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Interested committees:

Title: BS EN 12966 Road vertical signs - Variable message traffic signs

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Introduction

This draft standard is based on national and international discussions. Your comments on this draft are invited and will assist in the preparation of the consequent standard.

For international standards, comments will be reviewed by the relevant UK national committee before sending the consensus UK vote and comments to the international committee, which will then decide appropriate action. If the international standard is approved, it is usual for the text to be published as a British Standard.

For national standards, comments will be reviewed by the relevant UK national committee and the resulting standards published as a British Standard.

UK Vote

Please indicate whether you consider the UK should submit a negative (with supporting technical reasons) or positive vote on this draft. Please indicate if you are aware of any reason why this draft standard should not be published as a British Standard.

Submission of Comments

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Template for comments and secretariat observations

Date: xx/xx/20xx	Document: ISO/DIS xxxx
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1	2	(3)	4	5	(6)	7
MB	Clause No./ Subclause No./Annex (e.g. 3.1)	Paragraph/Figure/ Table/Note	Type of comment	Commend (justification for change) by the MB	Proposed change by the MB	Secretariat observations on each comment submitted
	3.1	Definition 1	ed	Definition is ambiguous and needs clarifying.	Amend to read '...so that the mains connector to which no connection...'	
	6.4	Paragraph 2	te	The use of the UV photometer as an alternative cannot be supported as serious problems have been encountered in its use in the UK.	Delete reference to UV photometer.	

English Version

Road vertical signs - Variable message traffic signs

Signaux de signalisation routière verticale - Panneaux à messages variables

Vertikale Verkehrszeichen - Wechselverkehrszeichen

This draft European Standard is submitted to CEN members for enquiry. It has been drawn up by the Technical Committee CEN/TC 226.

If this draft becomes a European Standard, CEN members are bound to comply with the CEN/CENELEC Internal Regulations which stipulate the conditions for giving this European Standard the status of a national standard without any alteration.

This draft European Standard was established by CEN in three official versions (English, French, German). A version in any other language made by translation under the responsibility of a CEN member into its own language and notified to the CEN-CENELEC Management Centre has the same status as the official versions.

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Recipients of this draft are invited to submit, with their comments, notification of any relevant patent rights of which they are aware and to provide supporting documentation.

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COMITÉ EUROPÉEN DE NORMALISATION
EUROPÄISCHES KOMITEE FÜR NORMUNG

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European foreword

This document (prEN 12966rev:2023) has been prepared by Technical Committee CEN/TC 226 “Road equipment”, the secretariat of which is held by AFNOR.

This document is currently submitted to the CEN Enquiry.

This document will supersede EN 12966:2014+A1:2018

The main changes with respect to the previous edition EN 12966:2014+A1:2018 are listed below:

- Scope has been changed by removing mobile and temporary installed VMS, although required by mandate M111
- Normative references have been dated
- Terms AVCP, CPR, FPC have been removed from clause 3
- Title of clause 4 has been changed from Product characteristics to Characteristics
- Everything that is non-mandated was deleted from clause 4
- New AVCP guidance document that does not have the ISO 9001 note is used
- Tunnel classes L1(T) and L2(T) found obsolete and have been removed from clause 4.4.1
- New wording in note to Table 11
- Note to clause 4.4.7 with reference to DELEGATED REGULATION (EU) 2021/1958 was added
- Clause 4.5.2.2 Pollution was removed
- Note to clause 4.5.2.4.3 providing explanation about applicability of DSLx classes added
- Note for clarification of Luminance and Luminance ratio requirements inside tunnels was added at clause 5.5.4.4.1
- Better wording in clause 5.5.5 in regard with explaining test angles of L3(T)
- Clarification on test angles of L3(T) added
- Wording in clause M.2.2 improved in regard with element spacing

NOTE The structure of the document follows the requirements requested by the CEN HAS Consultant at the time of drafting the document.

This document has been prepared under a Standardization Request given to CEN by the European Commission and the European Free Trade Association, and supports essential requirements of Regulation (EU) No 305/2011.

For relationship with Regulation (EU) No. 305/2011 [1], see informative Annex ZA, which is an integral part of this document.

prEN 12966:2023 (E)

EN 12966, *Road vertical sign – Variable message traffic signs*, covers the product standard, assessment, and verification of constancy of performance (AVCP) including type testing and factory production control.

It derives from performance requirements and test methods published in CEN, CENELEC, CIE, IEC, and ISO documents.

Introduction

This document is designed for use by manufacturers, who are placing their variable message traffic signs on the market, as well as by Road Authorities and private developers who wish to use variable message signs. It provides requirements for performance of characteristics of these signs, test and assessment methods and the means of assessment and verification of constancy of performance (AVCP).

This document is a product standard covering the requirements for variable message traffic signs (VMS). A VMS is a sign where the information shown can be changed or switched on or off as required. The information can be text and/or symbols.

VMS fall into the two different types of continuous and discontinuous. Continuous VMS show sign faces of the types of fixed signs defined in EN 12899. Discontinuous VMS use luminous elements to show different messages on a single sign face.

There is diversity of VMS. Some have elements that are placed with a view of displaying a few predetermined messages, while other have elements placed in arrays. Some can show messages where all elements have approximately the same luminous intensity while other can vary the luminous intensity individually. Some can show certain predetermined colours, while other can show a range of colours. Some can show only character legends while other can show a wider range of legends.

This document does not describe the detailed form and configuration of a VMS. Therefore, test modules representing the VMS are used to demonstrate compliance with the requirements of this document because of the impracticality of testing some complete VMS.

Because of the major demands on a sign for good legibility and visibility throughout the required viewing range, the main properties of the sign are described. These properties can vary depending on the situation. For example, it will not be necessary to ask for a minimum temperature requirement of -40 °C in Greece, but this needs to be considered in Lapland. For visual performance there will be a difference between installation on highways - with good distance visibility and a narrow beam width - and installation in cities, where there is only short distance legibility and when a wide beam width may be required.

This document uses requirements for performance of the characteristics, which are not dependent on technology. The visual and environmental performance is demonstrated on a test module representing the VMS. This European Standard contains a number of defined requirements on VMS, some of which have to be demonstrated on the test module, others that are to be verified by the manufacturer. It is the manufacturer's responsibility to ensure that the VMS is fully represented by the test module.

The performances of the main characteristics of discontinuous VMS are given by classes, which are designed to be selected by choosing a combination of classes dependent on the end-user's requirements. National annexes may define class combination applicable to the local needs. This combination covers not only the regulatory requirements of the destination country but also issues of lifetime, quality, maintenance, and construction, all of which affect the ability of a sign in its particular application, to meet safety and fitness for purpose. The details in the informative annexes are provided as useful guidance on the additional aspects relating to VMS for those setting up purchasing contracts for signs or signing systems.

