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English Version

Road vertical signs - Variable message traffic signs

Signaux de signalisation routière verticale - Panneaux à messages variable

Vertikale Verkehrszeichen - Wechselverkehrszeichen

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

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EUROPEAN COMMITTEE FOR STANDARDIZATION
COMITÉ EUROPÉEN DE NORMALISATION
EUROPÄISCHES KOMITEE FÜR NORMUNG

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Foreword

This document (FprEN 12966:2014) 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 Formal Vote.

This document will supersede EN 12966-1:2005+A1:2009, EN 12966-2:2005 and EN 12966-3:2005.

This document has been prepared under a mandate given to CEN by the European Commission and the European Free Trade Association, and supports essential requirements of EU Directive(s).

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

FprEN 12966, with the introductory element and the main element of the title “*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 and ISO documents.

The main changes with respect to the previous edition are listed below:

— The new structure of the standard has been adapted to the structure proposed by CEN BT for harmonised standards

  — Consequently the contents of Clauses 4 to 8 of the previous edition have been moved to Clause 4 Product characteristics in sub-clauses 4.1 to 4.6;

  — Contents of Clause 9 of the previous edition have been moved to Clause 5 Testing, assessment and sampling methods;

  — Contents of EN 12966-2:2005 and contents of EN 12966-3:2005 have been moved to Clause 6-Assessment and verification of constancy of performance (AVCP) and revised in accordance with requirements of CPR;

  — contents of Clause 10 of the previous edition have been moved to Clause 7-Classification and designation;

  — contents of Clause 11 of the previous edition have been moved to Clause 8-Marking, labelling and packaging;

  — contents of Clause 12 of the previous edition are now included in Clause 6-Assessment and verification of constancy of performance (AVCP);

  — contents of Clause 13 of the previous edition are now included in sub-clause 4.6-Dangerous substances;

  — informative Annex B of the previous edition has been renamed to informative Annex L;

  — informative Annex C of the previous edition has been renamed to informative Annex M, information and guidance on graphics for discontinuous light emitting signs including figures has been added for better understanding;

- informative Annex D of the previous edition has been renamed to informative Annex N, information and guidance on dimensions, luminance, beam width, legibility and efficiency for discontinuous VMS including figures has been added for better understanding;
- informative Annex E of the previous edition has been renamed to informative Annex O;
- informative Annex F of the previous edition has been renamed to informative Annex P ;
- new normative Annex B has been added to define declaration codes for marking;
- new informative Annex Q has been added to give guidance for technical documentation;
- new informative Annex R has been added showing templates for summary of test results;

— visual performance requirements of continuous VMS (4.3) and discontinuous VMS (4.4), have been updated, test methods have been simplified (5.5);

— physical performance requirements have been updated (4.5), test method have been adjusted accordingly (5.4);

— informative Annex ZA has been revised in accordance with requirements of the CPR.

NOTE 1 The structure of the document follows the requirements requested by the CEN CPR Consultant at the time of drafting the document.

NOTE 2 Due to fact that the Framework Partnership Agreement between the Commission and CEN & CENELEC is not signed yet, there are currently no New Approach Consultants in place for 2014. Therefore the provisions of CEN-CENELEC Guide 15 cannot be met.

This shall not prevent the processing of draft standards nor the offering of harmonized standards to the Commission. In particular, draft standards can be sent to vote without Consultant assessment.

This note will be removed from the Foreword of the finalized publication.

Introduction

This European Standard 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 European Standard 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 European Standard 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 European Standard 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 European Standard 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 should 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 should 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 European Standard provides specifications for two types of variable message signs (VMS); i.e. continuous (see 3.4) and discontinuous (see 3.7).

This European Standard covers mobile, temporary and 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 European Standard 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.

This European Standard 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, in whole or in part, are normatively referenced in this document and are indispensable for its application. 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 50556:2011, *Road traffic signal systems*

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

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

EN 60068-2-5, *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, *Environmental testing — Part 2-14: Tests — Test N: change of temperature (IEC 60068-2-14)*

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

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

EN 60529, *Degrees of protection provided by enclosures (IP Code) (IEC 60529)*

EN 60598-1, *Luminaires — Part 1: General requirements and tests (IEC 60598-1)*

EN 60664-1, *Insulation coordination for equipment within low-voltage systems — Part 1: Principles, requirements and tests (IEC 60664-1)*

EN 60950-1:2006, *Information technology equipment — Safety — Part 1: General requirements (IEC 60950-1:2005, modified)*

EN 60950-22:2006, *Information technology equipment — Safety — Part 22: Equipment installed outdoors (IEC 60950-22:2005, modified)*

EN ISO 9227:2012, *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 015-2004, *Colorimetry*

CIE S 017:2011, *International lighting vocabulary*

3 Terms and definitions

For the purposes of this document, the terms and definitions given in CIE 015-2004 and CIE S 017:2011 and the following apply.

NOTE When reading this document for the first time, particular attention regarding terminology as given in Annex L helps for better understanding.

3.1
AVCP
assessment and verification of constancy of performance

3.2
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

3.3
cantilever support
support system with a single post and a cantilever arm supporting VMS(s) mounted over the traffic lane(s)

3.4
continuous VMS
these are 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
these 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 (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 with external illumination
L_{a10}
during daylight condition when the VMS is ON, illuminated by sun at 10° above horizon, the apparent 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 with external illumination
L_{a5}
during daylight condition when the VMS is ON, illuminated by sun at 5° above horizon, the apparent 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 by reflection of external illumination
L_{b10}
during daylight condition, when the VMS is OFF, Lb is the luminance caused by reflection of sun light at 10° above horizon

3.18.4
luminance by reflection of external illumination
L_{b5}
during daylight condition, when the VMS is OFF, Lb(*) 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, Le is the luminance caused by emitted light only.

3.19
luminance ratio
LR
ratio of luminance emitted from the VMS in the ON state (L_e) compared to the luminance emiited in the OFF state by reflection (L_b).

NOTE 1 to entry: For calculation refer to 5.5.4.4.

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 3.10.

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, 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 Product 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	C1, C2 [a]	C2 is the more restrictive
Luminance (La)	L1, L2, L3,L1(*), L2(*), L3(*) [b]	L3 has the highest luminance (*) for specific situations (see 4.4.3)
	L1(T), L2(T), L3(T) [c]	These classes are for tunnel use
Luminance ratio (LR)	R1, R2, R3 [d]	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 classes are covered by classes L1, L2. L3 respectively.

[d] Only one luminance ratio class may be declared.

NOTE 1 Care is needed because some class-combinations are not possible and/or are not effective.

NOTE 2 Specific design issues are covered in N.3, where guidance is given on class combinations, and 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 015-2004.

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	0,624	0,605	0,650	0,669	-	-
	y	0,370	0,370	0,331	0,331	-	-
Yellow	x	0,536	0,547	0,613	0,593	-	-
	y	0,444	0,452	0,387	0,387	-	-
White	x	0,300	0,440	0,500	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	0,028	-	-
	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	-	-

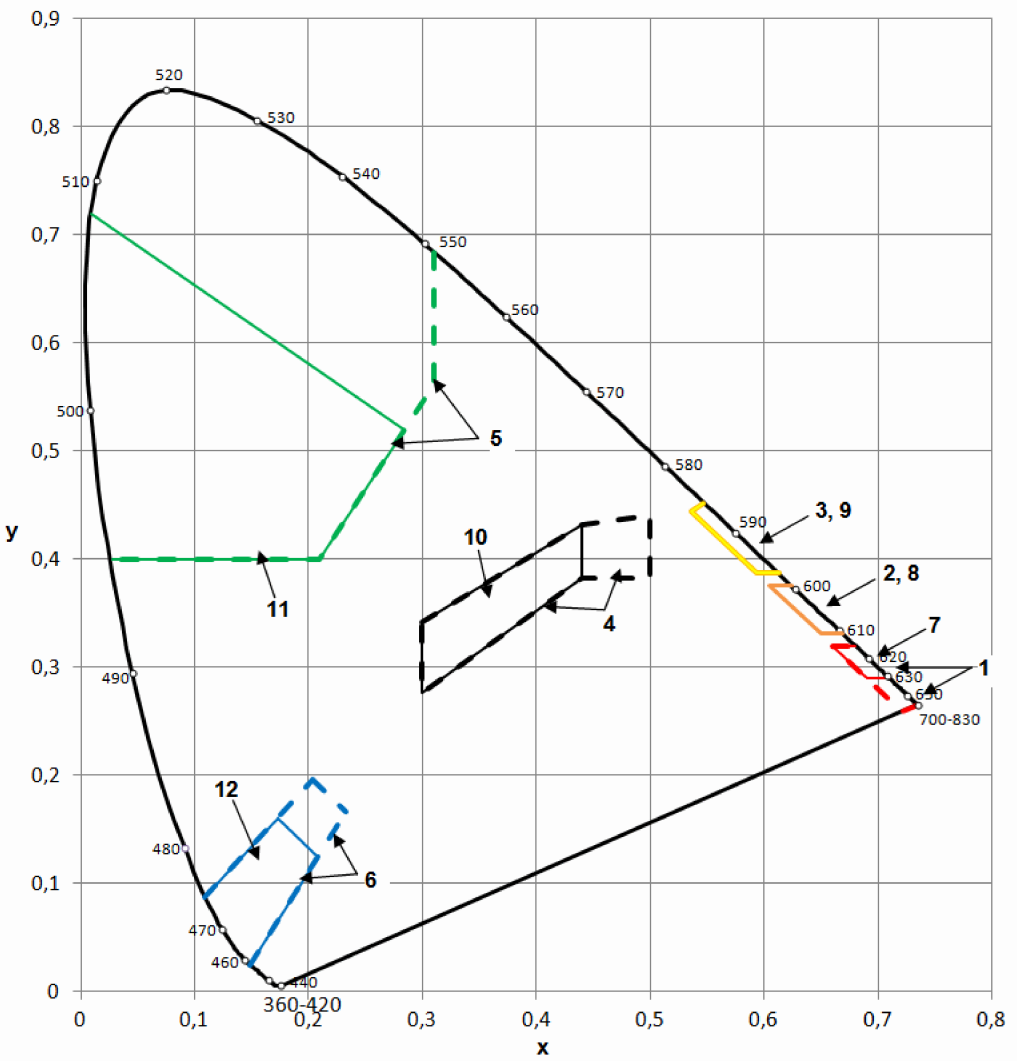
Table 3 — Corner points (CIE 1931 chromaticity co-ordinates x, y) of the chromaticity areas for the colours of class C2

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	0,624	0,605	0,650	0,669
	y	0,370	0,370	0,331	0,331
Yellow	x	0,536	0,547	0,613	0,593
	y	0,444	0,452	0,387	0,387
White	x	0,300	0,440	0,440	0,300
	y	0,342	0,432	0,382	0,276
Green	x	0,009	0,284	0,209	0,028
	y	0,720	0,520	0,400	0,400
Blue	x	0,109	0,173	0,208	0,149
	y	0,087	0,160	0,125	0,025

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

NOTE 4 The 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

		1	red	rC1	7	red	rC2
		2	orange	oC1	8	orange	oC2
_ _	Class C1	3	yellow	yC1	9	yellow	yC2
___	Class C2	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 Lx(*) - 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 of Table 4 to Table 9 shall be considered. These are 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/m²)					
		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/m²)					
		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/m²)					
		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/m²)					
		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/m²)					
		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/m²)					
		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 have to 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 Lx(*) 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 For luminance classes Lx(T) there is no luminance ratio requirement.

