

TR 2518
Issue A
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**Specification for
Portable Variable
Message Signs for
use on the Highways
Agency Trunk Road
Network**

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TR 2518A

Specification for Portable Variable Message Signs

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1 INTRODUCTION

- 1.1 This specification covers the essential requirements for Portable Variable Message Signs (VMS) for use on the motorways and trunk roads operated and managed by the Highways Agency. Within this document a complete Portable VMS unit shall be referred to as the 'Equipment'.

Approval

- 1.2 Equipment manufactured according to this specification is to be approved in accordance with the Secretary of State's statutory requirements.
- 1.3 Approval shall be in accordance with the requirements of the self-declaration process in TRG 0600.

Note: It is recognised that at the time of publishing this specification that TRG 0600 may not fully cover all the self-declaration issues relating to VMS. This will be addressed during the period of any contract awarded on the basis of this specification.

Implementation

- 1.4 This standard will be immediately implemented from the date of issue. New approvals will be conducted against this standard and TRG 0600.
- 1.5 Approvals issued against previous standards will remain valid. Retrospective action against this standard will not be mandatory.

Glossary of Terms

The following terms are used in this specification:

Approval Authority	The purchaser of the Equipment
Character Module	A matrix of light-emitting cells used for the display of individual text characters comprising 7 rows each of 5 cells
Contractor	The organisation which has entered into the Contract with the Purchaser, including its sub-contractors and suppliers
Control System	Electronic equipment used by the Purchaser at an installation to set and clear messages from the Equipment. It shall also monitor the Equipment by receiving status messages

Design Authority	The organisation responsible for the design of the Equipment
Display Panel	The portion of a Portable VMS containing Character Modules and Lanterns upon which Messages are displayed. It includes the border surrounding the display elements which incorporates Lanterns.
Drive Code	Data code corresponding with a particular display
Electronic Address	Digital Address of a device on the control system
Equipment	The equipment to be supplied under the Contract and includes all electrical and mechanical hardware, optical, electronic and telecommunication equipment, structures, mountings and enclosures, computer software and all documentation as defined in the Contract
Lantern	An optical device comprising part of the Display Panel which may flash to draw attention to a displayed Message
Message	A sequence of characters shown on the Display Panel of a VMS
Message Sign Sub System	An Installation system responsible for managing the text element of Sign/Signal systems
Multi-drop	Used to define a circuit which connects transceivers at more than two points
NMCS IP Address Plug	A programmable device which assigns the electronic address and various configuration data for the Equipment
Purchaser	The recipient of Equipment provided by a Contractor to this specification in a contractual arrangement
RJ45	A standard for cable connectors
RS 485	A data transmission standard
Standard Transponder	A device which acts as a 'master' in communications between the Message Sign equipment and the HA-TMS

Abbreviations

1.6 The following abbreviations are used in this document, being specific to vehicle legislation:

RV(C&U) 86: Road Vehicles (Construction and Use) Regulations 1986 (SI 1986 No.1078) as amended.

RVL 89: Road Vehicles Lighting Regulations 1989

1.7 The following general abbreviations are used in this document:

ALM Ambient Light Monitor

cd candela

GPRS General Packet Radio Service

GVW Gross Vehicle Weight

HA Highways Agency

HA-TMS Highways Agency Traffic Management System

IPxx Index of Protection standard (to BS EN 60529)

IP Internet Protocol

LED Light Emitting Diode

MCB Miniature Circuit Breaker

MTBF Mean Time Between Failure

NMCS National Motorway Communications System

NRTS National Roadside Telecommunications Service

PCB Printed Circuit Board

UMTS Universal Mobile Telecommunications System

USB Universal Serial Bus

VMS Variable Message Sign

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2 EUROPEAN HARMONISED STANDARDS

2.1 Portable VMS equipment shall meet where applicable the requirements of European Harmonised Standards:

- BS EN 12320 Building hardware - Padlocks and padlock fittings - Requirements and test methods
- BS EN 12899-1 Fixed, Vertical Road Traffic Signs
- BS EN 12966 Road vertical signs – Variable message traffic signs
- BS EN 41003 Particular safety requirements for equipment to be connected to telecommunications networks
- BS EN 50293 Electromagnetic Compatibility Road Traffic Signal Systems Product Standard
- BS EN 60309-2 Plugs, socket-outlets and couplers for industrial purposes. Dimensional interchangeability requirements for pin and contact-tube accessories
- BS EN 60446 Basic and Safety Principles for Man-Machine Interface, Marking and Identification of Conductors by Colours or Numerals
- BS EN 60529 Specification for degrees of protection provided by enclosures (IP code)
- BS EN 60950-1 Information technology equipment

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3 NATIONAL REQUIREMENTS

3.1 This section outlines the performance requirements for Portable VMS Equipment intended for use on HA operated or managed motorways and all-purpose trunk roads.

Configuration

3.2 A Portable VMS shall comprise:

- a VMS Display Panel;
- a Local Controller; and,
- all ancillary equipment including power supplies required to operate the Equipment.

3.3 These items shall be permanently mounted on a trailer to allow the Equipment to be transported between sites. They shall be suitably housed to provide environmental & security protection and prevent unauthorised operation.

3.4 The Display Panel shall have two 'modes':

- Transportation Mode; this mode will be used for both transportation of the Equipment and storage when non-operational.
- Operation Mode; this mode will be used at all times when the Equipment is required to display a message.

3.5 Operation mode shall only be used when the Equipment is stationary. Once in Operation mode, the lower edge of the Display Panel enclosure shall be between 2.13m and 2.50m above local ground level measured to the parking area below the sign.

3.6 It shall be possible to securely fix the Display panel in either Operation or Transportation modes.

3.7 In Operation mode the Display Panel shall face approaching traffic and be perpendicular to their direction of travel.

3.8 It shall be possible to rotate the Display Panel about its central vertical axis to allow correct alignment with the carriageway:

- It shall be possible to rotate the display panel through a minimum of $\pm 20^\circ$.
- It shall be possible to securely fix the Display panel when aligned,
- The maximum increment between fixed points shall be 5° .

3.9 In Transportation mode the position of the Display Panel shall be such that wind resistance is minimised when in transit. This shall be achieved by ensuring that the narrowest part of the Display Panel faces the direction of travel during transportation.

- 3.10 In Transportation mode no part of the Equipment (including the Display Panel, stabilisers and ancillary items) shall extend beyond the main structure of the trailer as RV(C&U) 86.
- 3.11 In Operation mode the equipment will be located at the roadside. The Equipment shall be designed to be deployed on a Parking Area as defined in APPENDIX C.
- 3.12 Once in Operation mode the Equipment shall be designed such to withstand a Wind Loading of WL7 as BS EN 12899-1.
- 3.13 While each Portable VMS shall be provided with a facility to operate from a mains electricity supply it shall be possible to operate the Equipment without a mains power supply connection for a period of time as defined in paragraph 3.57 below.

Display Panel

- 3.14 The Display Panel shall comprise a number of light emitting character modules. These shall be used for the display of text-based messages, with or without flashing amber lanterns, as requested by the Control System. The configuration of the Display Panel with respect to the number of characters per row and number of rows is shown in APPENDIX A.
- 3.15 Text messages shall be displayed on the Display Panel as section 3.39 below.
- 3.16 The Display Panel shall incorporate four number amber flashing Lanterns. These shall be 125mm in diameter, as TR 2516B.
- 3.17 In addition to the requirements of TR 2516B, amber lanterns shall:
- have an optical performance equal to or better than a minimum luminous intensity on the 0° Horizontal and 0° Vertical axis of 500cd.
 - other intensity levels are shown in the table below and are expressed as percentages of the actual value on the 0° Horizontal and 0° Vertical axis
 - have a luminance uniformity of 10:1 or better.
 - when measured on-axis under simulated solar illumination of 40,000 Lux at an angle of 10° to the axis, the ratio of the actual luminous intensity of the lantern light to the luminous intensity of the phantom signal shall be greater than 8:1.

AMBER LANTERN INTENSITY LEVELS				
Vert	Horiz→	0°	±5°	±10°
+5.0°		50	20	*
+2.5°		75	60	*
0°		100	75	40
-5.0°		12.5	*	6

* No specific value required, but the light intensity at each test point shall meet at least the level achieved by the next consecutive measurement. For vertical values + refers to angles above the horizontal and – refers to values below the horizontal.

3.18 The required chromaticity regions for the colour boundaries of the lantern light and combined colours from real lantern and phantom light shall be within the requirements of the following table:

AMBER LANTERN COLOUR BOUNDARIES							
1		2		3		4	
x	y	x	y	x	y	x	Y
0.536	0.444	0.547	0.452	0.613	0.387	0.593	0.387

3.19 Lanterns shall be controlled as section 3.44 below.

3.20 The Display Panel and Lantern luminance shall be controlled by an Ambient Light Monitor (ALM).

- The ALM shall incorporate a minimum of two ambient light sensors to measure ambient light conditions;
- The ambient light sensors must operate independently to detect illuminance from all directions;
- The ambient light sensors may be situated in separate faces of the Display Panel enclosure;
- The design shall ensure that light sensors cover the whole range of light levels from full daylight to darkness within their active operating range, with an accuracy of ± 2 Lux or 5%, whichever is the greater;
- The Luminance shall be determined from the sensor reading the highest ambient light level;

- Readings from the ambient light sensors shall be averaged over a time period of 180s \pm 10s such that luminance changes do not occur as a result of short-term changes in external illuminance.

3.21 The Optical Performance of the Display Panel shall be as TR 2516B, Table 3.4, Level 1.

Photometric Parameter	Optical Performance
Colour	C2
Luminance	L3
Luminance Ratio	R3
Beam Width	B3

Local Controller

3.22 In this section, any reference to the control of the Portable VMS or reporting to an instation shall be as per APPENDIX B. Where such control is not configured the Equipment shall operate in isolation and the requirement to control the Equipment or report to an instation shall not apply.