Installed discontinuous VMS shall be regulated in view of the ambient light and the stroke width of legends to provide the intended apparent luminance and balance of colours. Symbols and fonts for character legends shall be designed to provide best possible legibility.

The working environment for VMS can be relatively harsh and equipment that is deemed "fit for purpose" is expected to last in an exposed, corrosive environment for a minimum of 10 years. It is essential that all materials and manufacturing processes take this into account.

1 Scope

This document provides specifications for two types of variable message signs (VMS); i.e., continuous (see 3.3) and discontinuous (see 3.6).

This document covers permanently installed VMS used in circulation areas, on public and private land, including tunnels for the information, guidance, warning and/or direction of traffic. Test modules are used to demonstrate compliance with the requirements.

This document specifies visual and physical characteristics of VMS as well as their durability aspects. It also provides relevant requirements and corresponding test methods, assessment, and verification of constancy of performance (AVCP) and marking.

NOTE Provisions for the evaluation of conformity with regards to type testing are further specified in 6.2; provisions with regards to factory production control (FPC) are further specified in 6.3.1.

This document does not cover:

- a) sign gantries, cantilevers, posts (supports) and foundations,
- b) signal heads,
- c) sizes and shapes of VMS messages,
- d) control units and monitoring units unless inside the VMS,
- e) control of sign luminance.

2 Normative references

The following documents are referred to in the text in such a way that some or all of their content constitutes requirements of this document. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

EN 12899-1:2007, *Fixed, vertical road traffic signs — Part 1: Fixed signs*

EN 12899-4:2007, *Fixed, vertical road traffic signs — Part 4: Factory production control*

EN 50293:2012, *Road traffic signal systems — Electromagnetic compatibility*

EN 50556:2018, *Road traffic signal systems*

EN 60068-2-1: 2007, *Environmental testing — Part 2-1: Tests — Tests A: Cold (IEC 60068-2-1)*

EN 60068-2-2:2007, *Environmental testing — Part 2-2: Tests — Tests B: Dry heat (IEC 60068-2-2)*

EN 60068-2-5:2018, *Environmental testing — Part 2-5: Tests — Test Sa: Simulated solar radiation at ground level and guidance for solar radiation testing (IEC 60068-2-5)*

EN 60068-2-14:2009, *Environmental testing — Part 2-14: Tests — Test N: change of temperature (IEC 60068-2-14)*

EN 60068-2-30:2005, *Environmental testing — Part 2-30: Tests — Test Db: Damp heat, cyclic (12 h + 12 h cycle) (IEC 60068-2-30)*

EN 60068-2-64:2008 +A1:2019, *Environmental testing — Part 2-64: Tests— Test Fh: Vibration, broadband random and guidance (IEC 60068-2-64)*

EN 60529:1991+A1:2000+A2:2013, *Degrees of protection provided by enclosures (IP Code) (IEC 60529:1989/A2:2013/COR1:2019)*

EN 60598-1:2021, *Luminaires — Part 1: General requirements and tests*

EN 62368-1:2020, *Audio/video, Information and communication technology — Safety - Part 1: Safety requirements (IEC 62368-1:201427, modified)*

EN ISO 9227:2017-07, *Corrosion tests in artificial atmospheres — Salt spray tests (ISO 9227:2012)*

IEC 60417-1, *Graphical symbols for use on equipment — Part 1: Overview and application*

ISO 7000:2014, *Graphical symbols for use on equipment — Registered symbols*

CIE 015:2018, *Colorimetry*

CIE S 017:2020, *International lighting vocabulary*

3 Terms and definitions

For the purposes of this document, the following terms and definitions given in CIE 015:2018 and CIE S 017:2020 and the following apply.

ISO and IEC maintain terminology databases for use in standardization at the following addresses:

- ISO Online browsing platform: available at <https://www.iso.org/obp/>
- IEC Electropedia: available at <https://www.electropedia.org/>

3.1

backing board

surround to the VMS, used depending on local circumstances, providing improved visibility of the VMS by means of increasing its size and by providing suitable visible contrast with the VMS background

3.2

cantilever support

support system with a single post and a cantilever arm supporting VMS(s) mounted over the traffic lane(s)

3.3

CCM

compliance criteria met

3.4

continuous VMS

similar to fixed signs, the only difference being that by some electro- and/or mechanical means they change between messages

EXAMPLE: Rotating prism signs, roller blinds, etc.

Note 1 to entry: Fixed signs are specified in accordance with EN 12899-1:2007.

3.5

control device

equipment used to execute a change of message other than by purely manual means

3.6

CWFT

classification without further testing

3.7

discontinuous VMS

signs which create messages using discontinuous individual elements that can be in one of two states (or more) and can thereby create various messages on the same sign face, in the following colours: white, yellow, orange, green, red and blue as specified herein

Example: Fibre optic signs, LED signs, LCD signs, etc.

3.8

display surface

visible part of a VMS that contains the elements that may be activated to display the message

3.9

distance between the light sources of adjacent elements

physical distance between the light sources of adjacent elements

Note 1 to entry: See Figure A.2.

3.10

element

basic visual light emitting and/or reflecting object or cluster of objects in the display surface of a VMS, activated in conjunction with other elements to form the desired message-see also definition of “pixel”

3.11

element spacing

centre-centre distance of adjacent elements

3.12

equivalent area

it is needed for achieving the equivalent appearance of a VMS with a fixed sign in accordance with EN 12899-1:2007

Note 1 to entry: Further explanation is given in Annex A.

3.13

front panel

visible part of a sign comprising the display surface; and the backing-board when this is integrated in the front of the VMS

3.14

front screen

screen protecting the display surface or the parts of it against dust, water, etc.

3.15

gantry

support system spanning a carriageway with one or more posts on each side of the carriageway supporting VMS mounted over the traffic lanes

3.16**horizontal reference plane**

horizontal plane containing the reference axis, when the VMS is positioned in such a way that the reference axis is horizontal

3.17**layout**

physical arrangement of characters (text) and symbols, on the display surface

3.18**luminance****3.18.1****luminance L_{a10} with external illumination**

during daylight condition when the VMS is ON, illuminated by sun at 10° above horizon, the perceived luminance of a VMS (L_{a10}) is composed by the emitted light (L_e) and the luminance caused by reflection of sun light (L_{b10})

3.18.2**luminance L_{a5} with external illumination**

during daylight condition when the VMS is ON, illuminated by sun at 5° above horizon, the perceived luminance of a VMS (L_{a5}) is composed by the emitted light (L_e) and the luminance caused by reflection of sun light (L_{b5})

3.18.3**luminance L_{b10} by reflection of external illumination**

during daylight condition, when the VMS is OFF, L_{b10} is the luminance caused by reflection of sun light at 10° above horizon

3.18.4**luminance L_{b5} by reflection of external illumination**

during daylight condition, when the VMS is OFF, L_{b5} is the luminance caused by reflection of sun light at 5° above horizon

3.18.5**luminance without external illumination L_e**

when the VMS is ON, L_e is the luminance caused by emitted light only.

