/NZS ISO/IEC 27001:2006 Information technology – Security techniques – Information security management systems – Requirements
Functional safety	• Comply with the IEC 61508 series • Functional safety study in conjunction with Waka Kotahi to determine any safety integrity level (SIL) requirements
Traffic management protocol interface (API)	• Interface to traffic management system (TMS) via field processor • Device driver compatible with a field processor
Alarms, events and status	Configurable and monitored from TOCs
Communications	Interface to the Waka Kotahi communications network
Mean time between failure (MTBF)	All VMS equipment shall have a specified MTBF of 55,000 hours or greater, unless otherwise specified or approved in writing by Waka Kotahi
Disposal	VMS should utilise materials where possible which are recyclable to minimise the adverse environmental effect of disposal

6.4.14 FAT, SAT, commissioning, spare parts, servicing manuals, warranty, defects liability period

Spare parts must be available at least seven years after sign manufacture is discontinued.

Further requirements including, but not limited to, factory acceptance testing (FAT), site acceptance testing (SAT), spare parts inventory, service manuals, warranty, defects liability period and terms of payment must be specified by Waka Kotahi in the procurement of VMS but are outside the scope of this specification. The latest version of ITS design standard: VMS – Fixed provides advice on many of these aspects.

7 APPENDIX A – WAKA KOTAHI VMS TYPES

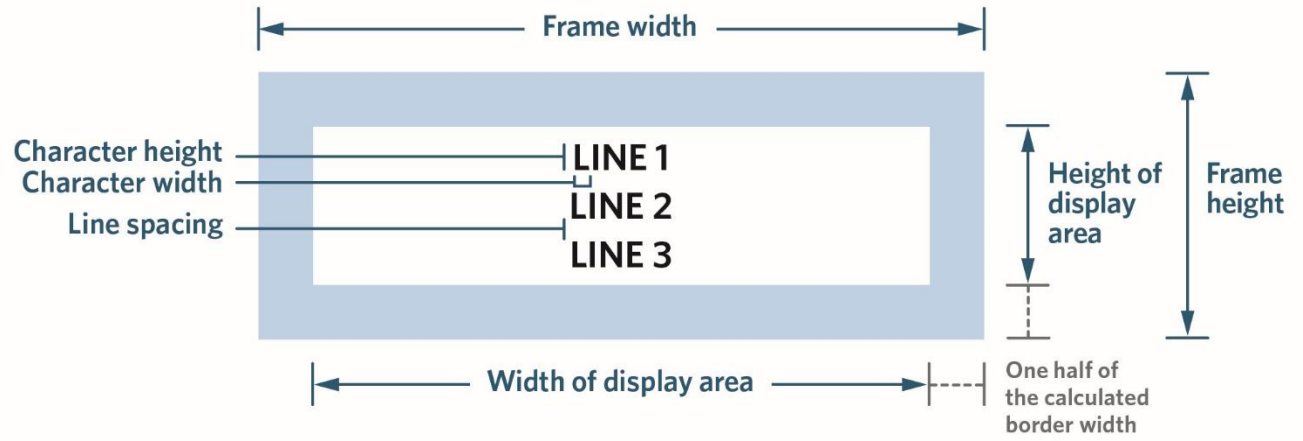
Waka Kotahi has made significant investment in VMS.

Regardless of their geographic location, all VMS are controlled from TOCs in Auckland and Wellington (and Lyttleton Tunnel, Christchurch) using the DYNAC ES traffic management system (TMS).

Consequently, a key operational requirement of VMS procured using this specification is to interface seamlessly with the DYNAC TMS. It is worth noting that the Waka Kotahi current version of DYNAC is not able to display multicolour messages (which many of the latest signs feature), however Waka Kotahi has an ATMS modernisation project underway which aims to update TMS functionality.

Type	**Motorway**	**Regional**		**Urban EJT Type D**
		Type A	**Type C**	
Location	**Motorways (urban state highways) and expressways**	**Rural state highways throughout NZ**		**Local road approaches to motorway interchanges**
Minimum character height (mm)	400	300	200	
Minimum border (mm)	100	75	50	
Lines of text	3	4		3
Minimum characters per line (DYNAC messages)	18	16		9
External VMS dimensions	7600 x 2300	4980 x 2390	3300 x 1590	1675 x 990
Minimum display area dimensions (w x h) (mm)	7040 x 1760	4800 x 2080	3072 x 1280	1536 x 896
Minimum pixel dimensions	352 x 88	240 x 104	192 x 80	96 x 56
Maximum pixel pitch (mm)	20		16	
Maximum power consumption (W)	2000	1500 (460 typical)	1250	440 (105 typical)
Maximum weight (kg)	800	625	280	60
Procurement documentation must require that structural supports and foundation are acceptable to accommodate both the dead weight and sail area of the VMS.				