3.23 Each Portable VMS shall incorporate a Local Controller. This shall:

- Monitor the operation of the Display Panel, all power sources and ancillary equipment
- Control the operation of the Display Panel and lanterns to display messages
- Act as an interface to all external control sources
- Provide information to operators at the sign.

3.24 The Local Controller shall be housed in a secure enclosure, which shall be mounted upon the Equipment trailer. The enclosure shall have a minimum rating of IP56.

3.25 The Local Controller shall:

- Operate without user intervention for extended periods of time;
- Restart upon power resumption, or a reset, without user intervention.

(N.B. In this case 'without user intervention' shall mean that no human interaction is required to restart the equipment, acknowledge alarms, press keys, etc.)

- 3.26 The Local Controller shall incorporate a password or other means of protection to prevent unauthorised setting of messages or changes to operational parameters.
- Separate levels of access shall be provided as a minimum for ‘Operator’ and ‘Engineer’ access.
- 3.27 The Local Controller shall provide information to local users. This may be in the form of individual status indicators or a display panel. The local information shall typically comprise:
- Current configuration;
 - Any fault status;
 - Status of power supplies and stored charge.
- 3.28 The Local Controller shall include a hardware based ‘Watchdog’ facility which in the event of a fatal fault shall automatically re-initialise the Equipment.
- The occurrence of such events shall be recorded/latched within operational/fault logs
 - The occurrence of such events shall also be reported in accordance with the Purchaser’s control system protocol when such a control system is enabled.
 - A ‘fatal fault’ shall be one which prevents a message from being correctly displayed, or a major failure of an element of the VMS e.g. an electrical generator.
- 3.29 The Local Controller shall include an easily accessible reset switch for use in the event of any irrecoverable software ‘lock-up’ or for other maintenance purposes.
- The switch shall not be accidentally operable i.e. operated by inadvertently knocking the switch during maintenance work;
 - The switch shall be located within a locked equipment Enclosure.

Basic Operation

- 3.30 As the Equipment will be required to operate for periods without a mains electricity supply, it shall be designed to minimise the power consumption of the Display Panel and all ancillary equipment; see section 3.57 below
- 3.31 Upon power-up or a restart, the equipment shall carry out an Initialisation sequence. This is described in 3.35 below.
- 3.32 During normal operation, the Equipment shall carry out background tests. Any anomalies detected shall be reported to any enabled control system. These features shall be as described in section 3.47 below

- 3.33 The Equipment shall be designed with due regard to the operational reliability of the Equipment, and future maintenance requirements. The Equipment shall satisfy the requirements of section 4.55 below.
- 3.34 The Equipment shall provide advanced diagnostics facilities to ease fault diagnosis and rectification. The requirements in relation to Diagnostic Facilities are given in APPENDIX D below.

Initialisation

- 3.35 The Equipment shall perform an Initialisation sequence on 'Power Up', 'Reset' and 'Watchdog Reset'.
- 3.36 During initialisation all control messages shall be ignored until Status Data and Test Result Data have been updated to reflect the Equipment's operational status and any fault conditions that have been established.
- Status Data shall be taken to mean data which describes the Equipment's operational status.
 - Test Result Data shall be taken to mean data which describes the results of the Equipment's self tests.
- 3.37 On initialisation the Equipment shall clear the contents of all buffers and perform the following:
- maintain a blank message display and maintain the lantern setting as OFF (except as noted in 3.38 below);
 - commence background self tests defined in section 3.47 below;
 - update Status and Test Result Data in accordance with the Purchaser's control system protocol;
 - await a valid control message.
- 3.38 If the Equipment is restarting after a power interruption or other reset and a message was displayed before the initialisation, the Equipment shall not display a blank message but shall re-display the message as previously displayed.

Message Display

- 3.39 Messages shall be set and monitored by the Local Controller when requested by the control system.
- 3.40 The Display Panel shall be capable of displaying the text characters, special characters and test characters, all as shown in Appendix A, Equipment Configuration.
- 3.41 Character and stored message Drive Codes shall be in accordance with the Purchaser's control system protocol and shall be reconfigurable from the Local Controller.

- 3.42 The character formats and stored messages shall be reconfigurable from the Local Controller.
- 3.43 The message to be displayed shall comprise any combination of individual Cells i.e. 'Free Format'.

Lanterns

- 3.44 The Equipment shall determine the status of the required lantern display (either ON or OFF) from the last control message requesting a text display, or in accordance with the Purchaser's control system protocol, as appropriate.
- 3.45 The Message Sign Equipment shall be capable of displaying and clearing lanterns independently of the state of the message display. However, the ability to set the Lanterns 'ON' with the Message 'OFF' (Blank) shall be inhibited but shall be reconfigurable.
- 3.46 When operating to support a message, the amber Lanterns shall flash alternatively top to bottom, commencing with the top Lanterns on first.
- The lanterns shall have a mark to space ratio of 1:1 with a period of 800ms;
 - The lantern flashing rate shall be accurate to 100 parts per million (unit time) measured over one minute or more.

Self Tests

- 3.47 The Equipment shall perform background self testing on its operation
- 3.48 The Equipment shall perform all operational testing that may be initiated from the control system when such a system is enabled.
- The Equipment shall correctly report its status and any fault conditions in accordance with the Purchaser's defined protocol.
- 3.49 Operational and Fault logs shall be maintained and these shall be available for download via the diagnostic facilities of the Local Controller.
- 3.50 Background Testing of the Equipment shall not be visible obtrusive to an observer at day or night.
- 3.51 Self tests procedures shall test and monitor, irrespective of Message and Lantern Display status and operation of:
- each optical emitter (main display area and Lanterns);
 - anti-condensation heaters or cooling fans (if provided);
 - all internal power supplies;
 - all energy sources.

3.52 The Equipment shall test and monitor the following functions at initialisation and then at intervals not exceeding 10 seconds:

- all internal software processing;
- all internal communications links;
- the messages displayed;
- luminance control circuits and the luminance state of optical emitters (using either optical detectors or current measurements);
- the sign's internal operating temperature.

System Interfaces

3.53 The Equipment shall be designed to operate from a communication interface as specified in APPENDIX B.

3.54 A facility shall be provided to permit local communication with the signs:

- 'Logs' may be downloaded from the Equipment to a maintenance device;
- The local configuration may be modified by uploading such items as revised message, characters or operational parameters.

3.55 The local communications shall be enabled by either of the following physical interfaces:

- A USB port
- An RJ45 port.

3.56 Arrangements which provide diagnostic facility access via a separate terminal and a wireless link shall not be precluded, provided that the integrity and security of the facilities can be assured.

Power Supply

3.57 The Equipment may operate from one of a number of electricity sources. The Equipment shall be provided with an automatic changeover system between each energy source.

3.58 All types of Equipment shall be capable of operation from an external 'mains' source of electricity, as defined below.

3.59 The complete electrical installations shall comply with TR 1100, Section 12.

- 3.60 All Equipment types shall be provided with an onboard energy store to allow the Equipment to operate without mains electricity source. This may comprise a combination of batteries, other means of energy storage and onboard energy generation. The exact configuration shall be at the manufacturer's discretion, to meet the timescale requirements of 3.64 below.
- 3.61 Where batteries are provided they shall:
- be sealed and maintenance free
 - have a minimum design life of 24-months;
 - Incorporate control circuits to prevent deep-discharging of any batteries.
- 3.62 The Equipment may be provided with an onboard electricity generation source.
- This may comprise photo-voltaic solar cells, an aero-generator, diesel powered generator or any other means to the agreement of the Purchaser.
 - It may include any combination of sources.
 - Any onboard electricity generation source shall include its fuel within the Equipment.
 - Where applicable the fuel store shall be bunded such that a failure of the fuel store when at full capacity will not result in a spillage of fuel.
 - The maximum noise level from any form of generation shall be 75dB(a) at 5m from the Equipment.
 - The onboard generation shall be used to charge the onboard energy store.
- 3.63 The onboard energy store, the onboard electricity generation source and any fuel store shall be housed in a secure enclosure mounted upon the Equipment trailer. The enclosure shall have a minimum rating of IP56.
- 3.64 The Equipment shall be designed for unattended operation without a permanent connection to the mains electricity supply. This shall be demonstrated by undertaking the following Test on all equipment, for the Test Duration:
- The Equipment shall operate continuously and be unattended for the Test duration;
 - The Equipment shall operate without a mains electricity supply or any replenishing of fuel supplies for the Test duration;
 - On-board batteries shall be fully charged and all fuel sources shall be full before testing commences;
 - Any means of onboard electricity generation shall be operational;

- The output generated by any source which does not have onboard fuel supply (e.g. photo-voltaic solar cells or an aero-generator) shall be operating at a maximum of 50% efficiency;
- The display panel shall illuminate 80% of its characters with the symbol 'B';
- The flashing lanterns shall be operational;
- The display panel and lanterns shall be illuminated at 75% of full brightness;
- All power sources shall operate the sign within the temperature range -15°C to +60°C. However this Test shall be carried out at a nominal operating temperature in the range of + 5°C to +20°C.
- The Equipment shall operate as described above for the following Test Durations:

Designation	Duration (hours)
2x12-240	340
4x12-240	340
2x12-320	340
4x12-320	340

Mains Power

3.65 The Equipment shall be provided with a connection point to allow it to operate from an external mains electricity power supply.

- The connection point shall be rated at a minimum of IP44 and manufactured to BS EN 60309-2:1999
- This external power supply shall operate the Display Panel and any onboard equipment, and recharge the onboard energy store whenever connected and 'live'.