3.19**luminance ratio LR** **3.19.1****luminance ratio LR_{10}**

ratio of luminance emitted from the VMS in the ON state (L_e) compared to the luminance emitted in the OFF state by reflection (L_{b10}).

Note 1 to entry: For calculation refer to 5.5.4.4.2.

3.19.2**luminance ratio LR_5**

ratio of luminance emitted from the VMS in the ON state (L_e) compared to the luminance emitted in the OFF state by reflection (L_{b5}).

Note 1 to entry: For calculation refer to 5.5.4.4.3.

3.20

manufacturer

any natural or legal person who manufactures a construction product or who has such a product designed or manufactured, and markets that product under his name or trademark

3.21

matrix

grid whose intersections hold the centre of the elements used in a VMS; a matrix may cover the whole display surface or part of it; axes X and Y of the grid may or may not be orthogonal

3.21.1

irregular matrix

spacing of intersections on either X or Y or both axes is not constant

3.21.2

regular matrix

spacing of intersections on the X and Y axes is constant but may differ between X and Y

3.22

message

configuration consisting of symbols and/or text

3.23

pixel

basic visual light emitting and/or reflecting object or cluster of objects in the display surface of a VMS, activated in conjunction with other elements to form the desired message

Note 1 to entry: See 3.11.

3.24

reference axis

axis originating on the reference centre of the VMS / test module being perpendicular to the front of it, unless otherwise defined by the manufacturer

3.25

reference centre

point on the VMS / test module which is designated to be the centre of the test area for specifying its performance and which is defined by the manufacturer

3.26

support

structure intended to maintain the VMS in its designed position (poles, posts, fixing, columns, ...)

3.27

test angles

horizontal test angle is the angle between the test axis and the vertical reference plane; and the vertical test angle is the angle between the test axis and the horizontal reference plane

Note 1 to entry: When the test axis is lower than the horizontal reference plane the vertical component of the test angle is designated as negative.

Note 2 to entry: When the test axis is to the left of the vertical reference plane as seen from the reference centre the horizontal component is designated as negative.

3.28**test axis**

line from the reference centre of the VMS / test module to the luminance meter head

3.29**test module**

representing the VMS for testing purpose

Note 1 to entry: See 5.3.

3.30**variable message traffic sign****VMS**

sign for the purpose of displaying one or more messages that may be changed or switched ON or OFF as required

3.31**vertical reference plane**

vertical plane containing the reference axis

3.32**VMS background**

part of environmental scenery, which, to the viewer, immediately surrounds the VMS

4 Characteristics**4.1 Dimensions and tolerances requirements**

Dimensions, shape and other physical parameters, character sizes, tolerances and character spacing shall be as required by the purchaser. The dimensions of the characters and symbols shall be defined using equivalent area as detailed in Annex A.

4.2 General design requirement

All parts of VMS shall be securely connected to the VMS housing.

NOTE Guidance is given in Annex O "Specific design issues".

4.3 Visual performance requirements of continuous VMS

The visual performance for continuous VMS (see 3.4) and its durability shall be in accordance with the relevant visual performance requirements and durability requirements of EN 12899-1:2007, 4.1.1.5, 7.2.2.1.4 or 7.3.1.8 as applicable to the specific type and class.

Compliance criterion: No deviation observed; abbreviation CCM (compliance criterion met) shall be used as declaration code.

For retro-reflective sign faces, non-retro-reflective sign faces, transilluminated signs and externally illuminated signs requirements are found in EN 12899-1:2007, 7.2.1, 7.2.2, 7.3 and 7.4 respectively.

4.4 Visual performance requirements of discontinuous VMS

4.4.1 Classification

The relevant class designations of the visual performance of discontinuous VMS shall be expressed as listed in Table 1.

Table 1 — Class designation of the visual performance parameters of VMS

Visual performance parameter	Class designation	Remarks
Colour ^a	C1, C2 ^a	C2 is the more restrictive
Luminance (L_a) ^b	L1, L2, L3, L1(*), L2(*), L3(*)	L3 has the highest luminance (*) for specific situations (see 4.4.3)
	L3(T) ^c	This class is for tunnel use
Luminance ratio ^d (LR)	R1, R2, R3	R3 has the highest luminance ratio
Beam width	B1, B2, B3, B4, B5, B6, B7	B7 has the widest beam
^a If one VMS using both classes for different colours, the colour is assigned together with the colour class, e.g. wC1, rC2... see Figure 1. ^b Only one luminance class may be declared, requirements of L1, L2 and L3 are covered by classes L1(*), L2(*) and L3(*) respectively. ^c The requirements for tunnel class is covered by class, L3 and L3(*) respectively. ^d Only one luminance ratio class may be declared.		

NOTE 1 Care is needed because some class-combinations may be not effective.

NOTE 2 Specific design issues are covered in N.3, where guidance is given on class combinations, and in Annex O.

4.4.2 Colour

A VMS may be able to display one or more of the colours red, orange, yellow, white, green, and blue specified herein.

The colour shall be measured in accordance with 5.5.3. The chromaticity coordinates of the colours are defined in accordance with the CIE 1931 Standard Colorimetric Observer as referenced in CIE 015:2018.

The chromaticity co-ordinates of the colour class C1 shall conform to Table 2. The chromaticity co-ordinates of the colour class C2 shall conform to Table 3. In Figure 1 these chromaticity areas are plotted in CIE 1931 chromaticity diagram.

The chromaticity areas in Table 2 and Table 3 for colours red, orange, yellow, white, green, and blue are as recommended in CIE S 004/E-2001 [3] for the colours of light signals.

NOTE 1 The colour distinction between orange and yellow or red is always difficult.

NOTE 2 Colour class C2 provides better colour distinction.