8 APPENDIX B – VMS DIMENSIONS



9 REFERENCES

This section lists all external and Waka Kotahi references included in this document.

9.1 Industry standards

Standard number / name	Source	Licence type and conditions
Health and Safety at Work Act 2015	NZ Legislation website	Publicly available
SR 2010/36 Electricity (Safety) Regulations 2010	NZ Legislation website	Available for purchase
EN 12899-1:2007 Fixed, vertical road traffic signs – Fixed signs	Standards NZ website	Available for purchase
IEC 60529:1989/AMD2:2013 Amendment 2 – Degrees of protection provided by enclosures (IP Code)	IEC Webstore	Available for purchase
AS/NZS 1170.2:2011 Structural design actions – Part 2: Wind actions	Standards NZ website	Available for purchase
EN 12966:2014+A1:2018 Road vertical signs – Variable message traffic signs	Standards NZ website	Available for purchase
AS/NZS 3000:2018 Electrical installations – Known as the Australian/New Zealand Wiring Rules	Standards NZ website	Available for purchase
EN 50293:2012 Road traffic signal systems. Electromagnetic compatibility	Standards NZ website	Available for purchase
AS/NZS ISO/IEC 27002:2006 Information technology – Security techniques – Code of practice for information management	Standards NZ website	Available for purchase
AS/NZS ISO/IEC 27001:2006 Information technology – Security techniques – Information security management systems – Requirements	Standards NZ website	Available for purchase
IEC 61508 series (for functional safety)	IEC Webstore	Available for purchase
IEC 60598-1:2014/AMD1:2017 Amendment 1 – Luminaires – Part 1: General requirements and tests	IEC Webstore	Available for purchase
IEC 60068-2:2020 SER Series – Environmental testing – Part 2: Tests – ALL PARTS	IEC Webstore	Available for purchase
AS/NZS 3112:2017 Approval and test specification – Plugs and socket-outlets	Standards NZ website	Available for purchase

Standard number / name	Source	Licence type and conditions
NTCIP 1203 v03 National Transportation Communications for ITS Protocol – Object Definitions for Dynamic Message Signs (DMS)	NTCIP website	Available for purchase

9.2 Waka Kotahi standards, specifications and resources

9.2.1 Standards and specifications

See the Waka Kotahi website for the latest versions of the ITS design standards, delivery specifications and core requirements listed below.

Document name
ITS design standard: VMS – Fixed

9.2.2 Resources

Document name / code	Waka Kotahi website link
Traffic control devices manual (TCDM)	https://www.nzta.govt.nz/resources/traffic-control-devices-manual/

9.3 Drawings

See the Waka Kotahi website for the latest versions of the ITS standard drawings listed below.

Drawing number

9.4 Supplemental information

9.4.1 Mechanical performance requirements

Condition	Applicable standard	Advice		Requirement	
		Section of applicable standard	Factor	Section of applicable standard	Statement
Temporary deflections caused by wind loads	EN 12899-1	5.3.1	Wind load	5.4.1	Not to exceed the maximum for the relevant class
Permanent deflections caused by dynamic loads	EN 12899-1	5.3.2	Dynamic snow load		Not to exceed 20% of the temporary deflection using the same load
Impact resistance	IEC 60598-1: 2014/AMD1:2017 Amendment 1 – Luminaires – Part 1: General requirements and tests	Impact tests shall be conducted on horizontally mounted VMS/test module front panel using a steel ball of 50mm diameter with a mass of 0.51kg dropped from a height of 1.3m to produce an impact energy of 6.5Nm.			
		The VMS/test module shall be conditioned at a temperature of 20 ± 2°C and then be subject to three single impacts, at the weakest point on the front panel of the VMS/test module.			
		The VMS/test module shall be cooled to a temperature of -5 ± 2 °C, which shall be maintained for three hours. Whilst the VMS/test module is at this temperature it shall be subjected to three single impacts at the weakest point on the front panel of the VMS/test module			
		After the test the VMS/test module front panel or parts of it shall show no damage other than small indentations in the front surface; it shall exhibit no cracking. The VMS/test module shall continue to meet all the requirements of the standard.			
				No damage observed; CCM	
Vibration resistance	IEC 60068-2:2020 SER Environmental testing – Part 2: Tests – ALL PARTS	Mounting:	The VMS/test module shall be securely fixed to the vibrating table.		
		Reference and checkpoints:	The reference point shall be chosen on the vibrating table; in the case the VMS/test module is larger than the table it shall be a virtual point, where the reference signal spectrum will be defined as the arithmetic mean of ASD (Acceleration Spectrum Density) values of signals measured at the check points.		
		Frequency range:	10 Hz to 200 Hz		
		ASD levels	0.013 g²/Hz (10 Hz to 50 Hz). 0.013 g²/Hz (50 Hz to 200 Hz with a negative slope 3 dB/octave). Overall r.m.s. acceleration 2.2 g.		
		Duration of conditioning:	90 min in each of 3 axes.		
		Reproducibility:	Low.		
		Initial measurements:	Visual inspection and function test.		
		Functioning during conditioning:	No.		
		Final measurements:	Visual inspection and function test. After the test no parts appear loose, all functionality unchanged.		