3.66 The maximum power consumption of the equipment shall be:

- 2 x 12 displays 1.0kW;
- 4 x 12 displays 2.0kW.

3.67 The power factor shall be as near unity as practicable. In all operating conditions it shall be not less than 0.85 lagging or 0.95 leading.

- 3.68 A label shall be provided adjacent to the electricity connection point. It shall state values of the following parameters for the Equipment:
- supply voltage;
 - supply frequency;
 - maximum rated current.
- 3.69 The Equipment shall be provided with a system of earthing which complies with BS 7671.
- The main system of earthing shall be TN-S.
 - All extraneous conductive and exposed conductive parts shall be connected to the main earthing terminal.
- 3.70 All mains wiring between modules or within an enclosure shall use the colours defined in BS EN 60446.
- 3.71 The Equipment shall be provided with a main electrical isolation switch. This switch shall be located behind a panel fitted with a hasp and staple:
- The hasp and staple shall be fitted with a padlock to BS EN 12320, maximum grade 2 (N.B. this is a low grade which shall allow the padlock to be easily cut in an emergency.)
 - The panel shall be labelled to indicate 'Emergency Isolation'.
- 3.72 The Equipment shall be provided with an external earth connection point to allow an external earth connection to be made.
- The earth connection point shall comprise an M10 x 30mm long stainless steel stud complete with 2 number nuts and washers;
 - Within the equipment, the earth stud shall be connected to the main earthing terminal;
 - It shall be positioned on the outside of the Equipment, on the Nearside.
- 3.73 It should be noted that for any installation of equipment the electrical supply, including the provision of power and earthing cables shall be designed and provided by 'others'. The demarcation point for this cabling shall be the connection points on the Equipment.

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4 CONSTRUCTION REQUIREMENTS

General

- 4.1 The Equipment shall be designed to have a design life of not less than ten-years when used in the UK environment and maintained in accordance with the manufacturer's recommendations.
- 4.2 The Equipment shall be manufactured to the requirements of TR 1100.
- 4.3 The complete Equipment shall satisfy the requirements of the Road Vehicles (Construction and Use) Regulations 1986 (SI 1986 No.1078) as amended and the Road Vehicles Lighting Regulations 1989 (SI 1989 No.1796).
- 4.4 As the Equipment shall be subject to frequent transportation, the supplier shall give due consideration to the vibration and damage that may occur:
- Screw fastenings shall include shake-proof fixtures and fitting;
 - Where appropriate, threads should be secured with a locking compound;
 - All auxiliary items shall be securely fastened down at all times;
 - All cables and conduits shall be securely fixed to prevent chaffing.
- 4.5 The Equipment may be manufactured from any material that is fit for purpose. Details of the material specification shall be provided to the Purchaser.
- 4.6 All materials shall be provided with a protective coating that is suitable for the design life of the enclosure. This shall comprise protection for both corrosion and UV light.

Testing

- 4.7 The Equipment shall be tested to the requirements of BS EN 12966. The Equipment shall comply with the following Classes:
- Temperature Class – T1
 - Pollution Class –D2
 - Protection Class: Water Penetration – P2 (IPx5)
Dust Penetration – P3 (IP6x)
- 4.8 Testing shall be carried out on a Test Module as defined in BS EN12966 section 9.1.

4.9 The equipment shall be tested to the requirements of BS EN 60068 2-29, as detailed below:

Bump	Equipment	The test shall be undertaken on a Test Module as defined in BS EN 12966-1, section 9.1 *
	Method	The Test Module shall be fixed rigidly to the Bump Table
	Severity	100m/s ² peak acceleration; 16ms duration; 1000 bumps in the most vulnerable direction
	Initial measurement	Visual inspection and functional test to specification
	Operating mode	Non operating
	Final measurement	Visual inspection and functional test to specification
	* The design and construction of the test module shall be to the approval of the Purchaser. Subject to the agreement of the Purchaser, the test module may exclude diesel electricity generating equipment.	

Optical Design and Technology

4.10 Message Sign characters shall be as TR 2516B, table 2.1.

4.11 The dimensional requirements in relation to the positioning of character modules and lanterns are shown in APPENDIX A below.

Display Panel Requirements

4.12 The Display Panel front face shall provide a smooth, flat, scratch-resistant and wipe-clean surface that is predominantly non-reflective.

- It shall be designed to meet the environmental and optical performance requirements and shall provide reflection-free viewing of the sign display for drivers when the equipment is mounted in its operational attitude.
- External light sources such as vehicle headlamps and street lighting shall be considered.
- Where a coating or masking material is used to achieve this, the material shall be suitable for the design life of the equipment

4.13 The front facing surfaces of the Display Panel which form the border around the active elements shall be coloured matt-black.

4.14 Where it is necessary to paint side and rear facing surfaces in order to achieve the required design life, these shall be matt-black or non-reflective grey (to BS 381C, No. 693, colour aircraft grey).

4.15 Other unpainted surfaces shall be dulled.

4.16 All finishes shall have a high quality aesthetic appearance for the design life of the equipment.

- 4.17 All covers, doors, protective screens, plates, glands, external connectors etc. necessary for environmental protection, shall be provided with seals which are maintenance free and shall remain effective for the design life of the equipment.
- 4.18 Where access doors are provided, these shall be fitted with a suitable 'stay' to retain the door in the open position for the safety of maintenance personnel working on the Display Panel. For security, access doors and panels shall be fitted with suitable locks.
- 4.19 Access doors comprising a sliding arrangement should avoid having an exposed bottom rail which may act as a dirt trap and thereby impose an additional maintenance burden.
- 4.20 Where vents or grilles are provided, these shall be positioned and protected to prevent any ingress of dirt and moisture and grilles shall be fitted with insect mesh.
- 4.21 The Display Panel shall incorporate drains in order to prevent any accumulation of water which might give rise to condensation which may affect optical performance.

Trailer construction

- 4.22 The Equipment shall be constructed as a trailer, to allow it to be transported to and from a deployment site. The trailer shall be constructed to fully comply with RV(C&U) 86.
- 4.23 The Equipment shall be fitted with a manufacturer's plate. This shall comply with all current legislation and display as a minimum:
 - Manufacturers name and address;
 - Chassis or serial number and model number;
 - Number of axles;
 - Maximum weight per axle;
 - Nose weight of coupling;
 - Maximum gross vehicle weight (GVW);
 - Date of manufacture.
- 4.24 The chassis or serial number shall also be covertly marked upon the trailer to allow identification in the case of recovery after theft.
- 4.25 The Equipment shall be provided complete with all necessary lamps, reflectors, rear markings and devices to comply with RVL 89. The lighting equipment shall be mounted securely to prevent unauthorised removal whilst still allowing routine maintenance. Protection shall be provided to limit accidental damage during transportation and manoeuvring.

4.26 The dimensions of the Equipment shall comply with the following maximums, when in Transportation mode:

Designation	Length (mm)	Width (mm)	Height* (mm)	Mass** (kg)
2x12-240	6000	2300	3000	2000
4x12-240	6000	2300	3000	2000
2x12-320	6000	2300	3000	3000
4x12-320	6000	2300	3500	3000

* Height shall not exceed factor of 1.7 times axle wheel-track

** 'dry weight' of the Equipment

4.27 The Equipment shall be provided with a braking system in compliance with RV(C&U) 86. It shall incorporate a manually operated handbrake which will allow the trailer to be dismantled on a gradient of at least 10%.

4.28 The Equipment shall be provided with the facility for attaching a number plate. This shall allow the number plate to be easily attached and removed. The format of the plate shall be a single row of characters.

4.29 The Equipment shall be attached using either a 50mm diameter ball hitch or a 40mm diameter eye hitch. The coupling shall be a commercially rated cast construction.

4.30 The Equipment shall be provided with a 7-pin connection, type 12N to allow connection to the towing vehicle.

- The Equipment shall be able to connect to both 12 volt and 24 volt electrical systems;
- The mechanism for changing between electrical systems shall be clearly labelled;
- A facility shall be provided to 'house' connection leads when not in use. This may comprise a connector of opposite gender into which it may be inserted to prevent damage.

4.31 The Equipment shall be provided complete with the following ancillary items, which shall be securely locked to the unit such that they may not be removed by unauthorised personnel, but may be utilised as required:

- a telescopic jockey-wheel with pneumatic tyre and anti-vibration body;
- spare wheel with tyre;
- 'corner rubbers'.

4.32 All items provided as part of the trailer shall be suitably robust and attached in a suitable manner for the anticipated operation. It shall be anticipated that operators may climb onto the trailer to gain access and items such as mud guards shall allow such loading.

- 4.33 The Equipment shall be provided complete with telescopic stabilising legs. The legs shall be raised in Transportation mode and lowered in Operation mode. When lowered the legs shall support the mass of the Equipment. A sufficient number of legs shall be provided to ensure the Equipment is stable in Operation mode in all design wind speeds.
- 4.34 The Equipment shall be provided complete with lashing down points. One lashing down point shall be provided coincident with each stabiliser leg. The lashing down point shall allow the Equipment to be secured to the parking area and ensure the Equipment is stable in Operation mode in all design wind speeds.
- 4.35 The Equipment shall be provided with lashing down straps. A single strap shall be provided for each lashing down point. They shall be adjustable to allow the Equipment to be securely lashed down in operation. They shall be designed for the maximum load exerted in all design wind speeds.
- 4.36 The Equipment shall be provided with at least one lifting eye. This facility will allow the Equipment to be raised up by a suitable lifting device and placed behind existing safety barrier. The eye(s) shall be sited such that when lifted the Equipment is level and stable.
- 4.37 The Equipment shall include a number of Enclosures. All Enclosures shall be securely constructed and provided with a locking mechanism to prevent unauthorised access. They shall be provided with environmental seals to prevent the ingress of moisture
- 4.38 Enclosures shall be provided for the following items:
- Local controller (see 3.24 above);
 - Power supply equipment (see 3.60 above);
 - Storage of miscellaneous items, with protection to IP44, to house the following and extra items as required:
 - a complete set of lashing down straps;
 - power cables;
 - earth rods;
 - all miscellaneous items supplied with the Equipment.
- 4.39 All metallic items of the Equipment shall be provided with a suitable finish to ensure the Equipment meets the required design life without the need for repair or repainting.
- The main body of the Equipment, including all Enclosures, shall be painted yellow (to BS 381C, No. 355, colour Lemon Yellow);
 - Structural supports to the display panel shall be matt-black or grey (to BS 381C, No. 693, colour Aircraft Grey);
 - All non-painted items shall be dulled to minimise reflections.