Table 2 — Corner points (CIE 1931 chromaticity co-ordinates x, y) of the chromaticity areas for the colours of class C1

Colour		Colour co-ordinates of corner points					
		1	2	3	4	5	6
Red	x	0,660	0,680	0,735	0,721	-	-
	y	0,320	0,320	0,265	0,259	-	-
Orange	x	0,629	0,610	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	0,500	0,500	0,440	0,300
	y	0,342	0,432	0,440	0,382	0,382	0,276
Green	x	0,310	0,310	0,209	0,026	-	-
	y	0,684	0,562	0,400	0,400	-	-
Blue	X	0,109	0,204	0,233	0,149	-	-
	Y	0,087	0,196	0,167	0,025	-	-

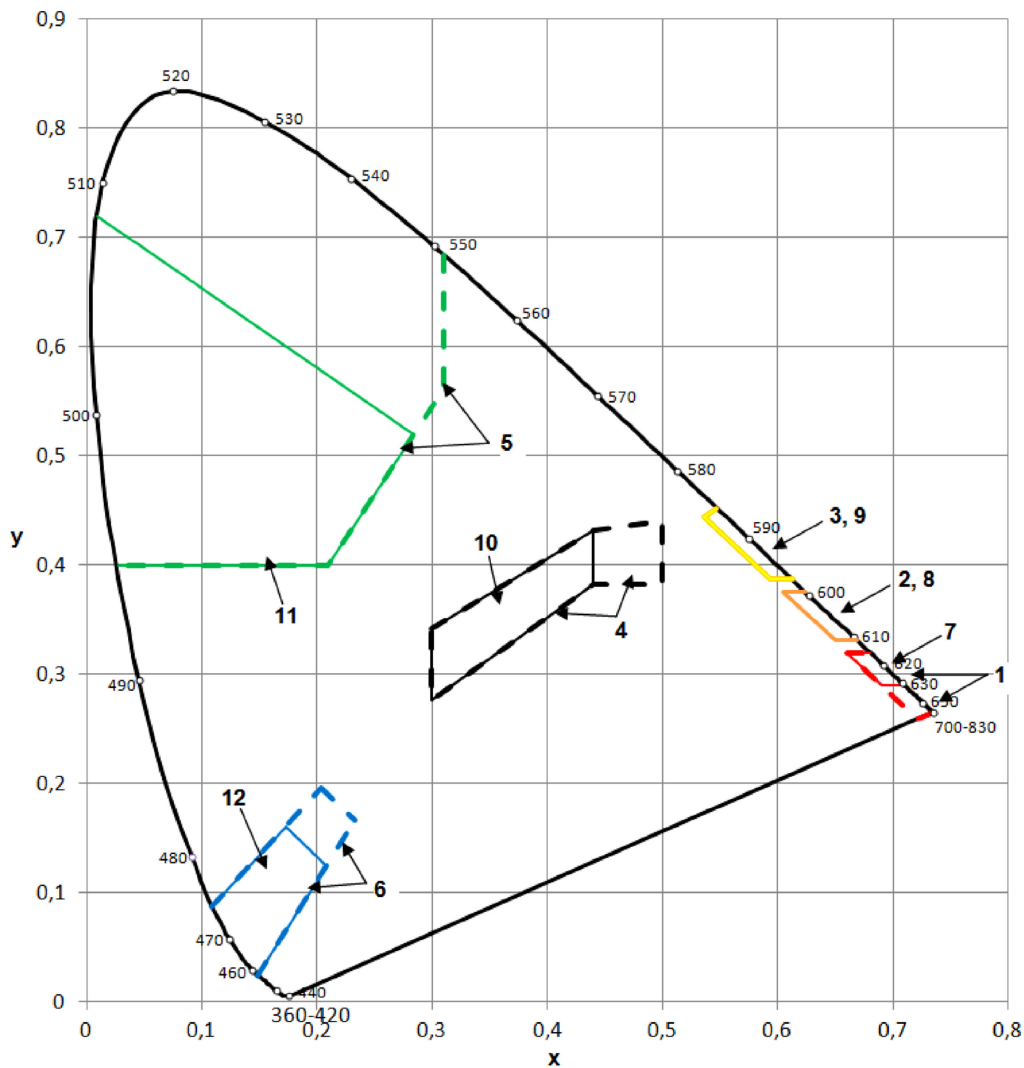
Table 3 — Corner points (CIE 1931 chromaticity co-ordinates x, y) of the chromaticity areas for the colours of class C2

Colour		Colour co-ordinates 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	0,629	0,610	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	0,026
	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

NOTE 3 Colour co-ordinates for yellow are identical in Table 2 and Table 3.

NOTE 4 Colour co-ordinates for orange are identical in Table 2 and Table 3.

Colours and classes shall be declared as indicated in Figure 1. If one VMS uses only one class for all colours, colour class shall be declared as C1 or C2 respectively.



Key							
--	Class C1	1	red	rC1	7	red	rC2
—	Class C2	2	orange	oC1	8	orange	oC2
		3	yellow	yC1	9	yellow	yC2
		4	white	wC1	10	white	wC2
		5	green	gC1	11	green	gC2
		6	blue	bC1	12	blue	bC2

Figure 1 — Chromaticity areas for the colour classes C1 and C2 plotted in the CIE 1931 chromaticity diagram

4.4.3 Luminance

4.4.3.1 Luminance under external illumination

When tested in accordance with 5.5.4, under external illumination from a solar simulator and with the VMS switched on, the luminance L_a shall comply with the requirements of row 1 of Table 4 to Table 9 - and row 2 in case of luminance class $L_x(*)$ - as relevant for the colours.

For classes L1 and L1(*) the sign shall achieve at least the luminance values $L_{a(\min)}$ of Table 4 to Table 9 row 1 with external illumination (solar simulator ON). For all luminance classes the sign shall not exceed the luminance values $L_{a(\max)}$ of Table 4 to Table 9 row 1 with external illumination (solar simulator ON).

When required, for specific situations (e.g., with the sun low in the sky) additional luminance and luminance ratios shall be measured in accordance with 5.5.4 with the external illumination set to 10 000 lx at 5°. This is denoted by an (*) in row 2 of Table 4 to Table 9.

Under external illumination luminance shall be measured at the test angles as specified in Table 24.

4.4.3.2 Luminance levels without external illumination

For classes L3, L3(*), L2 and L2(*), the sign shall achieve at least the luminance values $L_{e(\min)}$ of Table 4 to Table 9 row 1 without external illumination (solar simulator OFF).

To show the ability of appropriate dimming when tested in accordance with 5.5.4, without illumination from a solar simulator and with the VMS switched on, with settings prescribed by the manufacturer, luminance shall comply with the requirements of row 4 and row 6 of Table 4 to Table 9 as relevant for the colours.

For use in tunnels, only sign luminance (without external illumination) corresponding to sign illuminance specified in row 4 and row 6 / columns L3, L3(*) of Table 4 to Table 9 shall be considered. This is designated (T) in Table 1.

NOTE 1 Specific design issues are covered in N.3, where guidance is given on class combinations, and Annex O.

NOTE 2 Rows 3 and 5 of Table 4 to Table 9 are provided as information, see M.2.

NOTE 3 The levels of Table 4 to Table 9 illustrate possible dimming levels of an installed VMS dependent on ambient light conditions.

NOTE 4 Relationships between the requirements of Table 4 to Table 9 for the different colours reflect the natural colour balance. Maintaining this balance when displaying different colours on installed VMS provides best legibility.