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

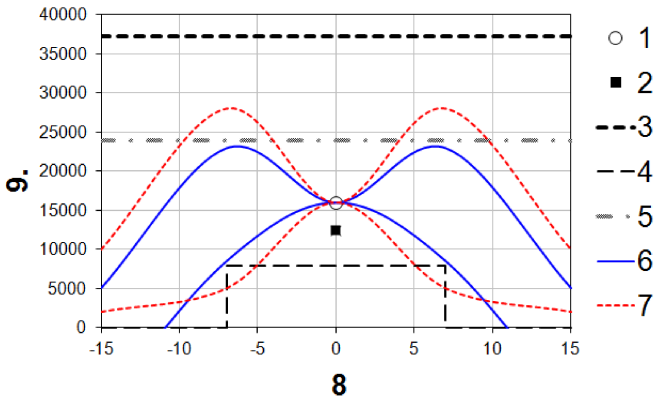
Any luminance at all measured angles within the horizontal and vertical beam width shall not be lower than 50 % of the measured luminance on the reference axis.

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 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 2 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 should be in the range 12 400 cd/m² ($L_{e(min)}$) to 37 200 cd/m² ($L_{a(max)}$). Suppose the actual measured luminance on the reference axis obeys this requirement and L_{MES} = 16 000 cd/m². The maximum luminance at all other angles results in 1,5 × 16 000 = 24 000 cd/m². The minimum luminance within the beam width angles will be at least 0,5 × 16 000 = 8 000 cd/m². Outside the beam width angles the luminance is allowed to be zero, but never larger than 1,5 × L_{MES} respectively $L_{a(max)}$.

Table 11 — Beam width classes

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

NOTE Class B7 provides light distributions as typically used at specific applications (e.g. car park).

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.

4.4.8 Durability of visual performance

Design solutions of VMS shall take into account 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 life time 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
Temporary deflections caused by wind loads	WL0 – WL9	WL9 is the most restrictive
Temporary deflections caused by bending	TDB0 – TDB6	TDB1 is the most restrictive
Permanent deflections caused by dynamic snow loads	DSL0 – DSL4	DSL4 is the most restrictive

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 of electrical / electronic components to the effects of pollution

The manufacturer shall declare the degree of resistance to pollution in accordance with EN 60664-1.

4.5.2.3 Resistance to corrosion

4.5.2.3.1 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.

4.5.2.3.2 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.

4.5.2.4 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

4.5.2.5 Mechanical performance requirements

4.5.2.5.1 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.

4.5.2.5.2 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.

4.5.2.5.3 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 Point loads are not applicable for VMS.

4.5.2.5.4 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.

4.5.2.5.5 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 50556:2011, 5.1, EN 60950-1:2006, and EN 60950-22:2006 as applicable.

4.5.4 Electromagnetic compatibility requirements

4.5.4.1 Electromagnetic emission

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

4.5.4.2 Electromagnetic immunity

For all types of environment the VMS shall conform to EN 50293:2012, representative test modules have to 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 harmonised test methods, verification and declaration on release/content should 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 the 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:

1) visual performance test,

2) electrical tests,

3) impact test,

4) vibration test,

5) corrosion test,

6) test of ingress protection against water and dust (IP) provided by enclosures,

7) temperature test (thermostatically controlled temperature regulation devices, if provided, shall be allowed to operate normally);

   a) cold;

   b) dry heat;

   c) solar radiation (mandatory only for class T4, can be carried out as alternative to the dry heat test for T1);

   d) damp heat cyclic

   e) change of temperature (can be substituted for the above tests a) and b), unless T3 is required);

8) 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

In order 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.

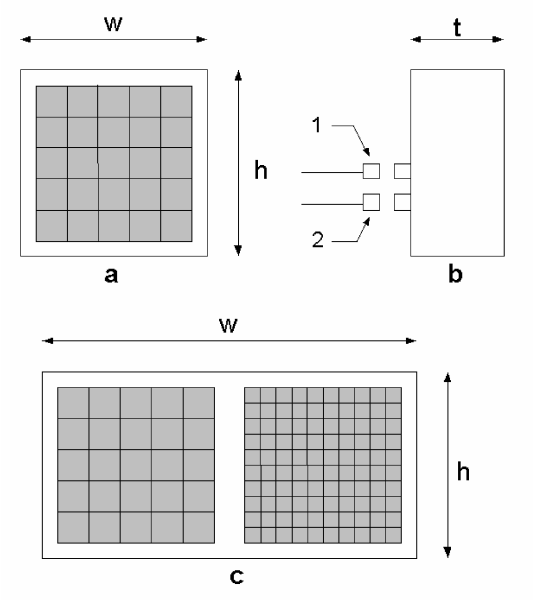
Documentary and safety instructions shall be provided detailing all necessary installation and operational procedures. Each of the settings for all parameters, relevant for the various tests, shall be stated therein in detail.

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 × h × t) of the test module shall be (1 350 × 1 350 × 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 ± 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 EN 60598-1	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 ± 2) °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 ± 2) °C, which shall be maintained for three hours. Whilst the VMS / test module is at this temperature it shall be subjected to three single impacts at the weakest point on the front panel of the VMS / test module [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

Vibration EN 60068-2-64	Mounting:	The VMS / test module shall be securely fixed to the vibrating table.
	Reference and check-points:	The reference point shall be chosen on the vibrating table; in the case the VMS / test module is larger than the table it shall be a virtual point, where the reference signal spectrum will be defined as the arithmetic mean of ASD (Acceleration Spectrum Density) values of signals measured at the check points.
	Frequency range:	10 Hz to 200 Hz.
	ASD levels:	0,013 g²/Hz (10 Hz to 50 Hz). 0,013 g²/Hz (50 Hz to 200 Hz with a negative slope 3 dB/octave). Overall r.m.s. acceleration 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.
	Final measurements:	Visual inspection and function test. After the test no parts appear loose, all functionality unchanged.

Table 20 — Corrosion test

Salt spray test EN ISO 9227:2012	Initial measurements:	Visual inspection and function test.
	State of the VMS / test module during the test:	Unpacked, locked and switched off.
	Duration of test:	240 h.
	Operating conditions:	35 °C ± 2 °C, neutral salt spray
	Treatment after test:	Rinse with fresh, deionised water
	Final measurements:	Visual inspection and function test. After the test corrosion shall not be observed on any parts inside or outside the VMS / test module.

Table 21 — Water ingress test - Severity

Water Ingress EN 60529	Severity:	In accordance with EN 60529.
	Pre-conditioning:	None.
	Initial measurements:	Visual inspection and function test shall be conducted before commencing the conditioning period.
	Conditioning:	The equipment shall be hosed on all faces and at all angles from vertically down to horizontal concentrating on points to be “most likely” to result in water ingress.
	Intermediate measurements:	The equipment shall be switched on and function test shall be continuously repeated throughout the test.
	Final measurements:	Visual inspection and function test. Acceptance in accordance with EN 60529. Ingress is allowed provided it has no harmful effect.

Table 22 — Dust ingress test - Severity

Dust Ingress EN 60529	Severity:	In accordance with EN 60529 category 2.
	Pre-conditioning:	None.
	Initial measurements:	Visual inspection and function test shall be conducted before commencing the conditioning period.
	Conditioning:	The equipment shall be switched OFF.
	Intermediate measurements:	None.
	Final measurements:	Visual inspection and function test. Acceptance in accordance with EN 60529 category 2.

Table 23 — Temperature test

Test		Class T1	Class T2	Class T3	Class T4
	General: During normal operation the majority of VMS generate heat, this results in increased temperatures within the equipment. Operation in high ambient air temperatures can further increase the internal temperature. When equipment is used in a situation where it can be in direct sunlight, the effects of solar radiation can result in the surface temperature of the equipment being significantly higher than the air temperature. For class T1 these effects shall be tested by either conducting the dry heat test or the solar radiation test. Class T4 is requiring the solar radiation test. The tests for dry heat and cold can be replaced by the “change of temperature” test, unless T3 is required.				
Cold EN 60068-2-1 **Test Ab**	Pre-conditioning:	None			
	Initial measurements:	Visual inspection and function test.			
	State of VMS / test module during conditioning:	Equipment switched off until the final hour.			
	Conditioning temperature:	-15 °C	-25 °C	-40 °C	-15 °C
	Conditioning time:	16 h			
	Measurement and/or loading during conditioning:	During the final hour at test temperature; switch on and function test shall be continuously repeated. During the warm up period function test shall be continuously repeated.			
	Recovery if non-standard:	Recovery at laboratory ambient.			
	Final measurements:	Visual inspection and function test.			
	Any deviation in procedure:	None.			
Dry heat EN 60068-2-2 **Test Bb**	Pre-conditioning:	None.			
	Initial measurements:	Visual inspection and function test.			
	State of VMS / test module during conditioning:	The equipment shall be switched on and function test shall be continuously repeated.			
	Conditioning temperature:	+60 °C	+55 °C	+40 °C	+55 °C
	Conditioning time:	16 h			
	Measurement and/or loading during conditioning:	Function test shall be continuously repeated during the cooling period.			
	Recovery if non-standard:	Recovery at laboratory ambient.			
	Final measurements:	Visual inspection and function test.			
Damp Heat Cycling EN 60068-2-30 **Method Db** **(12 h + 12 h cycle)**	Any deviation in procedure:	None.			
	Air temperature:	+40 °C			+55 °C
	Number of cycles:	2 cycles.			
	Initial measurements:	Visual inspection and function test.			
	State of VMS / test module during conditioning:	Unpacked, switched on and ready to use.			

Test		Class T1	Class T2	Class T3	Class T4
	Details of mounting and supports:	None.			
	Variant:	Variant 1.			
	Intermediate measurements:	Function test continuously repeated during first 3 h of each cycle; during the last hour of each cycle at the relevant air temperature of the class and during the final cool down period of the last cycle.			
	Recovery conditions:	Recovery at laboratory ambient.			
	Special precautions to be taken regarding removal of surface moisture:	Not applicable.			
	Final measurements:	Visual inspection and function test.			
Solar radiation EN 60068-2-5 **Test Sa**	Pre-conditioning:	None.			
	Initial measurements:	Visual inspection and function test.			
	Attitude of VMS / test module as installed:	Equipment in its normal operational attitude. The front face of the VMS / test module is exposed to solar radiation simulator at an elevation of 60°			
	Test procedure	Procedure B.			
	Object of the test	This test can be carried out as an alternative to the dry heat test Bb for class T1. This test is mandatory to achieve class T4			
	Air temperature within the test chamber during irradiation:	+40 °C	n. a.	n. a.	+55 °C
	Maximum permissible air velocity within the test chamber:	Normal air circulation required to achieve temperature stability.			
	Humidity conditions:	No requirement.			
	Test duration:	1 cycle.			
	Measurement and/or loading during conditioning:	The VMS / test module shall be switched on and the function test will be continuously repeated during the first three hours of test, the last hour of radiation and during the cool down period.			
	Recovery conditions:	Recovery at laboratory ambient.			
	Final measurements:	Visual inspection and function test.			
Change of temperature EN 60068-2-14 **Test Nb**	Mounting or supporting of the VMS / test module, if other than prescribed:	As prescribed.			
	Lower temperature TA:	-15 °C	-25 °C	-40 °C	-15 °C
	Upper temperature TB:	+60 °C	+55 °C	+40 °C	+55 °C
	Rate of change of temperature:	1 °C / min			
	Number of cycles:	1 cycle.			
	Initial measurements:	Visual inspection and function test.			