- 4.40 All finishes shall have a high quality aesthetic appearance for the design life of the equipment.
- 4.41 Non-metallic items shall be manufactured from a suitable material that meets the design life requirement and will not deteriorate when stored in an outdoor environment for the duration of the design life. They shall not be damaged by the effects of ultraviolet light or rain. These items may include mud guards, cable conduits, etc. They may be self-coloured or painted.

Security

- 4.42 It is anticipated that Portable VMS will be left unattended at the roadside for extended periods of time. Security features shall be incorporated in the Equipment to prevent:
- removal of the complete Equipment from site;
 - removal of major components from the Equipment, e.g. solar panels, generators, etc;
 - dismantling of the Equipment;
 - operation of the Equipment.
- 4.43 When designing security features due consideration shall be given to balance the requirements of security and maintenance. In all cases the primary requirement shall be to ensure that the Equipment is secure when in Operation.
- 4.44 The number of exposed nuts, bolts and other fixings shall be minimised. Where these features cannot be avoided, the following minimum measures shall be applied:
- Any exposed bolts shall be welded to the part they are securing;
 - Any exposed bolts shall have a security head.
- 4.45 The Equipment shall be provided with a main securing point, to allow it to be chained to the parking area. (N.B. this facility may be provided by placing a chain around a main structural member of the trailer.)
- 4.46 The Equipment shall be provided with a pair of wheel clamps to prevent the trailer being towed. Each wheel clamp shall be secured by a padlock.
- 4.47 Each wheel shall be provided with at least one locking wheel nut. These shall NOT be of a 'protruding-pin' variety.
- 4.48 Each Enclosure shall be provided with a locking facility. Where this is provided by a padlock, it shall be enclosed to prevent the lock from being forced open with a pry-bar.
- 4.49 Where a security fitting is provided for a padlock, it shall be supplied complete with a suitable padlock.

- All padlocks and padlock fittings shall be type-tested to BS EN 12320, minimum grade 5.
 - Padlocks shall be closed or open shackle to suit the hasp.
 - All individual padlocks supplied with a single Portable VMS shall be keyed-alike and supplied with four number keys
- 4.50 If required by the Purchaser, the Equipment shall include a radio-based tracking device. This shall be linked to an inertial system which may be activated by the operator.
- If activated, the inertial system shall trigger the tracking system if the Equipment is moved.
 - The tracking system shall broadcast its current position to allow it to be located. The system deployed shall be recognised by UK police forces to allow a recovery to be made. It shall be supplied complete with a lifetime contract.
 - The tracking device shall be discretely and securely sited within the Equipment.
- 4.51 The onboard means of electricity generation shall be housed in a secure enclosure mounted upon the Equipment trailer. Whilst it shall be possible to access and remove any means of generation for maintenance the level of security shall not be compromised and shall take priority over ease of maintenance.
- 4.52 The fuel store for the onboard means of electricity generation shall be secured to prevent unauthorised removal of fuel or adding of foreign material to the store.
- 4.53 All fuel lines shall be routed to prevent accidental or malicious damage to the fuel lines.

Reliability

- 4.54 The design shall provide high reliability with a system Mean Time Between Failure (MTBF) of 30,000 hours minimum when calculated in accordance with the PD IEC TR 62380 standard.

Maintenance

- 4.55 The Equipment shall employ a modular design which allows all modules, including character modules, lanterns, PCBs, power supplies and any other assemblies within the Enclosure to be easily tested, removed and replaced in an open motorway environment.
- 4.56 The equipment will be maintained by a third-party maintenance to a first-line level, so ease of operation and a modular design that facilitates the easy swap-out of faulty modules is essential.
- 4.57 To assist third-party maintainers, the equipment shall incorporate adequate clear labelling in English. Labelling shall be suitable for the design life of the equipment. Examples of items that should be labelled include:

- All controls, switches, switch positions and settings, fuses, MCBs, test points, connectors, socket outlets and indicators such as lamps or LEDs shall be clearly labelled to identify their circuit designation, function and, where appropriate, rating;
 - All components, modules and card positions shall be clearly labelled to identify and define the function of the component, equipment and card etc;
 - All parts of onboard generating equipment that require routine service or replacement.
- 4.58 Each equipment enclosure shall be fitted with a lamp which may be used to assist maintenance operatives during the hours of darkness.
- Lamps shall only be fitted to enclosures which have permanently fitted equipment; they are not required for storage enclosures;
 - Lamps shall be switched so that they may only be switched on by an operator when the enclosure is open;
 - All lamps shall automatically switch off when the enclosure is closed;
- 4.59 All replaceable modules shall be fitted with retained (i.e. vibration proof) sockets and plugs as appropriate to allow easy disconnection and removal of equipment.
- 4.60 Where the onboard energy store requires batteries to be replaced on a regular basis, details shall be provided. This shall include:
- Nominal voltage;
 - Current rating;
 - Potential suppliers;
 - Connection configuration;
 - Replacement procedure.
- 4.61 Detailed information shall be given on the recycling of original batteries supplied with the Equipment.
- 4.62 Any onboard generating equipment that requires routine maintenance shall be equipped with an hour-meter to record the duration of operation and allow maintenance to be carried out at the correct interval.
- 4.63 Information shall be provided to allow the routine maintenance of any onboard energy generation equipment. This shall include such items as:
- Location and reference information for all items which require routine maintenance;
 - Type and specification for all lubricants with information for the safe disposal of all lubricants supplied with the original Equipment;

- A detailed service schedule.

4.64 Any onboard means of electricity generation shall be provided with an emergency fuel isolation facility.

- The handle to the valve may be exposed for ready isolation, or
- Where the valve is concealed it shall be possible to isolate the fuel using a standard tool.

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5 NORMATIVE REFERENCES

5.1 Where undated references are listed, the latest issue of the publication applies.

British Standards

5.2 The British Standards Institution, London, publishes British Standards.

Contact: [+44 \(0\) 1344 404 429](tel:+44%201344%20404%20429)

WEB: <http://www.bsonline.bsi-global.com>

BS 381	Specification for colours for identification, coding and special purposes
BS 4730	Specification for UK 7 Bit Coded Character Set
BS 7671	Requirements for Electrical Installation
BS 7987 (HD 638)	Road Traffic Signal Systems
BS EN 12320	Building hardware — Padlocks and padlock fittings — Requirements and test methods
BS EN 12899-1	Fixed, Vertical Road Traffic Signs
BS EN 41003	Particular Safety Requirements for Equipment to be Connected to Telecommunications Networks
BS EN 50293	Electromagnetic Compatibility Road Traffic Signal Systems Product Standard
BS EN 60068 2-29	Environmental testing. Test methods. Environmental testing procedures. Tests. Test Eb and guidance. Bump
BS EN 60309-2	Plugs, socket-outlets and couplers for industrial purposes. Dimensional interchangeability requirements for pin and contact-tube accessories
BS EN 60446	Basic and Safety Principles for Man-Machine Interface, Marking and Identification of Conductors by Colours or Numerals
BS EN 60529	Degrees of Protection Provided by Enclosure – IP Code
BS EN 60950	Information Technology Equipment - Safety
PD IEC TR 62380	Reliability data handbook. Universal model for reliability prediction of electronics components, PCBs and equipment

Specifications

5.3 The following specifications are published by the Highways Agency

Contact: [+44 \(0\) 117 372 8270](tel:+44%20117%20372%208270)

WEB: <http://www.tsplansregistry.org/homepage.htm>

MCE 1126	NMCS Internet Interface Specification
MCE 1137	NMCS IP Address Plug Type 9300 Hardware and Software Requirements

TRG 0600	Self-Certification and Approval of Equipments for the Control of Vehicular and Pedestrian Traffic on Roads
TR 1100	General Specification for Motorway Signs, Signalling and Communications Equipment.
TR 2067	NMCS2 RS485 Communications Electrical and Protocol
TR 2070	NMCS2 Message Control Point to Point
TR 2142	NMCS2 Motorway Message Control (RS485) Message Sign Equipment
TR 2516	Performance Specification for Discontinuous Variable Message Signs

Other publications

5.4 Other publications can be obtained from the Stationery Office.

Contact: [+44 \(0\)20 7242 6393](tel:+442072426393)

WEB: <http://www.tso.co.uk>

TSRGD	Traffic Signs Regulations and General Directions:2002
TA 84	Code of Practice for Traffic Control and Information Systems for All-Purpose Roads

6 HISTORY

TR 2518A October 2008

Approval of this document for publication is given by the undersigned:

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APPENDIX A EQUIPMENT CONFIGURATION

A1 This appendix sets out the requirements for Portable VMS configuration in terms of size, appearance and character set.