Table 4 — L_e and L_a luminance limits for white on reference axis

Row reference	Sign illuminance (lx)	Luminance classes (cd/m ²)					
		L3, L3(*)		L2, L2(*)		L1, L1(*)	
		$L_{e(min)}$	$L_{a(max)}$	$L_{e(min)}$	$L_{a(max)}$	$L_{a(min)}$	$L_{a(max)}$
1	40 000	12 400	37 200	6 200	18 600	3 100	9 300
2	10 000	12 400 (*)	37 200	6 200 (*)	18 600	3 100 (*)	9 300
3	4 000	2 200	6 600	1 100	3 300	550	1 650
4	400	600	1 800	300	900	150	450
5	40	250	750	200	600	100	300
6	≤ 4	75	225	60	180	30	90

Table 5 — L_e and L_a luminance limits for yellow on reference axis

Row reference	Sign illuminance (lx)	Luminance classes (cd/m ²)					
		L3, L3(*)		L2, L2(*)		L1, L1(*)	
		$L_{e(min)}$	$L_{a(max)}$	$L_{e(min)}$	$L_{a(max)}$	$L_{a(min)}$	$L_{a(max)}$
1	40 000	7 440	22 320	3 720	11 160	1 860	5 580
2	10 000	7 440 (*)	22 320	3 720 (*)	11 160	1 860 (*)	5 580
3	4 000	1 320	3 960	660	1 980	330	990
4	400	360	1 080	180	540	90	270
5	40	150	450	120	360	60	180
6	≤ 4	45	135	36	108	18	54

Table 6 — L_e and L_a luminance limits for orange on reference axis

Row reference	Sign illuminance (lx)	Luminance classes (cd/m ²)					
		L3, L3(*)		L2, L2(*)		L1, L1(*)	
		$L_{e(min)}$	$L_{a(max)}$	$L_{e(min)}$	$L_{a(max)}$	$L_{a(min)}$	$L_{a(max)}$
1	40 000	4 800	14 400	2 400	7 200	1 200	3 600
2	10 000	4 800 (*)	14 400	2 400	7 200	1 200	3 600
3	4 000	852	2 556	426	1 278	213	639
4	400	232	696	116	448	58	174
5	40	100	300	50	150	25	75
6	≤ 4	28	84	14	42	7	21

Table 7 — L_e and L_a luminance limits for green on reference axis

Row reference	Sign illuminance (lx)	Luminance classes (cd/m ²)					
		L3, L3(*)		L2, L2(*)		L1, L1(*)	
		$L_{e(min)}$	$L_{a(max)}$	$L_{e(min)}$	$L_{a(max)}$	$L_{a(min)}$	$L_{a(max)}$
1	40 000	3 720	11 160	1 860	5 580	930	2 790
2	10 000	3 720 (*)	11 160	1 860 (*)	5 580	930 (*)	2 790
3	4 000	660	1 980	330	990	165	495
4	400	180	540	90	270	45	135
5	40	75	225	60	180	30	90
6	≤ 4	23	69	18	54	9	27

Table 8 — L_e and L_a luminance limits for red on reference axis

Row reference	Sign illuminance (lx)	Luminance classes (cd/m ²)					
		L3, L3(*)		L2, L2(*)		L1, L1(*)	
		$L_{e(min)}$	$L_{a(max)}$	$L_{e(min)}$	$L_{a(max)}$	$L_{a(min)}$	$L_{a(max)}$
1	40 000	3 100	9 300	1 550	4 650	775	2 325
2	10 000	3 100 (*)	9 300	1 550 (*)	4 650	775 (*)	2 325
3	4 000	550	1 650	275	825	138	414
4	400	150	450	75	225	38	114
5	40	63	189	50	150	25	75
6	≤ 4	19	57	15	45	7,5	22,5

Table 9 — L_e and L_a luminance limits for blue on reference axis

Row reference	Sign illuminance (lx)	Luminance classes (cd/m ²)					
		L3, L3(*)		L2, L2(*)		L1, L1(*)	
		$L_{e(min)}$	$L_{a(max)}$	$L_{e(min)}$	$L_{a(max)}$	$L_{a(min)}$	$L_{a(max)}$
1	40 000	1 240	3 720	620	1 860	310	930
2	10 000	1 240 (*)	3 720	620 (*)	1 860	310 (*)	930
3	4 000	220	660	110	330	55	165
4	400	60	180	30	90	15	45
5	40	25	75	20	60	10	30
6	≤ 4	7,5	22,5	6,0	18	3,0	9,0

Without external illumination luminance shall be measured at the test angles as specified in Table 25.

4.4.4 Luminance ratio

Luminance ratio is a balance between light-output L_a and sign-reflection L_b (see 5.5.4.4). Ideally the value of L_b (reflection) should be kept as low as possible. The luminance ratio values shall be measured in accordance with 5.5.4. For classes Rx minimum luminance ratio values specified in Table 10 must be achieved.

Luminance ratios LR_{10} , as appropriate for each colour, shall be maintained for illuminance specified in row 1 of Table 4 to Table 9; for $L_x(^*)$ classes luminance ratio values LR_5 shall be maintained additionally for illuminance specified in row 2 of Table 4 to Table 9. If values LR_{10} and LR_5 are different, the lower value determines the declared LR class. For test angles refer to 5.5.2 Table 24.

NOTE 1 The luminance ratio requirements and associated test methods apply only to strong sunlight as defined in row 1 and row 2 of Table 4 to Table 9. Consequently, neither a requirement for the luminance ratio nor an applicable test method of LR for the luminance class L3(T) is possible.

NOTE 2 Specific design issues are covered in Annex N.3, where guidance is given on class combinations for luminance and luminance ratio.

Table 10 — Minimum luminance ratio values (LR) for various colours and classes R1, R2 and R3, at test angles on the reference axis and off the reference axis

Colour	Minimum luminance ratio classes					
	R3		R2		R1	
	on reference axis	vertical off-axis	on reference axis	vertical off axis	on reference axis	vertical off-axis
white	16,7	8,35	10	5	5	3
yellow	10	5	6	3	3	1,8
orange	6,5	3,25	3,9	1,95	1,9	1,15
green	5	2,5	3	1,5	1,5	0,9
red	4,2	2,1	2,5	1,25	1,25	0,75
blue	1,7	0,85	1	0,5	0,5	0,3

4.4.5 Beam width

Beam width shall be measured in accordance with 5.5.5. The minimum beam width angles shall be in accordance with Table 11, which shows seven beam width classes.

Any luminance at all measured angles within the horizontal and vertical beam width shall not be lower than 50 % of the measured luminance on the reference axis.