Test		Class T1	Class T2	Class T3	Class T4
	State of VMS / test module when introduced into the chamber:	Ready for use but switched off.			
	Exposure time t1:	16 h			
	Measurements during conditioning and the period after which they shall be carried out:	Switch on and function test continuously repeated during the warm up from laboratory ambient temperature. Switch on and function test continuously repeated during the last hour at TB and during the cool down to laboratory ambient temperature.			
	Recovery:	Minimum of 1 h at laboratory ambient.			
	Final measurements:	Visual inspection and function test.			

5.4.4 Electromagnetic compatibility (EMC)

The VMS represented by the test module shall be tested in accordance with the requirements of EN 50293:2012.

5.5 Visual performance test methods

5.5.1 General

All optical tests shall be repeated for each individual colour of the colour class the VMS is required to display.

The tests shall be performed at an ambient temperature of (20 ± 3) °C.

NOTE The visual performance can depend on ambient temperature.

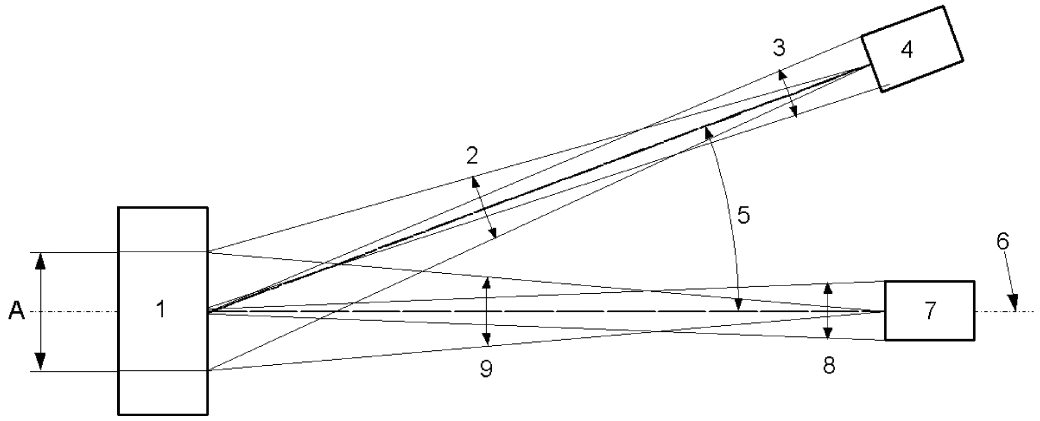
Before making measurements luminous sources shall have been in operation for sufficient time to be stabilised. Supplied sources shall be suitably aged so that their electrical and optical characteristics are as stable as possible. A light source shall be considered stable when its light output does not change more than ± 2 % over a time period of 15 min.

Test modules may be operated on any side with the agreement of the manufacturer, in order to facilitate testing. Care shall be taken to ensure the correct optical orientation of components and surfaces of the test- and measurement equipment to assure a representative assessment. Any deviation from normal mounting position shall be recorded.

Measurement shall be made with a photo-detector and measuring unit that is stable in operation and not subject to fatigue when exposed to maximum level of luminance. The combination of detector and measuring unit in all ranges shall have linear response to light up to the maximum level of luminance. The spectral sensitivity of the detector shall closely follow the CIE spectral luminous efficiency curve V_λ of CIE 018.2-1983 [4].

For all photometric measurements stray light shall be eliminated.

The measurement configuration of the test module representing the VMS, solar simulator and the luminance meter shall be arranged in accordance with Figure 4.



Key

A	diameter of the measurement area	5	(10 ± 0,1)° and (5 ± 0,1)° for Lx (*)
1	VMS / test module	6	reference axis
2	≤ 3°	7	luminance meter
3	≤ 2°	8	≤ 0,5°
4	solar simulator	9	≤ 3°

Figure 4 — Side elevation of the set-up for the measurement of luminance and luminance ratio

As shown in Figure 4 some angles are limited in order to limit measuring errors. The measuring aperture of the luminance meter shall not be greater than 3°. The beam divergence of the solar simulator at the area of interest shall not be larger than 3°. The aperture of the solar simulator and the luminance meter, as seen from the VMS / test module, shall not be larger than 2° and 0,5°, respectively.

The solar simulator shall have a spectral content close to that of natural daylight and a correlated colour temperature within the range of 5 000 K to 6 500 K.

The solar simulator, in conjunction with an optical attenuation device, shall be capable of achieving the required illuminance range, which shall be uniform (± 10 %) over the area of measurement.

The illumination shall be measured in the reference centre perpendicular to the reference axis.

5.5.2 Test angles

Test angles for the measurement of luminance with external illumination and luminance ratio shall be as listed in Table 24, test angles for measurement of luminance without external illumination shall be as listed in Table 25, test angles for measurement of beam width shall be as listed in Table 26, as well as test angles for measurement of uniformity of luminous intensity and colour in case of use of monochromatic elements, and test angles for measurement of uniformity of luminous intensity and colour in case of coloured elements are formed by mixing colour (e.g. by RGB) as listed in Table 27.

Table 24 — Test angles (in degrees, with respect to the reference axis), used for the measurement of luminance under external illumination and luminance ratio

	Solar simulator		Luminance meter	
	Horizontal	**Vertical**	**Horizontal**	**Vertical**
L1, L2, L3 **L1(*), L2(*), L3(*)**	0 0	+10 / 40 000 lx +10 / 40 000 lx	0 0	0 -2,5
L1(*), L2(*), L3(*)	0 0	+5 / 10 000 lx +5 / 10 000 lx	0 0	0 -2,5
NOTE 1 Test angles for the solar simulator are the same for all beam width classes. NOTE 2 To determine La values measurements need to be performed with all elements of the test area ON, to determine Lb values measurements need to be performed with all elements of the test area OFF, see 5.5.4				

Table 25 — Test angles (in degrees, with respect to the reference axis), used for the measurement of luminance without external illumination

	Table 4 to Table 9	Solar simulator	Luminance meter	
	Row reference		**Horizontal**	**Vertical**
L1, L2, L3 **L1(*), L2(*), L3(*)**	Row 1	OFF	0	0
L1(*), L2(*), L3(*)	Row 2	OFF	0	0
L1, L2, L3 **L1(*), L2(*), L3(*)** **L1(T), L2(T), L3(T)**	Row 4	OFF	0	0
	Row 6	OFF	0	0

Table 26 — Test angles (in degrees, with respect to the reference axis), used for the measurement of beam width, and for uniformity of luminous intensity and colour of monochromatic elements

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

Table 27 — Test angles (in degrees, with respect to the reference axis), used for the measurement of uniformity of luminous intensity and colour of elements formed by mixing colours

Beam width class	Photometer	
	Horizontal	Vertical
B1	0 -5 +5 -2,5 +2,5 0	0 0 0 -2,5 -2,5 -5
B2	0 -7 +7 -3,5 +3,5 0	0 0 0 -2,5 -2,5 -5
B3	0 -10 +10 -5 +5 0	0 0 0 -2,5 -2,5 -5
B4	0 -10 +10 -5 +5 0	0 0 0 -5 -5 -10
B5	0 -15 +15 -7,5 +7,5 0	0 0 0 -2,5 -2,5 -5
B6	0 -15 +15 -7,5 +7,5 0	0 0 0 -5 -5 -10

Beam width class	Photometer	
	Horizontal	Vertical
B7	0	0
	-30	0
	+30	0
	-15	-10
	+15	-10
	0	-20

5.5.3 Colour

Measurements shall be made in accordance with the procedure specified in CIE 015-2004 and undertaken in the correct sequence as detailed in 5.1. Results shall be expressed in terms of chromaticity co-ordinates.

All colour measurements shall be made without external illumination.

The colour of the light emitted shall be carried out for the highest and the lowest setting specified by the manufacturer in accordance with 4.4.3.

In case of the use of monochromatic elements the colour of the light emitted shall be measured at the test angles listed in Table 26, as appropriate to the beam width class.

In case of the use of elements formed by mixing colours the colour of the light emitted shall be measured at the test angles listed in Table 27, as appropriate to the beam width class.

5.5.4 Luminance and luminance ratio

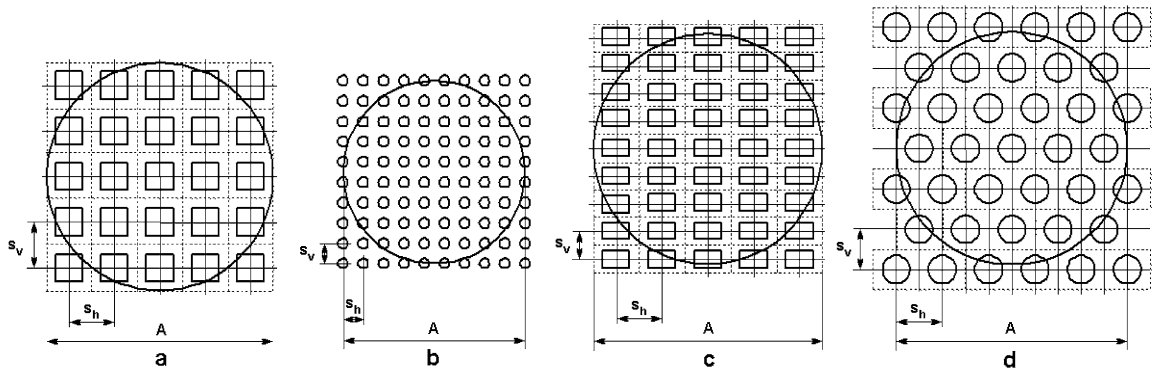
5.5.4.1 General

Tests shall be undertaken in the correct sequence as detailed in 5.1.

5.5.4.2 Test area for luminance ratio measurement

The test area shall meet the following criteria:

- contain elements in the form of a regular matrix;
- be fully populated with elements;
- a minimum size of (100 × 100) mm, including the outer dimensions of the equivalent areas of the elements;
- contain at least 5 × 5 = 25 elements;
- constant spacing of the elements in each of the directions of the matrix system, but these spacings need not be the same (Figure 5c and Figure 5d);
- element spacing’s to be equal to those of the VMS.



Key

s_v vertical separation

s_h horizontal separation

A diameter of the measurement area

The equivalent areas of the elements are indicated by dotted lines.

NOTE In Figure 5, examples are given, where $A \geq 100$ mm. a) 5 × 5 matrix ($s_v = s_h$) ; b) 10 × 10 matrix ($s_v = s_h$); c) 5 × 9 matrix ($s_v = 0{,}6 \times s_h$); d) hexagonal grid ($s_v = 0{,}5 \times \sqrt{3} \times s_h$).

Figure 5 — Layout examples for a test module and the positioning of the measuring area (circle) of the luminance meter

When the VMS / test module has (5 × 5) elements the measuring area shall just encompass the extremities of the equivalent areas of the five elements in both the horizontal and vertical directions (Figure 5a).

When the VMS / test module has more than (5 × 5) elements the measuring area shall comprise a circle with a diameter of at least 100 mm (Figure 5b).

When the element spacing of the horizontal and vertical direction is not equal, the measuring area shall just encompass the extremities of the equivalent areas of the five elements in direction with the largest element spacing (Figure 5c).