9.4.2 Resistance of VMS to surface corrosion

Condition	Applicable standard	Requirement	
			Statement
Resistance to corrosion – salt spray test	EN 60068-2	Initial measurements:	Visual inspection and function test.
		State of the VMS/test module during the test:	Unpacked, locked and switched off.
		Duration of test:	240 hrs
		Operating conditions:	35°C ± 2°C neutral salt spray
		Treatment after test:	Rinse with fresh, deionised water
		Final measurements:	Visual inspection and function test. After the test corrosion shall not be observed on any parts inside or outside the VMS/test module.

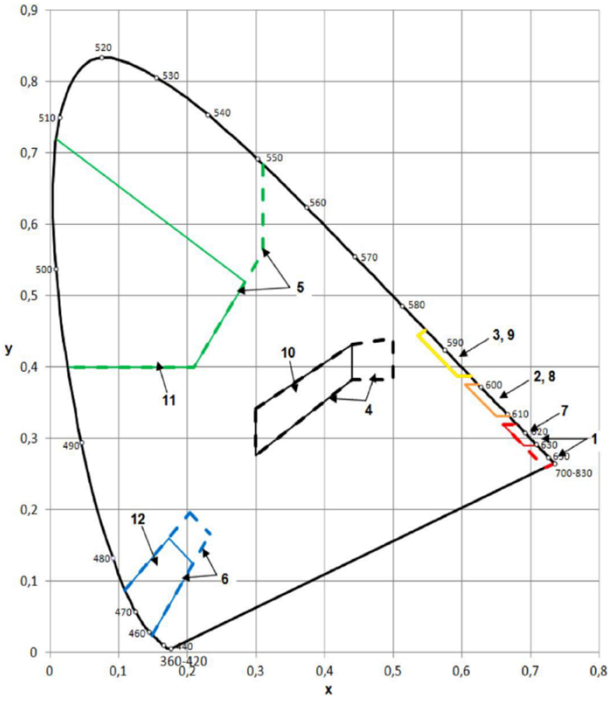
9.4.3 Enclosure: ingress protection against water and dust

Condition	Applicable standard	Test criterion	
Water ingress	IEC 60529	Severity:	In accordance with IEC 60529.
		Pre-conditioning:	None.
		Initial measurements:	Visual inspection and function test shall be conducted before commencing the conditioning period.
		Conditioning:	The equipment shall be hosed on all faces and at all angles from vertically down to horizontal concentrating on points to be —"most likely" to result in water ingress.
		Intermediate measurements:	The equipment shall be switched on and function test shall be continuously repeated throughout the test.
		Final measurements:	Visual inspection and function test. Acceptance in accordance with IEC 60529 ingress is allowed provided it has no harmful effect.
Dust ingress	IEC 60529	Severity:	In accordance with IEC 60529 category 2.
		Pre-conditioning:	None.
		Initial measurements:	Visual inspection and function test shall be conducted before commencing the conditioning period.
		Conditioning:	The equipment shall be switched OFF.
		Intermediate measurements:	None.
		Final measurements:	Visual inspection and function test. Acceptance in accordance with IEC 60529 category 2.

9.4.4 Colour chromaticity diagrams

The solid coloured lines in the chromaticity diagram show the areas for the colours of class C2.

Colour	Axis	Colour coordinates of corner points			
		1	2	3	4
Red	x	0.660	0.680	0.710	0.690
	y	0.320	0.320	0.290	0.290
Orange	x	0.624	0.605	0.650	0.669
	y	0.370	0.370	0.331	0.331
Yellow	x	0.536	0.547	0.613	0.593
	y	0.444	0.452	0.387	0.387
White	x	0.300	0.440	0.440	0.300
	y	0.342	0.432	0.382	0.276
Green	x	0.009	0.284	0.209	0.028
	y	0.720	0.520	0.400	0.400
Blue	x	0.109	0.173	0.208	0.149
	y	0.087	0.160	0.125	0.025



1: Red, 2: Orange, 3: Yellow, 4: White, 5: Green, 6: Blue, 7: Red, 8: Orange, 9: Yellow, 10: White, 11: Green, 12: Blue

9.4.5 Luminance and LR levels

The * superscript denotes the luminance and LR levels required for scenarios when the sun is low in the sky.