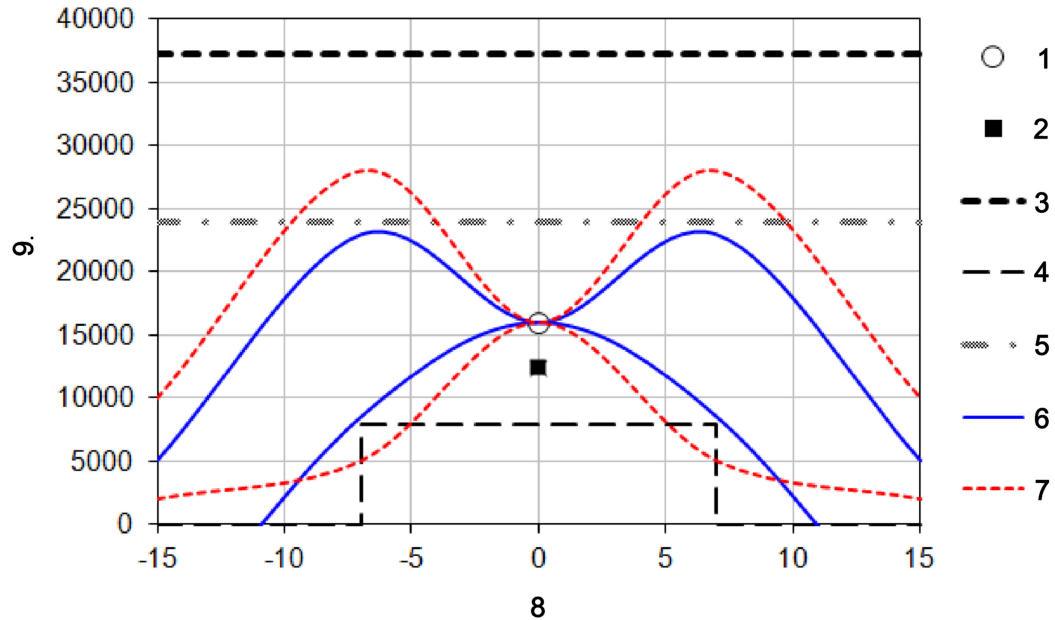
Any luminance at all measured angles within the horizontal and vertical beam width shall not be more than 150 % of the measured luminance on the reference axis.

Any luminance at all measured angles shall not exceed the maximum luminance in accordance with Table 4 to Table 9.

NOTE 1 There are no requirements given in Table 11 for maximum beam width. Beam widths are defined as a minimum performance requirement. A higher beam width class fulfils the requirements of the lower beam classes, with the exception of B5 which only fulfils the requirements of classes B1, B2 and B3.

NOTE 2 Figure 2 shows examples of passed and failed luminance distributions for the white colour, luminance class L3, and beam width class B2 with the sign set to the luminance level to achieve the performance at an illuminance of 40 000 lx. For this test, the solar simulator is not operating.

NOTE 3 Specific design issues are covered in N.3, where guidance is given on class combinations.



Key

- 1 actual measured luminance L_{MES} on reference axis
- 2 minimum luminance on reference axis $L_{e(min)}$
- 3 maximum luminance at all angles $L_{a(max)}$
- 4 lower limit (50 % of L_{MES})
- 5 upper limit (150 % of L_{MES})
- 6 passed luminance distributions
- 7 failed luminance distributions
- 8 horizontal angle (degrees)
- 9 luminance ($cd.m^{-2}$)

Figure 2 — Examples of passed and failed luminance distributions

EXAMPLE As shown in Table 4 the luminance for the colour white on the reference axis shall be in the range $12\,400\,cd/m^2$ ($L_{e(min)}$) to $37\,200\,cd/m^2$ ($L_{a(max)}$). Suppose the actual measured luminance on the reference axis obeys this requirement and $L_{MES} = 16\,000\,cd/m^2$. The maximum luminance at all other angles results in $1,5 \times 16\,000 = 24\,000\,cd/m^2$. The minimum luminance within the beam width angles will be at least $0,5 \times 16\,000 = 8\,000\,cd/m^2$. Outside the beam width angles the luminance is allowed to be zero, but never larger than $1,5 \times L_{MES}$ respectively $L_{a(max)}$.

Table 11 — Beam width classes

Beam width class	Beam angles (degrees)	
	Horizontal	Vertical
B1	-5	0
	+5	0
	0	-5
B2	-7	0
	+7	0
	0	-5
B3	-10	0
	+10	0
	0	-5
B4	-10	0
	+10	0
	0	-10
B5	-15	0
	+15	0
	0	-5
B6	-15	0
	+15	0
	0	-10
B7	-30	0
	+30	0
	0	-20

NOTE Beam width classes shall be chosen in accordance to the application, guidance is provided by Annex N.

4.4.6 Uniformity of luminous intensity

Uniformity measurements shall be in accordance with 5.5.6.

Requirement A: For the luminous intensities of any individual element of the VMS the ratio of the average output from the highest 12 % of the elements of the VMS, to the lowest 12 %, shall be less than 3:1.

Requirement B: For the luminous intensities of any individual element of the VMS the ratio of the average output from the highest 4 % of the elements of the VMS, to the lowest 4 %, shall be less than 5:1.

The number of elements in consideration shall be rounded to the next highest whole number. The luminous intensity uniformity shall apply to each separate colour.

Compliance criteria: Requirements A and B shall be met; abbreviation CCM (compliance criteria met) shall be used as declaration code.

4.4.7 Visible flicker

During testing there shall be no visible light flicker, whether the light sources of a VMS are operating with full intensity or dimmed. In the case of doubt, the lowest frequency of the light emitted by the VMS represented by the test module shall be measured and declared. This frequency shall not be less than 90 Hz.

Compliance criterion: No flicker shall be observed; abbreviation CCM (compliance criterion met) shall be used as declaration code.

NOTE Frequencies above 90 Hz do not present visible flicker ¹.

4.4.8 Durability of visual performance

Design solutions of VMS shall consider impact to visual performance (i.e., colour, luminance and luminance ratio) caused by aging effects. The visual performance requirements are minimum requirements and shall be achieved during the entire technical lifetime of the VMS. Durability of the visual performance shall be demonstrated by the test in accordance with 5.1, 8) after following the test sequence of 5.1 from point 1 to point 7.

Compliance criterion: No change in classification after testing; abbreviation CCM (compliance criterion met) shall be used as declaration code.

4.5 Physical performance requirements

4.5.1 Classification

The relevant class designations of the physical performance of VMS shall be declared. This shall be expressed with class designations for resistance to the effects of external conditions as listed in Table 12.