It is also allowed to use a non-rectangular grid when it is possible to modify it to a rectangular grid by moving rows of element along horizontal and vertical lines (Figure 5d).

5.5.4.3 Measurement of luminance

Luminance shall be measured ON axis without external illumination in accordance with Table 4 to Table 9 row 1, row 4 and row 6 to show the ability of appropriate dimming.

In case L(T) classes are measured for tunnel applications the luminance of the area under test shall be measured without external illumination in accordance with the requirements of Table 4 to Table 9 row 4 and row 6.

5.5.4.4 Calculation of luminance ratio

5.5.4.4.1 General

To achieve classes L1, L2 or L3, luminance L_{a10} and reflection Lb_{10} of the area under test shall be measured under external illumination of 40 000 lx / 10°, luminance ratio LR_{10} shall be calculated in accordance with 5.5.4.4.2.

To achieve classes L1(*), L2(*) or L3(*), luminance L_{a5} and reflection Lb_5 of the area under test shall be additionally measured under external illumination of 10 000 lx / 5°, luminance ratio LR_5 shall be calculated in accordance with 5.5.4.4.3.

L1(*), L2(*) and L3(*) cover all requirements of respectively L1, L2 and L3 with additional measurement for low sun applications.

To establish that the VMS represented by the test module is emitting light to an appropriate level, luminance L_e is measured for classes L3(*), L3, L2(*) and L2 without external illumination.

The declared LR class shall consider the smaller value of LR_{10} and LR_5.

5.5.4.4.2 Measurement of luminance ratio LR_{10} at 40 000 lx /10° illumination

Luminance measurements shall be made with the VMS / test module in the following states:

a) all elements of the test area ON;

b) all elements of the test area OFF.

Luminance ratio LR_{10} shall be calculated as follows:

$$LR_{10} = \frac{L_{a10} - L_{b10}}{L_{b10}} \tag{1}$$

and

$$LR_{10} = \frac{L_e}{L_b} \tag{2}$$

where

L_{a10} is the measured luminance of the VMS / test module in the ON-state when illuminated at 10° with 40 000 lx – see 3.18.1;

L_e is the measured luminance of the VMS / test module in the ON-state without external illumination - .see 3.18.5;

L_{b10} is the measured luminance of the VMS / test module in the OFF-state when illuminated at 10° with 40 000 lx – see 3.18.3

The luminance of the VMS represented by the test module shall be measured at the test angles listed in Table 24.

5.5.4.4.3 Calculation of luminance ratio LR_5 at 10 000 lx / 5° illumination

Luminance measurements shall be made with the VMS / test module in the following states:

a) all elements of the test area ON;

b) all elements of the test area OFF.

Luminance ratio LR_5 shall be calculated as follows:

$$LR_5 = \frac{L_{a5} - L_{b5}}{L_{b5}} \tag{3}$$

and

$$LR_5 = \frac{L_e}{L_{b5}} \tag{4}$$

where

L_{a5} is the measured luminance of the VMS / test module in the ON-state when illuminated at 5° with 10 000 lx– see 3.18.2;

L_e is the measured luminance of the VMS / test module in the ON-state without external illumination - .see 3.18.5;

L_{b5} is the measured luminance of the VMS / test module in the OFF-state when illuminated at 5° with 10 000 lx – see 3.18.4

The luminance of the VMS represented by the test module shall be measured at the test angles listed in Table 24.

5.5.5 Beam width

Tests shall be undertaken in the correct sequence as detailed in 5.1.

The beam width shall be tested in accordance with the luminance measurements with the solar simulator off using the luminance setting of row 1 of Table 4 to Table 9 – or to row 4 in case Lx(T) is tested only. The luminance measurements shall be repeated with steps of 1° or less in the horizontal reference plane to 1° beyond the angle requirements (Table 26) in both the positive and negative directions and at steps of 1° or less in the vertical reference plane in the negative direction only.

Any luminance at all measured angles within the beam width shall not vary by more than ± 50 % when compared to the value measured on the reference axis.

Beam width may be obtained by measuring luminous intensity and calculating the luminance using the equivalent area.

5.5.6 Uniformity of luminous intensity

Tests shall be undertaken in the correct sequence as detailed in 5.1.

The luminous intensity of each individual element of the VMS / test module shall be measured without external illumination. The uniformity shall be determined by calculating the luminous intensity ratio as defined in 4.4.6.

In case of use of monochromatic elements luminous intensity uniformity shall be measured for the highest setting (see row 1 of Table 4 to Table 9) at the test angles specified in Table 26, appropriate to the beam width class.

In case of use of elements formed by mixing colours luminous intensity uniformity shall be measured for the highest setting (see row 1 of Table 4 to Table 9) at the test angles specified in Table 27, appropriate to the beam width class.

For setting in accordance with row 4 of Table 4 to Table 9 the measurement has to be performed on axis only.

A minimum of 25 individual elements shall be measured.

5.5.7 Visible flicker

Tests shall be undertaken in the correct sequence as detailed in 5.1.

Visible flicker test shall be conducted on vertically mounted VMS / test module during all function tests.

The VMS / test module shall be conditioned as required by the relevant function test and shall be observed in full intensity and in dimmed mode during 2 min.

During observation 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 recorded.

NOTE Frequencies above 90 Hz do not present visible flicker.

6 Assessment and verification of constancy of performance (AVCP)

6.1 General

The compliance of VMS with the requirements of this European Standard and with the performances declared by the manufacturer in the declaration of performance (DoP) shall be demonstrated by:

— determination of the product-type on the basis of type testing

— factory production control by the manufacturer, including product assessment.

The manufacturer shall always retain the overall control and shall have the necessary means to take responsibility for the conformity of the product with its declared performance(s).

6.2 Type testing

6.2.1 General

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 (see 5.3).

All performances related to characteristics included in 4.4, 4.3 and 4.5 in this European Standard shall be determined when the manufacturer intends to declare the respective performances unless the standard gives provisions for declaring them without performing tests. (e.g. use of previously existing data, classification without further testing - CWFT - and conventionally accepted performance).

Assessment previously performed in accordance with the provisions of this European Standard, may be taken into account provided that they were made to the same or a more rigorous test method, under the same system for assessment and verification of constancy of performance (AVCP) on the same product or products of similar design, construction and functionality, such that the results are applicable to the product in question.

NOTE 1 Same AVCP system means testing by an independent third party under the responsibility of a notified product certification body.

For the purposes of assessment, the manufacturer's products may be grouped into families, where it is considered that the results for one or more characteristics from any one product within the family are representative for those same characteristics for all products within that same family

NOTE 2 Products may be grouped in different families for different characteristics.

Reference to the assessment method standards should be made to allow the selection of a suitable representative sample.

In addition, the determination of the product-type shall be performed for all characteristics included in the standard for which the manufacturer declares the performance:

— at the beginning of the production of a new or modified VMS (unless a member of the same product family), or

— at the beginning of a new or modified method of production (where this may affect the stated properties); or

— whenever a change occurs in the VMS design, in the raw material or in the supplier of the components, or in the method of production (subject to the definition of a family), which would affect significantly one or more of the characteristics.

Where components are used whose characteristics have already been determined, by the component manufacturer, on the basis of assessment methods of other product standards, these characteristics need not be re-assessed. The specifications of these components shall be documented.

Products bearing regulatory marking in accordance with appropriate harmonised European specifications may be presumed to have the performances declared in the DoP, although this does not replace the responsibility on the VMS manufacturer to ensure that the VMS as a whole is correctly manufactured and its component products have the declared performance values.

The test module representing the VMS is defined in 5.3. In the case of verification by calculation, of some characteristics (e.g. temporary deflections caused by wind loads), the manufacturer shall also provide relevant drawings, calculations and the technical specifications. This module shall be retained for at least ten years. The manufacturer may produce products based on a design and/or calculations and will verify the assumptions of the design and/or calculations as part of demonstrating conformity with this European Standard.

6.2.2 Test samples, testing and compliance criteria

Requirements expressed in Clause 4 and Table 28 or Table 29 shall be tested on at least one VMS represented by a test module.

Table 28 — Characteristics of continuous VMS

Characteristics	Requirements and compliance criteria clauses	Assessment method and declaration of results
General design requirement		
Provision to retain loose equipment	4.2	Manufacturer's declaration
Resistance to horizontal loads, expressed as		
- temporary deflections caused by wind loads	4.5.2.5.2	declared as appropriate class selected of EN 12899-1:2007, 5.3.1
- permanent deflections caused by dynamic loads	4.5.2.5.3	declared as appropriate class selected of EN 12899-1:2007, 5.3.2
- temporary bending deflection	4.5.2.5.2	declared as appropriate class selected of EN 12899-1:2007, 5.4.1
Performance under impact, dealt by		
- impact resistance	4.5.2.5.4	tested acc. to 5.4.3 Table 18 and declared as "CCM"
Visibility characteristics, expressed as		

Characteristics		Requirements and compliance criteria clauses	Assessment method and declaration of results
daylight chromaticity & luminance factor		4.3	declared as appropriate class selected of EN 12899-1:2007, 4 [a)]
			declared as appropriate class selected of EN 12899-1:2007, 7.2.2.1.3 [b)]
			declared as appropriate class selected of EN 12899-1:2007, 7.3.1.3 [c)]
mean	luminance		declared as appropriate class selected of EN 12899-1:2007, 7.3.1.4 [c)]
	illuminance		declared as appropriate class selected of EN 12899-1:2007, 7.4.1.2 [d)]
luminance contrast			declared as appropriate class selected of EN 12899-1:2007, 7.3.1.5 [c)]
uniformity	luminance		declared as appropriate class selected of EN 12899-1:2007, 7.3.1.6 [c)]
	illuminance		declared as appropriate class selected of EN 12899-1:2007, 7.4.1.3 [d)]
retro reflectivity		4.3	declared as appropriate class selected of EN 12899-1:2007, 4 [e)]
Durability, of			
a) mechanical characteristics, against			
- vibration		4.5.2.5.5	tested in accordance with 5.4.3 Table 19 and declared as “CCM”
- corrosion		4.5.2.3.1	declared the material, system of protection and class acc. to EN 12899-1:2007, 7.1.7 Table 15
- extreme temperature		4.5.2.1	tested in accordance with 5.4.3 Table 23 and declared as appropriate class selected of 4.5.2.1
- ingress of water and dust		4.5.2.4	tested in accordance with 5.4.3 Table 21 and Table 22 and declared as appropriate class selected of 4.5.2.4
b) visibility characteristics, expressed as			
- Resistance to weathering		4.3	tested in accordance with EN 12899-1:2007 4.1.1.5, 7.2.2.1.4 or 7.3.1.8 and declared as “CCM“
Electrical performance requirements			
- Electrical supply and limits		4.5.3.1	declared as Pass / Fail in accordance with 4.5.3.1
- Electrical safety		4.5.3.2	declared as Pass / Fail in accordance with 4.5.3.2, EN 50556:2011 5.1, EN 60950-1:2006, and EN 60950-22:2006 as applicable
Electromagnetic compatibility requirements			
- Electromagnetic emission		4.5.4.1	declared as Pass / Fail in accordance with EN 50293:2012
- Electromagnetic immunity		4.5.4.2	declared as Pass / Fail in accordance with EN 50293:2012

Characteristics	Requirements and compliance criteria clauses	Assessment method and declaration of results
a) VMS externally illuminated or using retro-reflective sign-face material. b) VMS externally illuminated or using non-retro-reflective sign-face material. c) VMS using trans-illuminated technology. d) VMS externally illuminated. e) VMS using retro-reflective sign-face material.		