Dimensions and Appearance

A2 The following configurations are permitted:

Designation	Number of rows	Number of characters per row	Size Range *	Lanterns
2x12-240	2	12	D (240mm)	Yes
4x12-240	4	12	D (240mm)	Yes
2x12-320	2	12	E2 (320mm)	Yes
4x12-320	4	12	E2 (320mm)	Yes

* Size Range to TR 2516B, Table 3.3 'Class Selection'

A3 The dimensions of the Display Panel shall be generally based on the cell size of individual pixels of a character module (also referred to as the stroke width). The nominal cell size shall be derived from BS EN 12966, and the table below.

Designation	BS EN 12966 Size
2x12-240	C
4x12-240	C
2x12-320	D
4x12-320	D

A4 The positioning of the Lanterns shall be as follows:

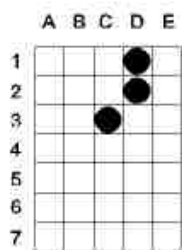
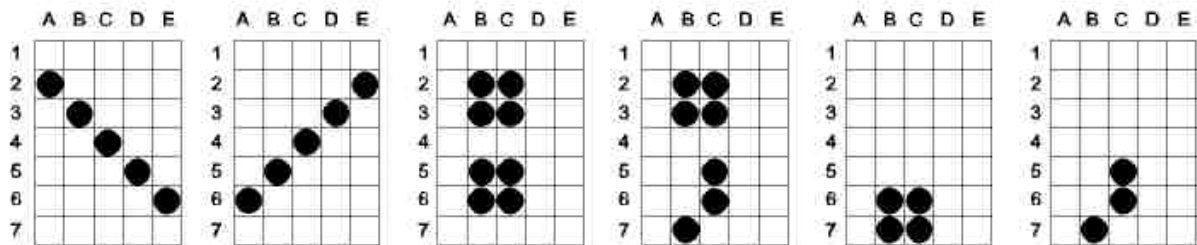
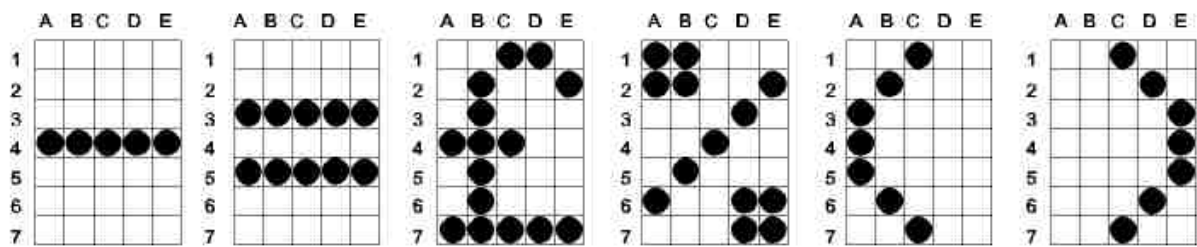
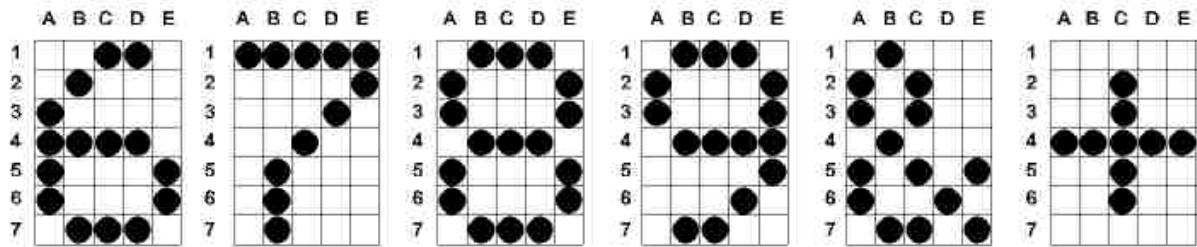
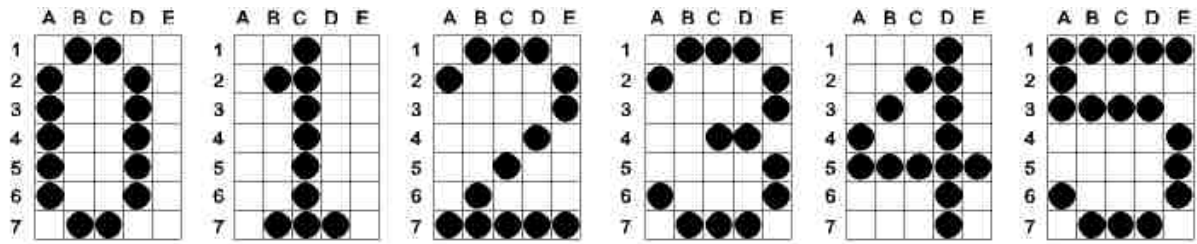
From	To	Distance
centre of lantern	vertical edge of the Display Panel	200mm
centre of lantern	horizontal edge of the Display Panel	200mm

A5 The layout of Character modules and Lanterns shall be symmetrical about horizontal and vertical axes.

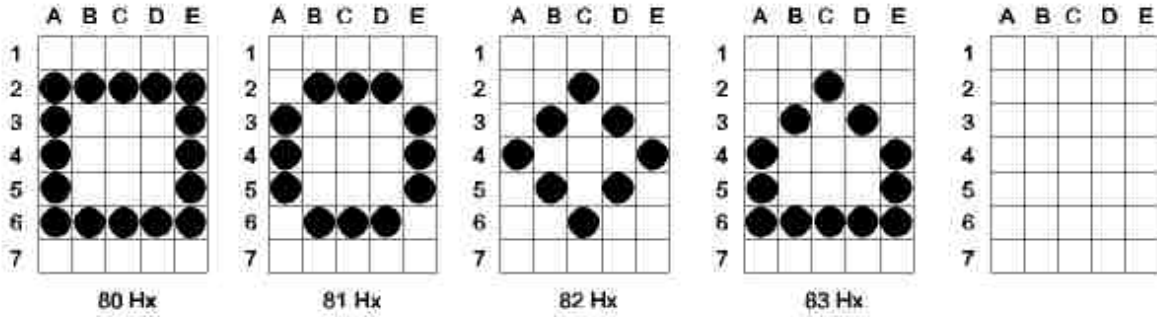
Text Character Format



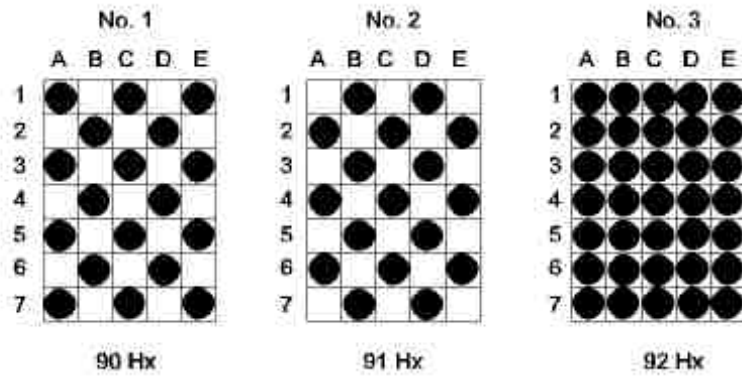
Text Character Formats (Continued)



Special Character Format



Test Character Format



APPENDIX B CONTROL AND COMMUNICATIONS

B1 This appendix sets out the requirements for the control of Portable VMS using communications from an HA-TMS instation to the VMS at the roadside using NMCS communications protocol.

B2 The Equipment shall be provided with an interface to allow the Equipment to be controlled from an HA-TMS instation using a wireless interface.

B3 The wireless interface shall support IP-based communications as defined by the requirements of HA Specification MCE 1126.

B4 The wireless interface shall be provided by a commercial network operator and shall support a protocol such as General Packet Radio Service (GPRS) or Universal Mobile Telecommunications System (UMTS).

B5 The Purchaser will provide SIM cards for the required network provider.

B6 Each wireless interface shall allow for two separate network connections to minimise the effects of poor reception in a particular location.

B7 The wireless shall support the operations defined for the hardwired option above.

B8 Operation via this interface shall be compatible with the NRTS interface provided by GeneSYS.

Equipment NMCS IP Address Plug Interface

B9 The Equipment shall accommodate an HA NMCS IP Address Plug Type 9300 to specification MCE1137. This shall provide a means of identifying those messages intended specifically for the individual Equipment. Site addresses will be specified in octal.

NMCS IP Control

B10 Ethernet Interfaces shall meet the requirements of MCE 1126. However, it should be noted that HA requirements in this respect are in a stage of ongoing development and are subject to change. The manufacturer's implementation shall therefore be upgradeable in order to accommodate any future changes or additional requirements

B11 Specification MCE 1126 defines communications via an IP interface. For portable VMS the NMCS protocol is defined for RS485 messages in HA specifications TR 2067, TR 2070 and TR 2142.

B12 TR 2142 defines certain amendments and additions to the HA standard RS485 message set (defined in TR 2070) that apply specifically to Message Signs. The 'Multimessage' protocol defined in TR 2142 shall be adopted.

Messages

B13 The valid control messages that may be received by the Equipment from the NMCS are:

STATUS REQUEST	(CF=(22H))
TEST	(CF=(24H))
REQUEST TEST RESULT	(CF=(25H))
FLASHER SYNCHRONISATION	(CF=(27H))
LUMINANCE BROADCAST	(CF=(2AH))
MULTIMESSAGE (INCOMPLETE)	(CF=(2BH))
MULTIMESSAGE (COMPLETE)	(CF=(2CH))
DEVICE MODIFICATION REQUEST	(CF=(30H))

B14 The valid reply messages that may be transmitted by the Equipment to the NMCS are:

ACKNOWLEDGEMENT	(CF=(21H))
STATUS REPLY	(CF=(23H))
TEST RESULT	(CF=(26H))
DEVICE MODIFICATION REPLY	(CF=(31H))

B15 Multimessage Message CRCs shall be calculated in accordance with TR 2142.