Table 12 — Class designation

External conditions	Class designation	Remarks
Temperature	T1, T2, T3, T4	
Ingress protection against water and dust	IP44, IP45, IP54, IP55, IP56	IP56 is the most restrictive
Corrosion	SP0, SP1, SP2	SP2 is the most restrictive
Classes of wind pressure	WL0 – WL9	WL9 is the most restrictive
Temporary deflections caused by bending	TDB0 – TDB6	TDB1 is the most restrictive
Dynamic pressure from snow clearance	DSL0 – DSL4	DSL4 is the most restrictive

¹ COMMISSION DELEGATED REGULATION (EU) 2021/1958 defines test procedures and technical requirements for the type-approval of motor vehicles with regard to their intelligent speed assistance systems (ISA) and for the type-approval of those systems. This Delegated Regulation states in Annex II, Catalogue of road signs - Part 1, Explanatory Notes: „Variable message signs may display any of the explicit numerical speed limit signs, implicit numerical speed limit signs and implicit non-numerical speed limit signs included in the table of the respective country. However, the refresh rate of the signs shall be at least 1 000 Hz to ensure the image is captured correctly for the purpose of adequate ISA system processing.“

4.5.2 Resistance to the effects of external conditions

4.5.2.1 Temperature

One or several of the temperature range classes listed in Table 13 shall be selected:

Table 13 — Temperature range classes

Temperature Class	ambient temperature (°C)	
	Minimum	Maximum
T1	-15	+60
T2	-25	+55
T3	-40	+40
T4	-15	+55
NOTE: Class T4 is requiring sun radiation test.		

Temperature performance of the VMS represented by the test module shall be tested in accordance with Table 23 as relevant to the specific class and shall meet the requirements given therein.

4.5.2.2 Resistance to corrosion

4.5.2.2.1 Resistance to corrosion of continuous VMS

The classes of surface protection of enclosures of continuous VMS against corrosion shall be in accordance with EN 12899-1:2007, 7.1.7.

Surface coating shall be applied in accordance with the instructions and recommendations of the manufacturer of the surface coating.

Materials used for continuous VMS shall be resistant to corrosion and shall be classified and declared in accordance with EN 12899-1:2007, 7.1.7, Table 15.

4.5.2.2.2 Resistance to corrosion of discontinuous VMS

Discontinuous VMS shall be resistant to corrosion; a test module representing the VMS shall be tested in accordance with 5.4.3, Table 20.

Compliance criterion: No corrosion observed; abbreviation CCM (compliance criterion met) shall be used as declaration code.

4.5.2.3 Ingress protection against water and dust (IP) provided by enclosures

VMS containing electrical equipment shall be protected against water and dust ingress in accordance with Table 14 (IP code as required by EN 60529, category 2); VMS or representative test module shall be tested in accordance with Table 21 and Table 22 and shall meet the requirements given therein.

Table 14 — Ingress protection level classes

Protection class
IP44
IP45
IP54
IP55
IP56

4.5.2.4 Mechanical performance requirements

4.5.2.4.1 General

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

4.5.2.4.2 Temporary deflections caused by wind loads

With the wind load determined in accordance with EN 12899-1:2007, 5.3.1 the temporary deflection shall not exceed the maximum for the relevant class of EN 12899-1:2007, 5.4.1.

4.5.2.4.3 Permanent deflections caused by dynamic loads

With the dynamic snow load determined in accordance with EN 12899-1:2007, 5.3.2 the permanent deflection shall not exceed 20 % of the temporary deflection using the same load.

NOTE 1 Dynamic snow load is defined in EN 12899 as the load that can act on traffic signs mounted on the roadside below 2 m height (above road level) when clearing snow with a snow plough. Class DSL0 applies to all other applications.

NOTE 2 Point loads are not applicable for VMS.

4.5.2.4.4 Impact resistance

VMS shall be capable of withstanding impact; representative test module shall be tested in accordance with Table 18 and shall meet the requirements given therein.

Compliance criterion: No damage observed; abbreviation CCM (compliance criterion met) shall be used as declaration code.

4.5.2.4.5 Vibration resistance

VMS shall be capable of withstanding vibration; representative test module shall be tested in accordance with Table 19 and shall meet the requirements given therein.

Compliance criterion: No alterations observed; abbreviation CCM (compliance criterion met) shall be used as declaration code.

4.5.3 Electrical performance requirements

4.5.3.1 Electrical supply and limits

4.5.3.1.1 Maximum power consumption

The maximum power consumption of the VMS shall be declared. Limits to the power consumption may be required by the purchaser.

4.5.3.1.2 Nominal voltages

The standard nominal voltage for connection to the public supply shall be taken to be 230 V AC r.m.s. single phase or 400 V AC r.m.s. three phases.

Where other voltages are used, these shall be declared.

4.5.3.1.3 Operating voltage range

Variations in the nominal supply voltage of -13% to $+10\%$ shall not affect the VMS functions. This shall be tested in accordance with Table 16 and Table 17 and shall meet the requirements given therein.

4.5.3.1.4 Mains frequency

Variations within the frequency range (50 ± 1) Hz shall have no effect. This shall be tested in accordance with Table 17 and shall meet the requirements given therein.

4.5.3.1.5 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. This shall be tested in accordance with Table 16 and Table 17 and shall meet the requirements given therein.

4.5.3.1.6 Low voltage

4.5.3.1.6.1 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. This shall be tested in accordance with Table 16 and shall meet the requirements given therein.

4.5.3.1.6.2 Voltage interruption

In the event of short supply voltage interruptions, the VMS shall operate as described in Table 15 and shall be tested in accordance with 5.4.2 and shall meet the requirements given therein.

Table 15 — Effect of voltage interruption

Duration (ms)	Effect
Less than 50	No effect
50 to less than 100	The VMS shall continue displaying the current message. The VMS may be affected by a variation of luminance during the voltage interruption.
Greater than or equal to 100	Shut down is allowed unless specified differently 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 4.5.3.1.5.

4.5.3.1.6.3 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 and shall meet the requirements given therein.

4.5.3.2 Electrical safety

VMS shall conform to electrical safety requirements of EN 50556:2018 and EN 62368-1:2020 as applicable.

4.5.4 Electromagnetic compatibility requirements**4.5.4.1 Electromagnetic emission**

For all types of environments, the VMS shall conform to EN 50293:2012, representative test modules must be tested accordingly.

4.5.4.2 Electromagnetic immunity

For all types of environments, the VMS shall conform to EN 50293:2012, representative test modules must be tested accordingly.

4.6 Dangerous substances

National regulations on dangerous substances may require verification and declaration on release, and sometimes content, of dangerous substances, when construction products covered by this European Standard are placed on those markets.

In the absence of European harmonized test methods, verification, and declaration on release/content shall be done taking into account national provisions in the place of use.

Release of dangerous substances may be assessed indirectly by controlling the content of the substance concerned.

NOTE An informative database covering European and national provisions on dangerous substances is available at http://ec.europa.eu/enterprise/sectors/construction/cpd-ds/index_en.htm.