Visual characteristics shall be checked in accordance with 5.1, test results shall be reported by making reference to the corresponding technical classes and values.

Table 29 — Characteristics of discontinuous VMS

Characteristics	Requirements and compliance criteria clauses	Assessment method and declaration of results
General design requirement		
Provision to retain loose equipment	4.2	Manufacturer's declaration
Resistance to horizontal loads, expressed as		
- temporary deflections caused by wind loads	4.5.2.5.2	declared as appropriate class selected of EN 12899-1:2007, 5.3.1
- permanent deflections caused by dynamic loads	4.5.2.5.3	declared as appropriate class selected of EN 12899-1:2007, 5.3.2
- temporary bending deflection	4.5.2.5.2	declared as appropriate class selected of EN 12899-1:2007, 5.4.1
Performance under impact, dealt by		
- impact resistance	4.5.2.5.4	tested in accordance with 5.4.3 Table 18 and declared as "CCM"
Visibility characteristics, expressed as		
- colour (chromaticity coordinates)	4.4.2	tested in accordance with 5.5.3 and declared as appropriate class selected of 4.4.2
- luminance	4.4.3	tested in accordance with 5.5.4.3 and declared as appropriate class selected of 4.4.3
- luminance ratio	4.4.4	tested in accordance with 5.5.4.4 and declared as appropriate class selected of 4.4.4
- beam width	4.4.5	tested in accordance with 5.5.5 and declared as appropriate class selected of 4.4.5
- uniformity of luminous intensity	4.4.6	tested in accordance with 5.5.6 and declared as "CCM" in accordance with 4.4.6
- visible flicker	4.4.7	assessed in accordance with 5.5.7 and declared as "CCM" in accordance with 4.4.7
Durability, of		
a) Mechanical characteristics, against:		
- vibration	4.5.2.5.5	tested in accordance with 5.4.3 Table 19 and declared as "CCM"
- corrosion	4.5.2.3.2	tested acc. to Table 20 and declared as "CCM"

- extreme temperature	4.5.2.1	tested in accordance with 5.4.3 Table 23 and declared as appropriate class selected of 4.5.2.1
- ingress of water and dust	4.5.2.4	tested in accordance with 5.4.3 Table 21 and Table 22 and declared as appropriate class selected of 4.5.2.4
b) Visibility characteristics, against:		
- cause for degradation of colour, luminance and luminance ratio	4.4.8	tested in accordance with 5.1 point 8) declared as “CCM“
Electrical performance requirements		
- Electrical supply and limits	4.5.3.1	declared as Pass / Fail in accordance with 4.5.3.1
- Electrical safety	4.5.3.2	declared as Pass / Fail in accordance with 4.5.3.2, EN 50556:2011, 5.1, EN 60950-1:2006, and EN 60950-22:2006 as applicable
Electromagnetic compatibility requirements		
- Electromagnetic emission	4.5.4.1	declared as Pass / Fail in accordance with EN 50293:2012
- Electromagnetic immunity	4.5.4.2	declared as Pass / Fail in accordance with EN 50293:2012

Visual characteristics shall be checked in accordance with 5.1.

Test results shall be reported by making reference to the corresponding technical Classes and values.

6.2.3 Test reports

The results of the determination of the product-type shall be documented in test reports. All test reports shall be retained by the manufacturer for at least 10 years after the last date of production of the VMS to which they relate.

6.2.4 Shared other party results

A manufacturer may use the results of the product-type determination obtained by someone else (e.g. by another manufacturer, as a common service to manufacturers, or by a product developer), to justify his own declaration of performance regarding a product that is manufactured to the same design (e.g. dimensions) and with raw materials, constituents and manufacturing methods of the same kind, provided that:

— the results are known to be valid for products with the same essential characteristics relevant for the product performance;

— in addition to any information essential for confirming that the product has such same performances related to specific essential characteristics, the other party who has carried out the determination of the product-type concerned or has had it carried out, has expressly accepted to transmit to the manufacturer the results and the test report to be used for the latter’s product-type determination, as well as information regarding production facilities and the production control process that can be taken into account for FPC;

— the manufacturer using other party results accepts to remain responsible for the product having the declared performances and he also:

— ensures that the product has the same characteristics relevant for performance as the one that has been subjected to the determination of the product-type, and that there are no significant differences with regard to production facilities and the production control process compared to that used for the product that was subjected to the determination of the product-type; and

— keeps available a copy of the determination of the product-type report that also contains the information needed for verifying that the product is manufactured to the same design and with raw materials, constituents and manufacturing methods of the same kind.

6.2.5 Cascading determination of the product type results

In determining the product-type, a manufacturer may replace type-testing or type-calculation by Appropriate Technical Documentation demonstrating that:

The VMS, covered by this Standard, which the manufacturer places on the market is a system made of components, which the manufacturer assembles duly following precise instructions given by the provider of such a system or of a component thereof, who has already tested that system or that component for one or several of its essential characteristics in accordance with the relevant harmonised technical specification. When these conditions are fulfilled, the manufacturer is entitled to declare performance corresponding to all or part of the test results for the system or the component provided to him. The manufacturer of the VMS may use the test results obtained by another manufacturer or system provider only after having obtained an authorisation of that manufacturer or system provider, who remains responsible for the accuracy, reliability and stability of those test results.

NOTE In particular the above clause is normally applied for reflective sign faces when affixed to a continuous VMS.

The determination of the product type report that the manufacturer of the component has obtained with regard to tests carried out by a notified body, and which is supplied to the assemblers, may be used for the regulatory marking purposes without the assembler having to involve again a notified body to undertake the determination of the product type of the essential characteristic(s) that were already tested, provided that:

— the assembler manufactures a product which uses the same combination of components (components with the same characteristics), and in the same way, as that for which the manufacturer of the component has obtained the determination of the product type report. If this report is based on a combination of components not representing the final product as to be placed on the market, and/or is not assembled in accordance with the components manufacturer's instruction for assembling the components, the assembler needs to submit his finished product to the determination of the product type;

— the manufacturer of the component has notified to the manufacturer the instructions for manufacturing/assembling the product and installation guidance;

— the assembler (manufacturer) assumes the responsibility for the correct assembly of the product in accordance with the instructions for manufacturing/assembling the product and installation guidance notified to him by the manufacturer of the component;

— the instructions for manufacturing/assembling the product and installation guidance notified to the assembler (manufacturer) by the manufacturer of the component are an integral part of the assembler's Factory Production Control system and are referred to in the determination of the product type report;

— the assembler is able to provide documented evidence that the combination of components he is using, and his way of manufacturing, correspond to the one for which the manufacturer of the component has obtained the determination of the product type report (he needs to keep a copy of the component manufacturer's determination of the product type report);

— regardless the possibility of referring, on the basis of the agreement signed with the manufacturer of the component, to the latter's responsibility and liability under private law, the assembler remains responsible for the product being in compliance with the declared performances, including both the design and the manufacture of the product, which is given when he affixes the regulatory marking on his product

6.2.6 System requirements

During the determination of the product-type on the basis of type testing sequence, if one test fails the manufacturer shall identify the cause of test failure and the proposed modification to the VMS / test module after which the failure within the sequence shall be retested.

The technical description, including drawings, shall be as specified in Annex Q.

Static calculations shall include all fixings and attachments.

The conformity of VMS to the requirements of this European Standard and with the stated values (including classes) shall be demonstrated by determination of the product-type on the basis of type testing.

6.2.7 Identification

Each test module representing the VMS submitted to product-type determination shall bear a label with at least the information specified in Table 30.

Table 30 — Identification label

Manufacturer / Site of manufacturer
Manufacturing date
Intended classes of performances to be obtained in accordance with EN 12966
ID-number
Related technical documentation

The related technical documentation shall illustrate the product for which the test module is a replacement, and its characteristics. Each test module submitted to product type determination shall be supplied with at least the information as detailed in Annex B.

6.3 Factory production control (FPC)

6.3.1 General

The manufacturer shall establish, document and maintain an FPC system to ensure that the VMS placed on the market comply with the declared performance of the essential characteristics.

The FPC system shall consist of procedures, regular inspections and tests and/or assessments and the use of the results to control raw and other incoming materials or components, equipment, the production process and the VMS.

All the elements, requirements and provisions adopted by the manufacturer shall be documented in a systematic manner in the form of written policies and procedures.

This factory production control system documentation shall ensure a common understanding of the verification of the constancy of performance and enable the achievement of the required product performances and the effective operation of the production control system to be checked. Factory production control therefore brings together operational techniques and all measures allowing maintenance and control of the compliance of the VMS with the declared performances of the essential characteristics.

In case the manufacturer has used shared product-type results, the FPC shall also include the appropriate documentation as foreseen in 6.2.4.

6.3.2 Requirements

6.3.2.1 General

The manufacturer is responsible for organising the effective implementation of the FPC system in line with the content of this product standard. Tasks and responsibilities in the production control organisation shall be documented and this documentation shall be kept up-to-date.

The responsibility, authority and the relationship between personnel that manages, performs or verifies work affecting product constancy, shall be defined. This applies in particular to personnel that need to initiate actions preventing product non-constancies from occurring, actions in case of non-constancies and to identify and register product constancy problems.

Personnel performing work affecting the constancy of performance of the product shall be competent on the basis of appropriate education, training, skills and experience for which records shall be maintained.

In each factory the manufacturer may delegate the action to a person having the necessary authority to:

— identify procedures to demonstrate constancy of performance of the product at appropriate stages;

— identify and record any instance of non-constancy;

— identify procedures to correct instances of non-constancy.

The manufacturer shall draw up and keep up-to-date documents defining the factory production control. The manufacturer's documentation and procedures should be appropriate to the product and manufacturing process. The FPC system should achieve an appropriate level of confidence in the constancy of performance of the product. This involves:

a) the preparation of documented procedures and instructions relating to factory production control operations, in accordance with the requirements of the technical specification to which reference is made;

b) the effective implementation of these procedures and instructions;

c) the recording of these operations and their results;

d) the use of these results to correct any deviations, repair the effects of such deviations, treat any resulting instances of non-conformity and, if necessary, revise the FPC to rectify the cause of non-constancy of performance.

Where subcontracting takes place, the manufacturer shall retain the overall control of the product and ensure that he receives all the information that is necessary to fulfil his responsibilities in accordance with this European Standard.

If the manufacturer has part of the product designed, manufactured, assembled, packed, processed and/or labelled by subcontracting, the FPC of the subcontractor may be taken into account, where appropriate for the product in question.

The manufacturer who subcontracts any/all of his activities may in no circumstances pass the above responsibilities on to a subcontractor.

NOTE Manufacturers having an FPC system, which complies with EN ISO 9001:2008 [2] and which addresses (includes) the provisions of the present European Standard are considered as satisfying the FPC requirements of the Regulation (EU) No 305/2011.

6.3.2.2 Equipment

6.3.2.2.1 Testing

All weighing, measuring and testing equipment shall be calibrated and regularly inspected in accordance with documented procedures, frequencies and criteria.

6.3.2.2.2 Manufacturing

All equipment used in the manufacturing process shall be regularly inspected and maintained to ensure that use, wear or failure does not cause inconsistency in the manufacturing process. Inspections and maintenance shall be carried out and recorded in accordance with the manufacturer’s written procedures and the records retained for the period defined in the manufacturer's FPC procedures.