Validity of Messages

B16 Where any message received includes a Parity Error, the Equipment shall designate the message as invalid, discard the message received and await further messages.

B17 Where any message received contains an Address other than that set within the NMCS IP Address Plug and other than the Broadcast Address (FFH) the Equipment shall designate the message as invalid, discard the particular message received and await further messages.

B18 Where any message received contains a Control Field (CF) other than one defined in section B13 above the Equipment shall designate the message as invalid, discard the particular message received and await further messages.

B19 Where any message received has a format and data content other than that defined in HA Specifications MCE 1126, TR 2142 and TR 2070, the Equipment shall designate the message as invalid, discard the particular message received and await further messages.

B20 The format and data content of all Reply messages transmitted by the Equipment to the NMCS shall conform to the format and content defined in HA Specifications MCE 1126, TR 2142 and TR 2070.

General

B21 This section describes the detailed operation of the sign that is required in order to interact correctly with the NMCS.

B22 For the purposes of defining operation the Equipment shall store the following:

- the Current Message for each line
- the Current Message CRC (12 Bits)
- the Current Lantern Requirement (1 Bit)
- the Lantern Status (1 Bit)
- fault Data (4 Bits)
- The current ambient illuminance level, as reported in the last valid LUMINANCE BROADCAST, (CF = (2AH)), message (4 bits)
- test Result Data (16 Bits)
- the New Message for each line
- the New Message Received CRC (12 Bits)
- the New Message Calculated CRC (12 Bits)
- the New Lantern Requirement (1 Bit)

B23 The 'Current' Message, CRC, and Lantern Requirement are those relating to the current display.

B24 The 'New' Message Requirement, CRC, and Lantern Requirement are those relating to the requirement determined from the new incoming control messages, up until they can be correctly displayed and become 'Current'.

B25 The value transmitted in the LUMINANCE BROADCAST, (CF = (2AH)) message shall be recorded but shall not be actioned. The illumination of the display panel and lanterns shall be based upon the ALM.

Initialisation, Status Data and Test Data.

B26 The general requirements associated with the initialisation and operational testing for the Equipment are defined in section 3.35 above.

- During the initialisation sequence and at regular intervals thereafter the Equipment shall perform the self tests described in 3.47 above. Regular intervals shall not exceed 12 hours.

- In addition, the Equipment shall store the CRC of the displayed Message and Lantern status which shall be calculated in accordance with TR 2142.
- The results of these self tests and the CRC check shall be stored and refreshed and be reported in subsequent STATUS REPLY, (CF=(23H)) and TEST RESULT, (CF=(26H)) messages.

Status Request Sequence

B27 On receipt of a valid STATUS REQUEST message, (CF = (22H)), the Equipment shall reply with the STATUS REPLY message, (CF = (23H)). The Data within the Status Reply shall contain Status Data, comprising 4 Bits for Fault Data and 12 Bits for the Current Message CRC as displayed on the Message Sign.

B28 The Data Content of the Status Reply shall depend on the result of the last complete Self Test and may not necessarily be the same as the requested setting as follows:

Fault Data:

- Fault Data must always be reported as defined during the last Self Test.

CRC Data:

- If Data Byte 1, Bit 6 was set (Binary 1) during the last Self Test the Message Sign Display will be 'OFF' and the CRC shall be reported as 'OFF' (2-line CRC=(1E3H); 4-line CRC=(DB5H))
- If Data Byte 1, Bit 6 was not set (Binary 0) during the last Self Test the CRC shall be reported as the value calculated during the last setting from the MULTIMESSAGE (INCOMPLETE) messages, (CF = (2BH)).

B29 The correct STATUS REQUEST message, (CF = (22H)), shall be ready for transmission within 200ms of receipt of the final bit of any valid control message which initiates a change of status.

B30 Whenever the Message Sign is set locally to a Test or Maintenance Mode, as may be provided by the supplier in his standard design, the CRC shall be reported as all bits binary '0'.

Flasher Synchronisation Sequence and Lantern Display

B31 The general requirements associated with Lantern operation for the Equipment shall be as described in section 3.44 above.

B32 The Lantern Requirement shall be derived from the last MULTIMESSAGE (COMPLETE) message, (CF = (2CH)).

B33 Upon receipt of a FLASHER SYNCHRONISATION message, (CF = (27H)), the Equipment shall reset the lantern clock within 20ms.

- The start of the sequence is top Lanterns 'ON'.

- A FLASHER SYNCHRONISATION message, (CF = (27H)), will be received approximately every one minute.

B34 The Equipment shall not reply to a FLASHER SYNCHRONISATION Message, (CF = (27H)).

B35 If the Equipment does not receive a FLASHER SYNCHRONISATION Message, (CF = (27H)), it shall continue to alternate the flashing Lanterns.

B36 If the Equipment does not receive a FLASHER SYNCHRONISATION Message, (CF = (27H)), for more than 3 minutes then it shall report this as a 'LANTERN/DIM/BRIGHT' fault in the next STATUS REPLY message, (CF = (23H)).

B37 The Equipment shall report any fault in the Lantern drive circuits or the Lanterns as a 'Lantern/Dim/Bright' fault in the next STATUS REPLY message, (CF = (23H)), and TEST RESULT message, (CF = (26H)), until the fault condition is cleared. Lantern faults to be reported shall include:

- Failure of one or more Lantern
- Failure of Lantern Control Circuits
- Incorrect Lantern Status displayed.

Luminance Broadcast Sequence and Luminance Control

B38 The Equipment must control the Luminance of the Display Panel and the Lanterns to comply with the Luminance Ratio requirements defined in TR 2516B using the following inputs:

- The ambient illuminance level reported in LUMINANCE BROADCAST messages, (CF=(2AH));
- Inputs from a minimum of two Ambient Light Sensors;
- The Dim/Bright bit within FLASHER SYNCHRONISATION messages, (CF=(27H)).

B39 The ambient illuminance level will be reported in the content of the DATA 2 byte in LUMINANCE BROADCAST messages, (CF=(2AH)),. Valid ambient illuminance levels are as follows:

01 0 - 3.9 Lux	09 14000 - 17999 Lux
02 4 - 39 Lux	0A 18000 - 19999 Lux
03 40 - 389 Lux	0B 20000 - 23999 Lux
04 390 - 999 Lux	0C 24000 - 29999 Lux
05 1000 - 3999 Lux	0D 30000 - 33999 Lux
06 4000 - 7999 Lux	0E 34000 - 39999 Lux
07 8000 - 9999 Lux	0F > 40000 Lux
08 10000 - 13999 Lux	

B40 The luminance control must operate as follows:

- i) The Luminance of the Display Panel and Lanterns must be controlled using inputs from the ALM;
- ii) In the event of a failure of the Luminance Control Circuits or all Ambient Light Sensors, the Display Panel and Lantern luminance will default to that corresponding with the ambient luminance level reported in the LUMINANCE BROADCAST message, (CF=(2AH));
- iii) The Display Panel and Lantern luminance will default to Dim/Bright Luminance Control via the dim/bright bit in the last valid FLASHER SYNCHRONISATION message, (CF=(27H)), in the event that it is operating via the LUMINANCE BROADCAST message, (CF=(2AH)), and:
 - a) a LUMINANCE BROADCAST message, (CF=(2AH)), is not received for more than 3 minutes;
 - b) the LUMINANCE BROADCAST message, (CF=(2AH)), received reports an invalid ambient illuminance level.

B41 A LUMINANCE BROADCAST message, (CF = (2AH)), will be received approximately every one minute.

Luminance Fault Reporting

B42 The Equipment must report any fault in the Dim/Bright circuits as 'LANTERN / DIM / BRIGHT' fault in the next STATUS REPLY, (CF=(23H)) and TEST RESULT, (CF=(26H)) messages. Dim/bright faults to be reported must include:

- failure of one or more Ambient Light Sensors;
- failure of Luminance control circuits;
- incorrect Luminance Level displayed.

B43 The Equipment must report the following faults as a 'LANTERN/ DIM/ BRIGHT' fault in the next STATUS REPLY message, (CF=(23H)):

- i) loss of LUMINANCE BROADCAST message, (CF=(2AH)), for more than three minutes;
- ii) a LUMINANCE BROADCAST message, (CF=(2AH)), reports an invalid level.
- iii) two consecutive LUMINANCE BROADCAST message, (CF=(2AH)), report an ambient illuminance level which conflicts with the FLASHER SYNCHRONISATION message, (CF=(27H)), dim/bright bit setting, in accordance with the rules given in B44
below

B44 The following rules shall be applied to determine whether a Luminance Conflict exists:

Flasher Sync. Setting	Luminance Broadcast Level	Conflict (DATA 2)
Dim	(01H) - (0FH)	No
Bright	(01H) - (03H)	Yes
Bright	(04H) - (0FH)	No

Message Control Overview

B45 The Message to be displayed and the Message Lantern Requirement is defined in multiple messages (Multimessages) transmitted by the Control Source as follows:

- A Message Sequence comprises a variable number of MULTIMESSAGE (INCOMPLETE) messages, (CF = (2BH)), followed by a MULTIMESSAGE (COMPLETE) message, (CF = (2CH))
- The Message to be displayed is defined by Drive Codes within Data Bytes 1 and 2 of the MULTIMESSAGE (INCOMPLETE) messages, (CF = (2BH))
- The Lantern Requirement and the Message Cyclic Redundancy Check (CRC) are defined by the content of Data Bytes 1 and 2 of the MULTIMESSAGE (COMPLETE) message, (CF = (2CH)).