5 Testing, assessment and sampling methods

5.1 Test sequence

Any and all test procedures shall be conducted in the following sequence on a single VMS / test module. Function tests in accordance with 5.3.3 shall be performed after tests of sequence point 2, 3, 4, 5, 6 and during all test conditions of sequence point 7:

- a) visual performance test;
- b) electrical tests;
- c) impact test;
- d) vibration test;
- e) corrosion test;
- f) test of ingress protection against water and dust (IP) provided by enclosures;
- g) temperature test (thermostatically controlled temperature regulation devices, if provided, shall be allowed to operate normally);
 - 1) cold;
 - 2) dry heat;
 - 3) solar radiation (mandatory only for class T4, can be carried out as alternative to the dry heat test for T1);
 - 4) damp heat cyclic;
 - 5) change of temperature (can be substituted for the above tests a) and b), unless T3 is required);
- h) Colour, luminance, and luminance ratio on reference axis in accordance with 4.4.2, 4.4.3 and 4.4.4 (only applicable for discontinuous VMS).

NOTE It is advantageous to perform the EMC test in accordance with 4.5.4 after test 2).

5.2 Durability

Durability against environmental factors shall be demonstrated by meeting the relevant test requirements in the sequence set out in 5.1.

5.3 Test modules

5.3.1 General

To allow for future developments in technology and sign design, the standard uses performance requirements to cover as many as possible technologies. This European Standard contains a number of defined requirements, some of which have to be demonstrated on the test module, others that are to be confirmed by the manufacturer.

It is not possible to define one uniform variable message traffic sign, bearing in mind the wide range of applications and technologies, the range of sizes, and various requirements for characters and symbols.

Testing, which cannot be carried out on the total VMS for practical reasons (e.g. due to large dimension and weight), will be carried out on a test module to demonstrate that all the requirements of this European Standard are achieved.

Test modules, manufactured to comply with the requirements given herein, shall:

- a) be complete with all components or devices (e.g. power supplies, controllers, elements, ventilation openings and draining holes, electrical safety devices, overvoltage protection and if applicable light sensors, heaters and fans, etc.) that are fitted in a production VMS unit and necessary to meet the performance requirements;
- b) be complete with all facilities, necessary for function test during the physical and visual performance tests;
- c) provide the necessary control system to enable performance testing, the “all ON/ all OFF” and “individual ON” modes with the respective illuminance requirements necessary for the visual performance measurements;
- d) include electrical test points to allow for the monitoring of the parameter(s) used for each of the visual performance test settings;
- e) be of sufficient elements to demonstrate the compliance of VMS as placed on the market with the requirements of this European Standard.

Documentary and safety instructions shall be provided detailing all necessary installation and operational procedures. Each of the settings for all parameters, relevant for the various tests, shall be stated therein in detail.

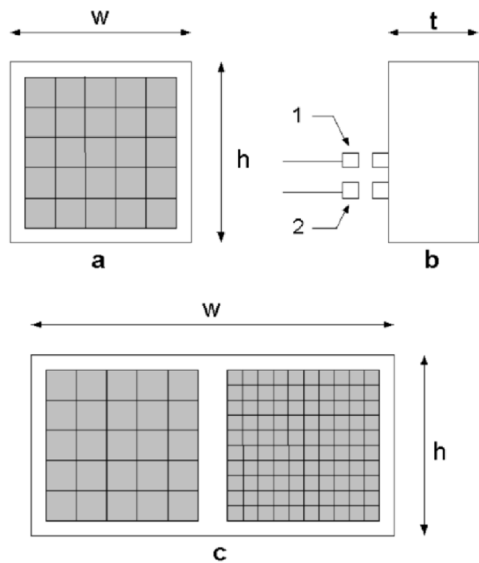
NOTE The test methods for visual performance of continuous signs including externally illuminated continuous signs are covered by EN 12899-1:2007.

5.3.2 Dimensions of test modules

The maximum size ($w \times h \times t$) of the test module shall be $(1\,350 \times 1\,350 \times 500)$ mm (Figure 3a, Figure 3b). If the dimensions of the production sign are within these limits, the test module can be identical to the VMS, as long as all other requirements of Clause 5 are fulfilled.

Each optical test area in a VMS / test module shall have minimum dimensions in accordance with 5.5.4.2. A test module can have one or more optical test areas with a different number of elements (Figure 3c).

Where a VMS is used for testing, the test area shall be identified as defined in 5.5.4.2.



Key

- | | | | |
|---|---------------|---|-----------|
| 1 | power input | w | width |
| 2 | control input | h | height |
| | | t | thickness |

NOTE The shaded squares are equivalent element areas (see 3.12) and form the optical test area.

Figure 3 — Examples of variable message traffic sign test modules in front view – a) and c) - and side view b)

The element spacing (spacing between the centres of the elements) shall be measured for the test modules, which meet the test requirements and shall be reported as the “element spacing”. The element spacing of the VMS shall be within $\pm 10\%$ of the element spacing measured on the test module.

5.3.3 Function test

5.3.3.1 General

The function test is based on alternate activation/deactivation of all the elements; it is the cyclic change of all elements from one state to another.

The test shall be carried out at the level used for the maximum applicable performance level.

Each cycle “ON/OFF” shall comprise at least 1 s ON followed by at least 1 s OFF. The test shall comprise a minimum of 10 cycles.

5.3.3.2 Test conditions

The function test shall be carried out in conditions as specified in 5.4.

5.4 Physical performance test methods

5.4.1 General

A function test shall be carried out during the execution of test procedure, at the moment and with the frequency indicated in the following.

5.4.2 Electrical tests

Prior to the commencement of the environmental test the following tests shall be undertaken in accordance with Table 16.

Table 16 — Operating voltage range, power-up activation and temporary overvoltage 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 This test is done only if a protection device is incorporated.		

The function test shall be repeated for different combinations of voltage and frequency in accordance with Table 17:

Table 17 — Frequency and voltage tests

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

5.4.3 Environmental and mechanical tests

The environmental and mechanical test methods shall be as detailed in the following Table 18 to Table 23.

Table 18 — Impact test

Impact Test	
Impact EN 60598	Impact tests shall be conducted on horizontally mounted VMS / test module front panel using a steel ball of 50 mm diameter with a mass of 0,51 kg dropped from a height h (1,3 m) to produce an impact energy of 6,5 Nm.
	The VMS / test module shall be conditioned at a temperature of $(20 \pm 2) ^\circ\text{C}$ and then be subject to three single impacts, at the weakest point on the front panel of the VMS / test module ^a .
	The VMS / test module shall be cooled to a temperature of $(-5 \pm 2) ^\circ\text{C}$, 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 ^a .
	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.
^a This is usually determined after consultation with the manufacturer.	

Table 19 — Vibration test

Resistance against Vibration		
Vibration EN 60068-2-64:2008 +A1:2019	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 g ² /Hz (10 Hz to 50 Hz). 0,013 g ² /Hz (50 Hz to 200 Hz with a negative slope 3 dB/octave). Overall r.m.s. acceleration 1,2 g.
	Duration of conditioning:	90 min in each of 3 axes.
	Reproducibility:	Low.
	Initial measurements:	Visual inspection and function test.
	Functioning during conditioning:	No.