6.3.2.3 Raw materials and components

The specifications of all incoming raw materials and components shall be documented, as shall the inspection scheme for ensuring their compliance. In case supplied kit components are used, the constancy of performance system of the component shall be that given in the appropriate harmonised technical specification for that component.

6.3.2.4 Traceability and marking

Individual VMS shall be identifiable and traceable with regard to their production origin. The manufacturer shall have written procedures ensuring that processes related to affixing traceability codes and/or markings are inspected regularly.

6.3.2.5 Controls during manufacturing process

The manufacturer shall plan and carry out production under controlled conditions.

6.3.2.6 Product testing and evaluation

The manufacturer shall establish procedures to ensure that the stated values of the characteristics declared are maintained. The characteristics and, where given, the parameters related to them, as established at the determination of the product-type, together with the means of regularly performed control (i.e. test methods, checks), acceptance criteria (with tolerances) and the minimum frequency of such control, shall be as specified in Table 31 for continuous VMS and as specified in Table 32 for discontinuous VMS.

All repetitive test – other than determination of the product-type – may use only the relevant part of the VMS / test module

Table 31 — Minimum frequency of testing continuous VMS for product testing and evaluation as part of FPC

Characteristic	Reference sub-clause	Test/control method	Minimum frequency of control	Acceptance criteria
Resistance to horizontal loads, expressed as				
- temporary deflections caused by wind loads	4.5.2.5.2	EN 12899-1:2007 5.3.1	one per year	Conformity to raw material specification and design per batch
- permanent deflections caused by dynamic loads	4.5.2.5.3	EN 12899-1:2007 5.3.2	one per year	Conformity to raw material specification and design per batch
- temporary bending deflection	4.5.2.5.2	EN 12899-1:2007 5.4.1	one per year	Conformity to raw material specification and design per batch
Performance under impact, expressed as				
- impact resistance	4.5.2.5.4	Table 18	one per batch of sign face material	tested in accordance with 5.4.3 Table 18 and declared as “CCM“
Visibility characteristics, expressed as				
a) chromaticity coordinates and luminance, dealt with by:				
- daylight chromaticity and luminance factor	4.3	As applicable see EN 12899-4:2007, Table 1a		
- mean luminance / mean illuminance	4.3			
- luminance contrast	4.3			
- uniformity luminance / uniformity illuminance	4.3			
b) retro reflectivity	4.3			
Durability of				
a) mechanical characteristics, against				
- corrosion	4.5.2.3.1	EN 12899-1:2007, 7.1.7 Table 15	one per year	Meets required class
- extreme temperature	4.5.2.1	Table 23	one per year	Meets required class
- ingress of water and dust [a]	4.5.2.4	Table 21	one per year	Meets required class
b) visibility characteristics, against				
- natural weathering	4.3	As applicable, see EN 12899-4:2007, Table 1a		
[a] For FPC, ingress of dust in finished product is deemed to be satisfied by the positive result of the test for ingress of water				

Table 32 — Minimum frequency of testing discontinuous VMS for product testing and evaluation as part of FPC

Characteristic	Reference sub-clause	Test/control method	Minimum frequency of control	Acceptance criteria
Resistance to horizontal loads, for:				
- temporary deflections caused by wind loads	4.5.2.5.2	EN 12899-1:2007, 5.3.1	one per batch	declared as appropriate class selected of EN 12899-1:2007, 5.3.1
- permanent deflections caused by dynamic loads	4.5.2.5.3	EN 12899-1:2007, 5.3.2	one per batch	declared as appropriate class selected of EN 12899-1:2007, 5.3.2
- temporary bending deflection	4.5.2.5.2	EN 12899-1:2007, 5.4.1	one per batch	declared as appropriate class selected of EN 12899-1:2007, 5.4.1
Performance under impact, as:				
- impact resistance	4.5.2.5.4	Table 18	one per year[a]	tested in accordance with 5.4.3 Table 18 and declared as “CCM“
Visibility characteristics, for:				
a) chromaticity coordinates, dealt with by:				
- colour	4.4.2	5.5.3	1 % per batch, at least one per year	Meets required class
b) luminance, dealt with by:				
- luminance	4.4.3	5.5.4.3	1 % per batch, at least one per year	Meets required class
- luminance ratio	4.4.4	5.5.4.4	1 % per batch, at least one per year	Meets required class
- beam width	4.4.5	5.5.5	One per batch	Meets required class
- uniformity	4.4.6	5.5.6	Continuously	Visual check and declared as “compliance with tests A and B”
- visible flicker	4.4.7	5.5.7	Continuously	assessed in accordance with 5.5.7 and declared in accordance with 4.4.7
Electrical performance requirements, by:				
- Electrical safety	4.5.3.2	Electrical evaluation	All	Meets requirements of EN 50556:2011, 5.1, EN 60950-1:2006, and EN 60950-22:2006 as applicable
Durability, of:				

Mechanical characteristics, against:				
- extreme temperature	4.5.2.1	Table 23	One per year	Meets required class
- ingress of water and dust [b]	4.5.2.4	Table 21	One per year	Meets required class
Visibility characteristics, against:				
- cause for degradation of colour, luminance and luminance ratio	4.4.8	5.1 point 8)	1 % per batch, at least one per year	tested in accordance with 5.1 point 8) and declared as “CCM“
[a] only if front screen is used [b] for FPC, ingress of dust in finished product is deemed to be satisfied by the positive result of the test for ingress of water				

6.3.2.7 Non-complying products

The manufacturer shall have written procedures which specify how non-complying products shall be dealt with. Any such event shall be recorded as they occur and these records shall be kept for the period defined in the manufacturer’s written procedures.

Where the product fails to satisfy the acceptance criteria, the provisions for non-complying products shall apply, the necessary corrective action(s) shall immediately be taken and the products or batches not complying shall be isolated and properly identified.

Once the fault has been corrected, the test or verification in question shall be repeated.

The results of controls and tests shall be properly recorded. The product description, date of manufacture, test method adopted, test results and acceptance criteria shall be entered in the records under the signature of the person responsible for the control/test.

With regard to any control result not meeting the requirements of this European Standard, the corrective measures taken to rectify the situation (e.g. a further test carried out, modification of manufacturing process, throwing away or putting right of product) shall be indicated in the records.

6.3.2.8 Corrective action

The manufacturer shall have documented procedures that instigate action to eliminate the cause of non-conformities in order to prevent recurrence.

6.3.2.9 Handling, storage and packaging

The manufacturer shall have procedures providing methods of product handling and shall provide suitable storage areas preventing damage or deterioration.

Whilst the product is in the manufacturer’s premises or under his responsibility, the manufacturer shall ensure that packaging prevents damage during handling and storage and that the product remains in conformity with the applicable technical specification until the date of delivery.

6.3.3 Product specific requirements

The FPC system shall address this European Standard and ensure that the products placed on the market comply with the declaration of performance.

The FPC system shall include a product specific FPC, which identifies procedures to demonstrate compliance of the product at appropriate stages, i.e.:

a) the controls and tests to be carried out prior to and/or during manufacture in accordance with a frequency laid down in the FPC test plan, and/or

b) the verifications and tests to be carried out on finished products in accordance with a frequency laid down in the FPC test plan

If the manufacturer uses only finished products, the operations under b) shall lead to an equivalent level of compliance of the product as if FPC had been carried out during the production.

If the manufacturer carries out parts of the production himself, the operations under b) may be reduced and partly replaced by operations under a). Generally, the more parts of the production that are carried out by the manufacturer, the more operations under b) may be replaced by operations under a).

In any case the operation shall lead to an equivalent level of compliance of the product as if FPC had been carried out during the production.

NOTE Depending on the specific case, it can be necessary to carry out the operations referred to under a) and b), only the operations under a) or only those under b).

The operations under a) refer to the intermediate states of the product as on manufacturing machines and their adjustment, and measuring equipment etc. These controls and tests and their frequency shall be chosen based on product type and composition, the manufacturing process and its complexity, the sensitivity of product features to variations in manufacturing parameters etc.

The manufacturer shall establish and maintain records that provide evidence that the production has been sampled and tested. These records shall show clearly whether the production has satisfied the defined acceptance criteria and shall be available for at least three years.

6.3.4 Initial inspection of factory and of FPC

Initial inspection of factory and of FPC shall be carried out when the production process has been finalised and in operation. The factory and FPC documentation shall be assessed to verify that the requirements of 6.3.2 and 6.3.3 are fulfilled.

During the inspection it shall be verified:

a) that all resources necessary for the achievement of the product characteristics included in this European Standard are in place and correctly implemented, and

b) that the FPC-procedures in accordance with the FPC documentation are followed in practice, and

c) that the product complies with the product-type samples, for which compliance of the product performance to the DoP has been verified.

All locations where final assembly or at least final testing of the relevant product is performed shall be assessed to verify that the above conditions a) to c) are in place and implemented. If the FPC system covers more than one product, production line or production process, and it is verified that the general requirements are fulfilled when assessing one product, production line or production process, then the assessment of the general requirements does not need to be repeated when assessing the FPC for another product, production line or production process.

All assessments and their results shall be documented in the initial inspection report.

6.3.5 Continuous surveillance of FPC

Surveillance of the FPC shall be undertaken at least once per year. The surveillance of the FPC shall include a review of the FPC test plan(s) and production processes(s) for each product to determine if any changes

have been made since the last assessment or surveillance. The significance of any changes shall be assessed.

Checks shall be made to ensure that the test plans are still correctly implemented and that the production equipment is still correctly maintained and calibrated at appropriate time intervals.

The records of tests and measurement made during the production process and of finished products shall be reviewed to ensure that the values obtained still correspond with those values for the samples submitted to the determination of the product-type and that the correct actions have been taken for non-compliant products.

6.3.6 Procedure for modifications

If modifications are made to the product, production process or FPC system that could affect any of the product characteristics declared in accordance with this European Standard, then all the characteristics for which the manufacturer declares performance, which may be affected by the modification, shall be subject to the determination of the product-type, as described in 6.2.1.

Where relevant, a re-assessment of the factory and of the FPC system shall be performed for those aspects, which may be affected by the modification.

All assessments and their results shall be documented in a report.

7 Classification and designation

7.1 General

The VMS shall be classified based on the test results obtained; the classes shall be indicated by performance codes as given in Annex B.