B46 The Drive Code ETX (03H) is used within the MULTIMESSAGE (INCOMPLETE) message, (CF = (2BH)), to define the end of each line of the Message.

B47 The Message to be displayed is transmitted to the Equipment with no leading Space Characters (20H) and a maximum of one trailing Space Character (20H).

B48 The Message to be displayed is transmitted to the Message Sign with any intermediate Spaces included.

B49 Where the Message to be displayed, including any intermediate Space Characters (20H) and the NULL (00H) and ETX (03H) for each line results in an odd number of bytes the Drive Code for Space Character (20H) is used at the end of the last message line followed by ETX (03H) to complete the final MULTIMESSAGE (INCOMPLETE) message, (CF = (2BH)).

Message Format

B50 The Equipment shall set and monitor the display of messages comprising of any combination of the following:

- Standard Characters with 8 Bit Drive Codes in the range (20H) to (5FH)
- Special Characters with 8 Bit Drive Codes in the range (80H) to (8FH)
- Test Characters with 8 Bit Drive Codes in the range (90H) to (9FH)
- Stored Messages with 8 Bit Drive Codes in the range (C0H) to (EFH).

B51 The Standard, Special and Test Character Formats for display shall be in accordance with APPENDIX A above.

B52 Drive Codes for Standard Characters must comply with BS 4730:1993 'Specification for UK 7 Bit Coded Character Set'.

Note: While BS 4730 has been withdrawn it will remain in use on HA contracts until a suitable replacement is identified as it is fundamental to defining the protocol via which the Sign will operate.

B53 The Stored Message Set corresponding to each Drive Code in the range (C0H) to (EFH) will be defined by the Purchaser where required.

Message Types

B54 The Equipment shall determine from the Drive Code within Data Byte 1 of the first MULTIMESSAGE (INCOMPLETE) message, (CF=(2BH)), whether a 'Text' or 'Stored Message' is to be displayed:

- Any Drive Code within the range defined for Standard, Special or Test Characters within Data Byte 1 shall define that a 'Text' message is to be displayed. The Drive Codes within Data Byte 2 and subsequent MULTIMESSAGE (INCOMPLETE) messages, (CF = (2BH)), will define the remainder of the text to be displayed.
- The Drive Code (F0H) within Data Byte 1 shall define that a 'Stored' Message is to be displayed. The Drive Code within Data Byte 2 shall define the Stored Message to be displayed. A second MULTIMESSAGE (INCOMPLETE), (CF = (2BH)), message containing NULL (00H) and ETX (03H) within Data Bytes 1 and 2 will define the end of the command.

B55 Further to the transmission of a valid 'Stored' Message MULTIMESSAGE (INCOMPLETE), (CF = 2BH)), only one additional MULTIMESSAGE (INCOMPLETE) message, (CF = (2BH)), containing NULL (00H) followed by ETX (03H) will be transmitted to the Equipment.

B56 The Drive Code NULL (00H) within DATA 1 followed by ETX (03H) within DATA 2 for each line of the message shall indicate the 'OFF' (Blank) is to be displayed i.e. switch-off the Display Panel and Lanterns.

B57 The Driver Code NULL (00H) followed by ETX (03H) for any line of the message shall indicate that 'OFF' (Blank) is to be displayed on that particular line only i.e. it shall be possible to display a Message on any line with the other line(s) 'OFF' (blank).

Message Display

B58 The general requirements associated with the display of messages shall be as described in section 3.39 above.

B59 In the event that an odd number of characters is required to be displayed in any line then the text in that line will be biased to the left by one character position i.e.

If
 Spaces to the Right of Text = 'X'
Then
 Spaces to the Left of Text = 'X-1'.

Multimessage Incomplete Sequence

B60 On receipt of MULTIMESSAGE (INCOMPLETE), (CF = (2BH)), messages the Equipment shall perform the following for properly formatted 'Text Only' Messages:

- reply with the ACKNOWLEDGEMENT message, (CF = (21H))
- store the message contents up to and including the first ETX (03H) as New Message for Line 1
- store the remaining message contents up to each subsequent ETX (03H) as New Message for each subsequent line.

B61 On receipt of MULTIMESSAGE (INCOMPLETE) messages, (CF = (2BH)), the Equipment shall perform the following for properly formatted 'Stored' Messages:

- reply with the ACKNOWLEDGEMENT message, (CF = (21H))
- store the message contents as New Message for each line.

Multimessage Complete Sequence

B62 On receipt of a valid MULTIMESSAGE (COMPLETE) message, (CF = (2CH)), the Equipment shall perform the following for properly formatted messages only:

- reply with ACKNOWLEDGEMENT message, (CF = (21H))
- store Message Contents as 'New Message' 'Lantern Requirement' and 'New Message Received CRC'
- prepare the 'New Message Calculated CRC' and compare the result with the 'New Message Received CRC'

B63 Where the 'New Message Calculated CRC' is identical to the 'New Message Received CRC' the Equipment shall:

- display 'Blank' with Lanterns 'OFF'
- store New Message for each line 1 as Current Message for each line
- store New Message Calculated CRC as Current Message CRC
- store New Message Lantern Requirement as Current Message Lantern Requirement

- store New Lantern Status as Current Lantern Status
- display the Current Message for each line
- display the Current Lantern Status
- store Fault Status and Test Result Data
- prepare a STATUS REPLY message, (CF = (23H)), ready for transmission
- await a valid control message.

B64 Where the 'New Message Calculated CRC' is different to the 'New Message Received CRC', or the message format and content is not in accordance with the above sections and HA Specification TR 2142, the Equipment shall:

- discard the 'New Message' lines, 'New Message Calculated CRC', 'New Message Received CRC' and 'New Message Lantern Requirement' and clear associated buffers
- continue to display the Current Message for each line;
- continue to display the Current Lantern Status
- await a valid control message.

B65 Where a valid Multimessage Incomplete Sequence is not followed within 10 seconds by a corresponding MULTIMESSAGE (COMPLETE) message, (CF = (2CH)), the Equipment shall:

- discard the 'New Message' lines, 'New Message Calculated CRC' and 'New Message Received CRC' and 'New Message Lantern Requirement' and clear associated buffers
- continue to display the Current Message for each line
- continue to display the Current Lantern Status
- await a valid control message.

B66 The Message shall be displayed, together with Lanterns if requested, within 1 second of the Equipment receiving a valid MULTIMESSAGE (COMPLETE) message, (CF=(2CH)).

Device Modification Request Sequence

B67 On receipt of a valid DEVICE MODIFICATION REQUEST message, (CF = (30H)), Equipment shall reply with the DEVICE MODIFICATION REPLY message, (CF = (31H)).

B68 The HA stores Type and motorway site equipment software modification number transmitted as part of the DEVICE MODIFICATION REPLY message, (CF = (31H)), will be defined by the Purchaser.

Fault Handling and Reporting

B69 The results of the Self-Test shall be stored as Test Result Data (16 Bits) and Status Data (16 Bits) which shall form the content of Data Bytes 1 and 2 of the STATUS REPLY message, (CF = (23H)), and TEST RESULT message, (CF = (26H)).

B70 The allocation of bits within Status Data (Bits 5 to 8 of Data byte 1) and Test Result Data (Bits 1 to 8 of Data Byte 1) shall be in accordance with Table 1, where '1' indicates Fault Condition, '0' indicates Normal Condition.

B71 The Data byte 2 within a TEST RESULT message, (CF = (26H)), shall contain one of the following values:

- (00H) i.e. all bits set to 0, indicating PASS
- (FFH) i.e. all bits set to 1, indicating FAIL.

B72 Where Self Tests identify the occurrence of faults while a Message is being displayed, the Equipment shall act in accordance with Table 1.

B73 Where Self Tests identify the occurrence of faults while no Message is being displayed, but Messages are subsequently requested, the Equipment should act in accordance with Table 1. The Equipment should continue to attempt to set the Message, except in the cases of fault numbers 6 and 7 in Table 1.

B74 When a fault is detected the Equipment shall continue to report the fault until it has been confirmed as cleared during a subsequent Self-Test or Message Setting.

B75 Fault Bits within the STATUS REPLY message, (CF = (23H)), and TEST RESULT message, (CF = (26H)), shall clear automatically and without external intervention when the Equipment detects that the fault has cleared.

B76 Following a Watchdog Reset (Fault 7 in Table 1) the Equipment shall perform the Initialisation Sequence defined in section 3.35 above, report the fault in the next requested STATUS REPLY message, (CF = (23H)) and TEST RESULT message, (CF = (26H)), and then clear the fault until the next occurrence.

B77 The Equipment shall inhibit the display of Messages and display 'OFF' (Blank) with Lanterns 'OFF' in the event of ANY failure within the Equipment which affects the validity of the Message Display or prevents the displayed Message from being changed by the Control System.