Row ref.	VMS illuminance (lx)	Luminance limits for specified colour on reference axis – L3, L3(*) (cd/m²)					
		White		Yellow		Orange	
		$L_{a(min)}$	$L_{a(max)}$	$L_{a(min)}$	$L_{a(max)}$	$L_{a(min)}$	$L_{a(max)}$
1	40,000	12,400	37,200	7440	22,320	4800	14,400
2	10,000	12,400 (*)	37,200	7440 (*)	22,320	4800 (*)	14,400
3	4000	2200	6600	1320	3960	852	2556
4	400	600	1800	360	1080	232	696
5	40	250	750	150	450	100	300
6	<= 4	75	225	45	135	28	84

Row ref.	VMS illuminance (lx)	Green		Red		Blue	
		$L_{a(min)}$	$L_{a(max)}$	$L_{a(min)}$	$L_{a(max)}$	$L_{a(min)}$	$L_{a(max)}$
1	40,000	3720	11,160	3100	9300	1240	3720
2	10,000	3720 (*)	11,160	3100 (*)	9300	1240 (*)	3720
3	4000	660	1980	550	1650	220	660
4	400	180	540	150	450	60	180
5	40	75	225	63	189	25	75
6	<= 4	23	69	19	57	7.5	22.5

		Minimum LR					
Class	**Colour**	White	Yellow	Orange	Green	Red	Blue
R3	On reference axis	16.7	10	6.5	5	4.2	1.7
	Vertical off axis	8.35	5	3.25	2.5	2.1	0.85

9.5 Operating voltages tests

Test sequence	Voltage value	Measurements
1	No power	No power supply
2	Nominal	Switch ON the VMS/test module and check that there is no partial, incomplete or false display
3	Nominal	Function test
4	Drop to the minimum voltage	Check that there is no partial, incomplete or false display
5	Drop to 50% of the nominal voltage	Check that there is no partial, incomplete or false display
6	Nominal	Check that there is no partial, incomplete or false display
7	Nominal	Function test
8	Raise to the maximum voltage	Check that there is no partial, incomplete or false display
9	Nominal	Check that there is no partial, incomplete or false display
10	Nominal	Function test
11[a]	Maximum voltage stated by the protection device	Check that there is no partial, incomplete or false display, no visual damage of the VMS/test module.
12[a]	Nominal	Check that there is no partial, incomplete or false display
13[a]	Nominal	Function test
[a] Test only to be undertaken if a protection device is incorporated		

Table 1: AC operating voltage tests

The functional test shall be repeated for different combinations of voltage and frequency in accordance with the following table:

Test sequence	Frequency value	Voltage value
1	Lower	Lower
2	Nominal	Nominal
3	Upper	Upper

Table 2: Permutations of voltage and frequency

Low-voltage interruptions. The effect of voltage interruption shall be as follows:

Duration (ms)	Effect
Less than 50	No effect
50 to less than 100	The VMS shall continue to display the current message but may be affected by a variation of luminance during the voltage interruption
Greater than or equal to 100	Shutdown is allowed unless specified by the purchaser. This shall not cause partial, incomplete or false messages to be displayed or cause damage to the VMS When the power supply is restored the VMS shall behave as described in Power-up activation (see section 6.2.7 Low voltage – switch-off voltage response)

10 CONTENT TO BE REDIRECTED

This section records any circumstances where content from this document will be reclassified and moved into future documents. This table is then updated with a reference to the new location.

Section reference	Section name	Future document	Class
4.7.5	Command and control, last bulleted point only: • support time synchronisation from an external clock, eg UTC, NTP)	Network time protocol design standard	012 System interfaces
5.1	Resistance to the effects of external conditions	Environmental core requirements standard	000 Core requirements
5.3	Mechanical	Environmental core requirements standard	000 Core requirements
5.3.5	Service replacement	Variable message signs – fixed design standard	001 Signs
5.4.5	Beam width, this sentence only: Selecting beam widths that are too wide for the location costs money, wastes energy and creates light pollution.	Variable message signs – fixed design standard	001 Signs
6.2	Electrical, excluding section 6.2.12 Service socket	Electrical core requirements standard	000 Core requirements
6.4.5	Doors and maintenance access, last paragraph only	Variable message signs – fixed design standard	001 Signs
6.4.6	Cable entries	Electrical core requirements standard	000 Core requirements
6.4.7	Electrolytic compatibility	Environmental core requirements standard	000 Core requirements
6.4.14	FAT, SAT, commissioning, spare parts, servicing manuals, warranty, defects liability period	Commissioning and handover core requirements standard	000 Core requirements