7.2 Continuous retro-reflective VMS

- Resistance to horizontal loads, expressed as
    - temporary deflections caused by wind loads WL0, WL1, WL2, WL3, WL4, WL5, WL6, WL7, WL8 or WL9
    - permanent deflections caused by dynamic snow load DSL0, DSL1, DSL2, DSL3 or DSL4
    - temporary bending deflections TDB0, TDB1, TDB2, TDB3, TDB4, TDB5 or TDB6
- Performance under Impact, expressed as
    - impact resistance CCM (compliance criterion met, no damage observed)
- Visibility characteristics , expressed as

a) Chromaticity coordinates and luminance, as

- daylight chromaticity and luminance factor CR1 and CR2

b) Retro reflectivity, as

- application classes / coefficient of retro reflection RA1 and RA2
- Durability, of:
    a) Mechanical characteristics, against

- vibration CCM (compliance criterion met, no alterations observed)
- corrosion SP0, SP1, SP2
- extreme temperature T1, T2, T3 or T4
- ingress of water and dust IP44, IP45, IP54, IP55 or IP56

b) Visibility characteristics, against

- accelerated weathering cause(natural, 3 years) CCM (compliance criterion met, no deviation observed)

7.3 Continuous, externally illuminated retro-reflective VMS

- Resistance to horizontal loads, expressed as
  - temporary deflections caused by wind loads WL0, WL1, WL2, WL3, WL4, WL5, WL6, WL7, WL8 or WL9
  - permanent deflections caused by dynamic snow load DSL0, DSL1, DSL2, DSL3 or DSL4
  - temporary bending deflections TDB0, TDB1, TDB2, TDB3, TDB4, TDB5 or TDB6
- Performance under impact, expressed as
  - impact resistance CCM (compliance criterion met, no damage observed)
- Visibility characteristics , expressed as

a) chromaticity coordinates and luminance, as

- daylight chromaticity and luminance factor CR1 or CR2
- mean luminance L1, L2, L3 or LS
- uniformity luminance U1, U2 or U3

b) retro reflectivity, as

- application classes / coefficient of retro reflection RA1 orRA2

- Durability, of:

a) Mechanical characteristics, against

- vibration CCM (compliance criterion met, no alterations observed)
- corrosion SP0, SP1, SP2
- extreme temperature T1, T2, T3 or T4
- ingress of water and dust IP44, IP45, IP54, IP55 or IP56

b) Visibility characteristics, against

- accelerated weathering cause(natural, 3 years) CCM (compliance criterion met, no deviation observed)

7.4 Discontinuous VMS

- Resistance to horizontal loads, expressed as
  - temporary deflections caused by wind loads WL0, WL1, WL2, WL3, WL4, WL5, WL6, WL7, WL8 or WL9
  - permanent deflections caused by dynamic snow load DSL0, DSL1, DSL2, DSL3 or DSL4
  - temporary bending deflections TDB0, TDB1, TDB2, TDB3, TDB4, TDB5 or TDB6
- Performance under impact, expressed as
  - impact resistance CCM (compliance criterion met, no damage observed)
- Visibility characteristics, expressed as
  - colour C1 or C2 ;
  - luminance L1, L2, L3, L1(*), L2(*) or L3(*), L1(T), L2(T) or L3(T);
  - luminance ratio R1, R2 or R3;
  - beam width B1, B2, B3, B4, B5, B6 or B7;
  - uniformity of luminous intensity CCM (compliance criterion met, compliance with test A and B)
  - visible flicker CCM (compliance criterion met, no flicker observed)
- Durability, of:

a) Mechanical characteristics, against
  - vibration CCM (compliance criterion met, no alterations observed)
  - corrosion CCM (compliance criterion met, no corrosion observed)
  - extreme temperature T1, T2, T3 or T4
  - ingress of water and dust IP44, IP45, IP54, IP55 or IP56

b) Visibility characteristics, against
  - cause for degradation of colour, luminance and luminance ratio CCM (compliance criterion met, no change in classification)

8 Marking, labelling and packaging

Finished VMS shall be clearly, durably and visibly marked with all information in accordance with Annex B.

Product classification codes shall be in accordance with Clause 7.

Additional markings - as electrical and physical ratings for the connection to the supplies e.g. rated or ranged voltage, current, frequency, wattage, weight, etc. - shall be permitted, provided that they do not give rise to misunderstanding. Where symbols are used, they shall conform to ISO 7000:2014 or IEC 60417-1 where appropriate symbols exist.

The information given in markings shall be in characters legible at a normal reading distance such that the total area of the marking shall be at least 100 cm^2 and shall be sufficiently durable to last the expected life of the VMS. Marking shall not be placed on the front face or any removable parts of VMS, which can be replaced in such a way that the marking would become misleading.

In considering the durability of the marking, the effect of normal use shall be taken into account.

Where regulatory marking provisions require information on some or all items listed in this clause, the requirements of this clause concerning those common items are deemed to be met and the information needs not be repeated for the purpose of this clause.

9 Product information

The following documentation shall be made available for each VMS:

a) Instructions for the assembly and erection of VMS.

b) Details of any limitations on location or use.

c) Instructions for the handling, maintenance and cleaning of VMS, including component replacement.

d) Safety and environmental instructions and their eventually derived precaution measures in regards to the operating, installing, servicing, transporting or storing VMS.

e) Details of luminance control device (if required).

Product information related to safety shall be in a language which is acceptable in the country in which the VMS is intended to be installed.

Annex A
(normative)

Equivalent area

A.1 General

This annex defines the concept of equivalent area and the use of this concept in the lay-out of VMS messages. The following photometric calculations and design examples demonstrate this.

Aspects, characters and figures of light emitting matrix signs shall be created by single elements. The design objective is that the light intensity (cd) together with element spacing (m) gives the impression of solid lines and surfaces (see Figure A.1). When the sign is seen from the appropriate distance the elements appear to merge, this creates the impression that the elements are larger than their actual size. The area that the elements are apparently illuminating is defined as the “equivalent area” (m^2). To achieve this effect the combination of luminance and element spacing shall be balanced. The luminance, measured in cd/m^2, is the light intensity per illuminated area (in this case the equivalent area) of each element.

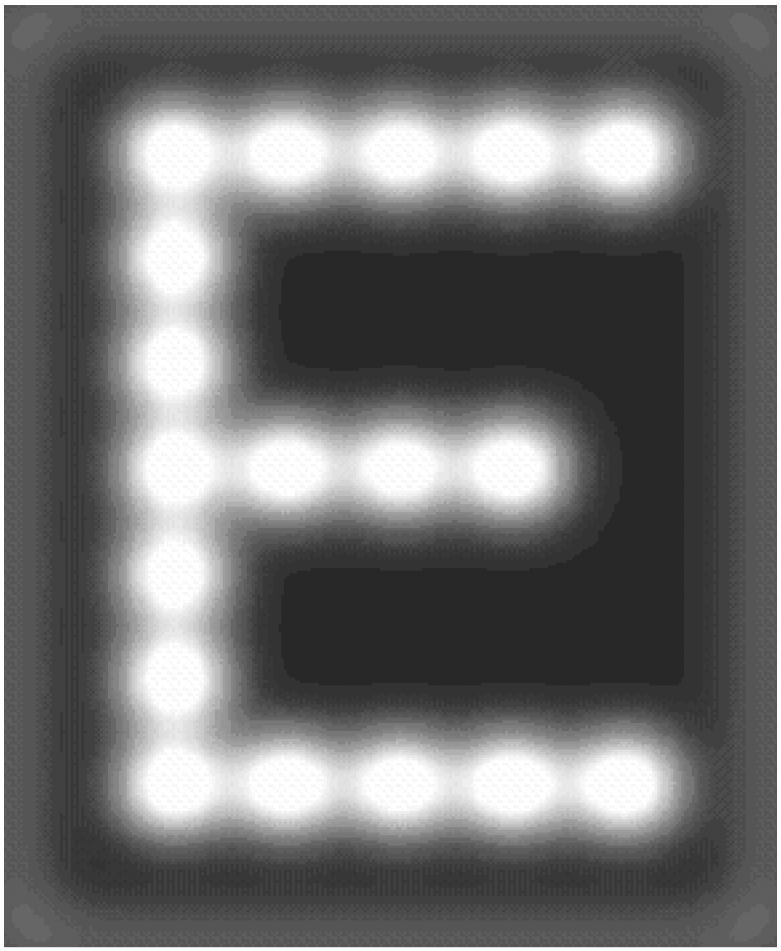


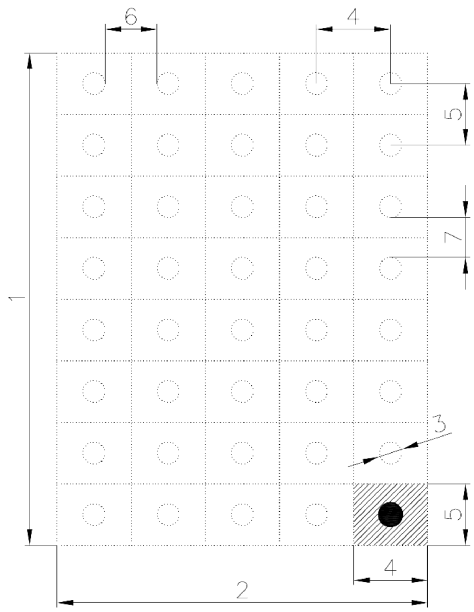
Figure A.1 — Merging of elements

In a regular matrix of a VMS, as in a test module, the equivalent area of an element is the area resulting from the product of the horizontal and the vertical element spacing (see Figure A.2).

A.2 Calculation of the luminance

VMS shall be produced by the compilation of a number of elements in a matrix on a surface. The luminous intensity of the elements shall be known. Therefore the desired luminance can be obtained by choosing the appropriate element spacing. The element spacing shall be calculated using the following method.

Consider an example character of a VMS with a regular orthogonal matrix of (5 × 8) elements (see Figure A.2). The horizontal element spacing is s_h and the vertical element spacing is s_v.



Key

1 equivalent height of the matrix (h_e)
2 equivalent width of the matrix (w_e)
3 physical diameter of the light source of the element
4 horizontal element spacing, width of equivalent of an element (s_h)
5 vertical element spacing, height of equivalent area of an element (s_v)
6 horizontal distance between the light sources of adjacent elements
7 vertical distance between the light sources of adjacent elements

NOTE The shaded area is showing the equivalent area of an element.

Figure A.2 — Character with a regular orthogonal matrix of (5 × 8) elements

The average luminance of the character can be calculated by Formula (A.1)

$$L = \frac{I}{s_h s_v} \tag{A.1}$$

where

L average luminance (cd/m^2) measured in the direction of reference axis

I average luminous intensity of a single element (cd)

When the luminous intensity and the luminance are known the product of the element spacing in horizontal and vertical direction is

$$s_h s_v = \frac{I}{L} \tag{A.2}$$

where the product s_h s_v is the size of the equivalent element area (m²) - shaded area in Figure A.2.

The luminous intensity (cd) of a single element (I) shall be considered as distributed uniformly over the equivalent area of that element, resulting in an average sign luminance (L) (cd/m^2). This is the luminance that will be seen when viewed from a distance such that the individual elements are indistinguishable. At this distance the elements appear to have the size of the equivalent element area.

NOTE The equivalent area of an element is the reciprocal of the element density (in terms of number of elements per unit of area).

EXAMPLE 1 Assume that the elements of the character emit white light and have a luminous intensity of 12 cd. In order to meet the requirements for luminance class L3, a luminance of at least 12 400 cd/m^2 shall be made.

According to Formula (A.2) the product of horizontal and vertical element spacing (s_h s_v) shall not be larger than

$$\frac{12\ \text{cd}}{12\ 400\ \text{cd/m}^2} = 0{,}000\ 968\ \text{m}^2$$

When the horizontal and vertical element spacing is the same, the spacing shall not exceed the square root of this area:

$$\sqrt{0{,}000\ 968\ \text{m}^2} = 0{,}031\,1\,\text{m} = 31{,}1\,\text{mm}$$

EXAMPLE 2 In Figure A.2 the horizontal element spacing is 50 % larger than the vertical element spacing.

In that case the vertical element spacing is

$$\sqrt{\frac{0{,}000\ 968\ \text{m}^2}{1{,}5}} = 0{,}025\ 4\ \text{m} = 25{,}4\ \text{mm}$$

and the horizontal element spacing is

1,5 × 25,4 mm = 38,1 mm.