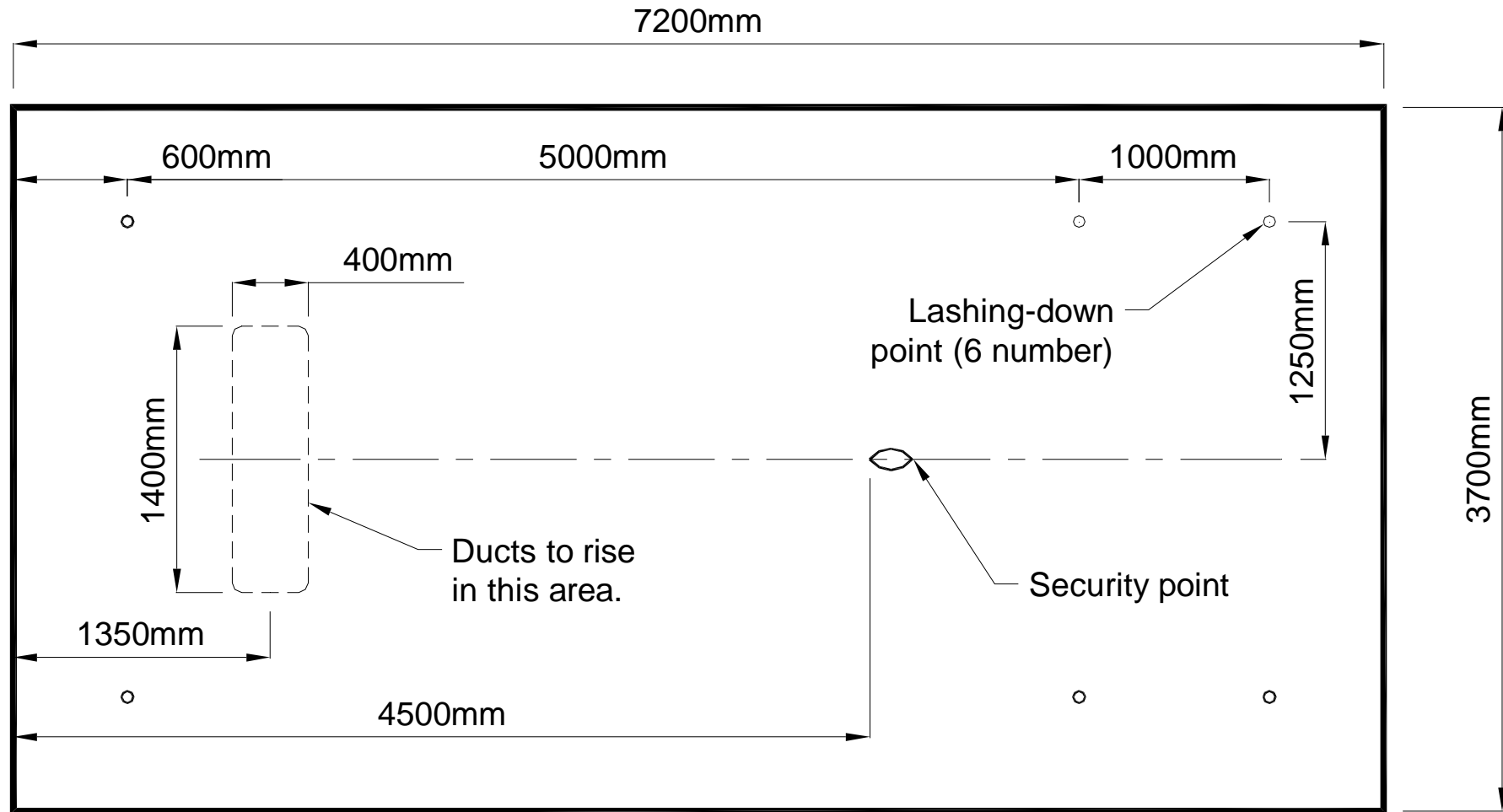
- In this event the next STATUS REPLY message, (CF = (23H)), shall report the CRC as 'OFF' and fault data as 'Message Fail' (Bit 6 set to binary 1). A TEST RESULT message, (CF = (26H)), shall be reported with bits set appropriate to the area of failure.
- The exception in the definition of 'ANY failure' above shall be a failure of the communications between the Equipment and the Control System. The Equipment response in the event of such a fault (i.e. whether to clear the display or continue to display the message previously selected) shall be a user configurable option.

Table 1 – Fault Handling and Reporting

NO.	MESSAGE SIGN FAULT	MESSAGE SIGN ACTION	STATUS DATA BYTE 1	TEST RESULT DATA BYTE 1
1.	Lantern fail.	Continue to Display Lantern Status. Continue to Display Message.	Bit 8	Bit 8
2.	Incorrect Lantern Status or Cycle displayed. Lantern Control Circuit Fail.	Switch OFF Lanterns. Continue to Display Message.	Bit 8	Bit 8
3.	Luminance Control Circuit Fail.	Continue to Display Lantern Status and Message.	Bit 8	Bit 7
4.	'Non-Critical' Display Panel Failure (≤ One Display Cell/Character)	Continue to Display Lantern Status and Message.	Bit 7	Not Used
5.	'Critical' Display Panel Failure (> One Display Cell/Character)	Switch OFF Lanterns Switch OFF Display Panel and Display OFF Current Message = OFF	Bit 7 + 6	Not Used
6.	Over temperature Alarm	Switch OFF Lanterns Switch OFF Display Panel and Display OFF Current Message + Lantern Requirement = OFF	Bit 6	Bit 6
7.	Watchdog Reset	Carry Out Initialisation Sequence	Bit 6 (Once only)	Bit 5 (Once only)
8.	'Non-Critical' Power Supply Failure (does not affect the operation of the Equipment)	Display Lantern Status and Continue to Display Message	Bit 5	Bit 3
9.	'Critical' Power Supply Failure (affects the operation of the Equipment)	Switch OFF Lanterns. Switch OFF Display Panel and Display OFF Current Message = OFF	Bit 6+5	Bit 3
10.	Internal Communications Fail affecting Sign Control.	Switch OFF Lanterns. Switch OFF all Lamp/Optical Devices and Display OFF Current Message & Lantern Requirement = OFF	Bit 6	Bit 2
11.	Heater Circuit Failure.	Continue to Display Lantern Status and Message.	Bit 5	Bit 1
12.	Loss of 3 successive Flasher messages	Continue to Display Lantern Status and Message.	Bit 8	Not Used

APPENDIX C PARKING AREA

- C1 This appendix defines the outline requirements for a parking area, upon which a Portable VMS may be deployed.
- C2 This outline in turn defines the physical limits and interface points for a Portable VMS.
- C3 The design includes 6 number lashing-down points. These shall be used to anchor the Portable VMS to the base. These shall allow the sign to operate in Wind Loading of WL7 as BS EN 12899-1 (see 3.12 above).
- C4 The design includes a security point. This shall be used for a secure fixing of the Portable VMS to the base.



VMS PARKING AREA

APPENDIX D DIAGNOSTICS FACILITY

D1 This appendix sets out the requirements for the operational and performance parameters associated with diagnostics and simulation facility.

General

D2 The Equipment shall support a Diagnostic Facility to aid with the repair of the Equipment. This Diagnostic Facility shall be provided by one of the following means or by a similar method subject to the approval of the Purchaser:

- An application with graphical interface running on the local controller;
- A software application to run on a laptop computer together with a cabled or short-range wireless interface;
- A handheld device provided complete with software together with a cabled or short-range wireless interface.

D3 The Diagnostic Facility shall support the following major functions which are in turn defined below:

- monitoring;
- testing;
- simulation;
- reconfiguration;

D4 The Diagnostic Facility shall be fully protected against invalid entries and clearly warn the user both audibly and visually upon such events. However it shall be possible to switch this protection off to such an extent that invalid data messages may be constructed for testing purposes.

D5 The Diagnostic Facility shall provide a visual interface with text/bit decoding for easy onscreen interpretation of status (including a representation of the current display) and test data. It shall not be necessary to examine the content of data messages to determine the operational status of the equipment or test results. The raw data message information shall be stored for subsequent evaluation or printout.

D6 While in use the Diagnostic Facility shall produce logs recording each change of equipment status and each event for future evaluation or print out. Account shall be taken of the effects that the running of background tasks may have on the accuracy of time measurements when in testing mode.

D7 Operational and Fault logs generated as part of the Equipment's normal operation and background testing and monitoring shall be available for download via the Diagnostic Facility. The use of an industry standard USB interface and a 'memory stick' is the preferred means of achieving this facility.

D8 The package shall incorporate a suitable means of ensuring that the Equipment returns to its default mode as soon as the Diagnostics Facility is disabled or disconnected.

MONITORING FACILITIES

D9 The application shall support the on-line monitoring and logging of all control (and reply) data messages, presented in a decoded format.

D10 The application shall support the display of all system status and report data stored internally within the Equipment.

D11 The use of the application in monitoring mode shall be invisible to the control system and all control messages received by the Equipment shall be processed as normal.

TEST FACILITIES

D12 To assist with the determination of Equipment faults and operational status, as a minimum the application shall provide for:

- a full test of the Display and Lantern operation and status based on the use of control defined in the Purchaser's protocol.
- additional detailed test to a modular level covering each processor controlled or monitored item in the equipment.

D13 The use of the application in test mode shall result in the Equipment reporting the status required by the Purchaser's protocol to indicate that the Sign is under local test.

- The Message Sign Equipment shall act upon any control message from the control system that solicits a reply in terms of Equipment status or requires a test to be performed.
- The Equipment shall NOT act upon any control message from the control system that requests a change of state (e.g. setting a Message or displaying Lanterns) while in test mode and shall simply acknowledge the message in accordance with the Purchaser's protocol.

D14 All other valid control messages from the control system shall be acknowledged in accordance with the Purchaser's protocol.

D15 It is recognised that the Test Facility may be used with the Equipment disconnected from the Purchaser's control system and the Sign Controller shall provide a means of facilitating this disconnection.

RECONFIGURATION FACILITIES

D16 To assist with the future maintenance and support of the Equipment, all system reconfiguration, including the selection of any user configurable parameters and operating software updates, shall be achievable from the Diagnostic Facility.

D17 Appropriate levels of authorisation shall be agreed with the Purchaser in respect of software updates and reconfigurable items.

D18 It is recognised that in most cases, in practice, the Reconfiguration Facility may be used with the Equipment disconnected from the Purchaser's control system and the Equipment shall provide a means of facilitating this disconnection easily.