As a check on the calculation the luminance can be determined by dividing the total luminous intensity of the test matrix by the equivalent area of the test matrix:

The equivalent width of the test matrix (w_e) is

5 × 38,1 mm = 190,5 mm.

The equivalent height of the test matrix (h_e) is

8 × 25,4 mm = 203,2 mm.

The equivalent area of the test matrix is

0,1905 m × 0,2032 m = 0,0387 m².

The luminous intensity of the test matrix is

5 × 8 × 12 cd = 480 cd.

The luminance of the test matrix is

$$\frac{480\ \text{cd}}{0{,}038\ 7\ \text{m}^2} = 12\ 400\ \text{cd/m}^2\ q.e.d$$

A.3 Calculation of non-matrix equivalent areas

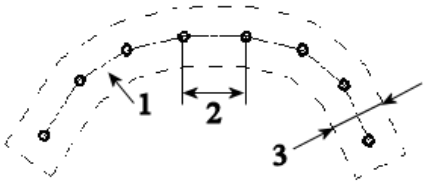
A.3.1 Equivalent area for a line of elements.

The symbol of the VMS message may not only be designed in a matrix system but also as a line of elements as shown in Figure A.3 and Figure A.4. The equivalent area A_e shall be calculated as following:

$$A_e = n \times (S_{av})\ 2$$

where

n	number of elements
S_{av}	average element spacing
W_s	stroke width ($W_s = S_{av}$)
S_i	element spacing of two elements *i* and *i+1*.



Key

1	A_e
2	s_i
3	w_s

Figure A.3 — Open line

where

$$S_{av} = \frac{\sum_{i=1}^{n-1} S_i}{n-1}$$

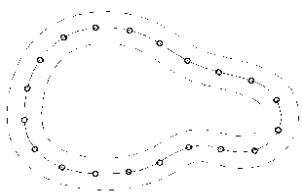


Figure A.4 — Closed line

For closed line

$$S_{\text{av}} = \frac{\sum_{i=1}^{n} S_i}{n}$$

A.3.2 Equivalent area for a symbol fully populated with elements

The symbol of the VMS message may not only be designed in a matrix but also as an area fully populated with elements system as shown in Figure A.5.

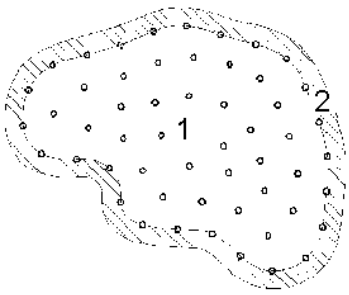
The equivalent area A_e will be calculated as following:

$A_e = S_1 + S_2$

where

S_1 inside area limited by the line of border elements;

S_2 half equivalent area of the border line elements.



Key

1 inside area fully populated with elements *(S_1)*

2 half equivalent area of the border line elements *(S_2)*

Figure A.5 — Example of symbol with an area fully populated with elements

A.3.3 Equivalent area for a symbol partially populated with elements

The symbol of the VMS message may be not designed in a matrix system but an area partially populated with elements as shown in Figure A.6.

The equivalent area A_e will be calculated as following:

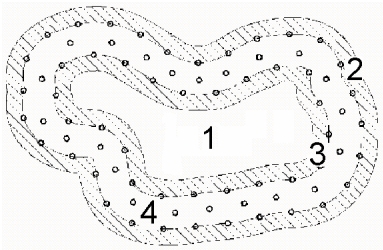
$A_e = S_1 + S_2 + S_3$

where

S_1 Inside area limited by the two lines of borders elements

S_2 Half equivalent area of outside border line elements

S_3 Half equivalent area of inside border line elements



Key

1 no element in this area

2 half equivalent area of outside border line elements *(S_2)*

3 half equivalent area of inside border line elements *(S_3)*

4 inside area fully populated with elements *(S_1)*

Figure A.6 — Example of symbol with an area partially populated with elements

Annex B
(normative)

VMS performance declaration codes for marking

B.1 General

The following annex establishes a codified way of presenting the performance characteristics, where marking on the VMS or on a label attached to it is required.

B.2 Code for continuous retro-reflective VMS

The following code of performance classes shall be used for the marking of continuous retro-reflective VMS (for better understandings refer to Figure ZA.4):

0	1	2	3	4	5	6	7	8	9	10	11

Key

0 release of dangerous substances
1 temporary deflections caused by wind loads
2 permanent deflections caused by dynamic snow loads
3 temporary bending deflection
4 impact resistance
5 daylight chromaticity & luminance factor
6 application classes / coefficient of retro-reflection
7 vibration resistance
8 corrosion resistance
9 resistance against extreme temperature
10 ingress protection against water and dust (IP) provided by enclosures
11 cause for degradation of colour, luminance, luminance ratio (P)

NOTE Release of dangerous substances needs only to be declared if there is at least one required dangerous substance which obliges the manufacturer to declare, as relevant in accordance with 4.6.

Figure B.1 — Code of performance classes of continuous retro-reflective VMS

B.3 Code for externally illuminated continuous retro-reflective VMS

The following code of performance classes shall be used for the marking of continuous, externally illuminated retro-reflective VMS (for better understandings refer to Figure ZA.5):

0	1	2	3	4	5	6	7	8	9	10	11	12	13

Key

0 release of dangerous substances
1 temporary deflections caused by wind loads
2 permanent deflections caused by dynamic snow loads
3 temporary bending deflection
4 impact resistance
5 daylight chromaticity & luminance factor
6 mean illuminance
7 uniformity illuminance
8 application classes / coefficient of retro-reflection
9 vibration resistance
10 corrosion resistance
11 resistance against extreme temperature
12 ingress protection against water and dust (IP) provided by enclosures
13 cause for degradation of colour, luminance, luminance ratio (P)

NOTE Release of dangerous substances needs only to be declared if there is at least one required dangerous substance which obliges the manufacturer to declare, as relevant in accordance with 4.6.

Figure B.2 — Code of performance classes of externally illuminated continuous retro-reflective VMS

B.4 Code for discontinuous VMS

The following code of performance classes shall be used for the marking of discontinuous VMS (for better understandings refer to Figure ZA.6):

0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15

Key

0 release of dangerous substances
1 temporary deflections caused by wind loads
2 permanent deflections caused by dynamic snow loads
3 temporary bending deflection
4 impact resistance
5 colour
6 luminance
7 luminance ratio
8 beam width
9 uniformity of luminous intensity
10 visible flicker
11 vibration resistance
12 corrosion resistance
13 resistance against extreme temperature
14 ingress protection against water and dust (IP) provided by enclosures
15 cause for degradation of colour, luminance, luminance ratio (P)

NOTE Release of dangerous substances needs only to be declared if there is at least one required dangerous substance which obliges the manufacturer to declare, as relevant in accordance with 4.6.

Figure B.3 — Code of performance classes of discontinuous VMS

Annex L
(informative)

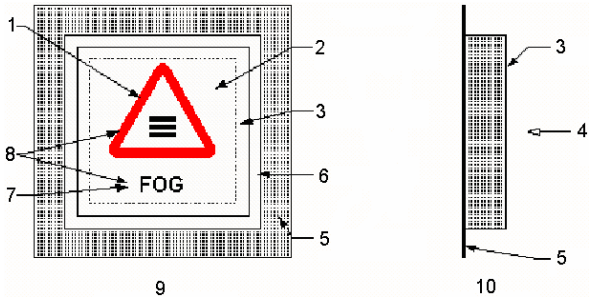
Terminology used in this European Standard

This annex is meant for readers new to the standard, who wish to get a quick introduction into the terminology used throughout this European Standard. Definitions of words inside [squared brackets] can be found in Clause 3.

VMS are used to display one or more messages, or can be blank. Each [message] can consist of text and/or symbols. The way these text and/or symbols are arranged is called the message [lay-out].

A VMS does not necessarily stand on its own. Sometimes one or more VMS can be fitted into a panel, which can possibly also display fixed text and/or symbols. In that case this European Standard does not cover the complete panel, but each VMS separately.

The most important area of the [front panel] of a VMS is the [display surface]; this is used for the message display; a (transparent) [front screen] can be used to protect the display surface; front screen and display surface are sometimes integrated; a [backing board] can be used to improve the contrast between the VMS and its [VMS background] (see Figure L.1).



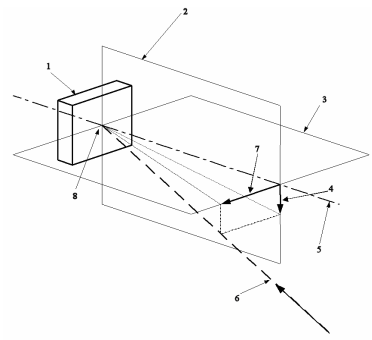
Key

1	symbol	6	front panel
2	display surface	7	text
3	front screen	8	message
4	viewing direction	9	front view
5	backing board	10	side view

Figure L.1 — Parts of a VMS

An [element] is the basic visual light emitting and/or reflective object (or cluster of objects) in the surface of the VMS. The reference grid, with the intersections at the centres of the elements used in a VMS, is called a [matrix]. Individual elements may have one or more light emitting parts.

For measurements on a VMS / test module the [reference axis] is the basis; this axis originates in the [reference centre] of the VMS. The [vertical reference plane] and the [horizontal reference plane] are vertical and horizontal planes containing the reference axis and the reference centre. Horizontal and vertical [test angles] describe the angle between the [test axis] and the vertical and horizontal reference planes respectively (see Figure L.2).



Key

1	VMS / test module	5	reference axis
2	vertical reference plane	6	test axis
3	horizontal reference plane	7	horizontal test angle
4	vertical test angle	8	reference centre

Figure L.2 — Test configuration

VMS can be operated with the help of a [control device]. When a VMS is in operation and it is displaying a message this is called the ON state; when the VMS is not displaying any message we speak of the OFF state.

Annex M
(informative)

Guidance on graphics for discontinuous light emitting signs

M.1 General

This annex gives informative design examples of VMS. Since the layout of the VMS is not normative, dependent on local needs, the purchasers can have their own design.

Signs comprise coloured backgrounds with contrasting coloured symbols. For light emitting signs the Vienna Convention on Road Signs and Signals [5] allows colour inversion. Purchasers have different requirements concerning inversion. Some require inversion, some allow inversion, and some do not allow it. Examples of non-inverted and inverted design issues are included in this annex.

The symbol designs can also be based on non-matrix systems, such as circles, arcs and even free forms. Examples of some of these different matrix systems, and the application of the normative design rules, are shown in this annex.

The use of regular matrix may not allow the exact reproduction of oblique lines, and circles: in both cases there may be a “staircase effect”. To reduce this and to improve the quality of the displayed pictogram, it is advisable to limit the distance between the elements as well as to use other techniques such as “anti-aliasing” capable of reducing the staircase effect, and techniques to improve the perception of the equivalent area.

M.2 Apparent luminance of lines and letter strokes

M.2.1 General

A VMS will be designed for a particular luminance class, which corresponds to a certain minimum luminance as listed in Table 4 to Table 9. All legends and graphics of the VMS that are designed for this luminance class should meet this minimum luminance. This luminance is the average luminance that is measured over substantial large areas, such as a VMS / test module, with sufficient light elements within the measuring field, as explained in Clause 5.

It is recommended that the luminance is set in relation to the ambient light. The luminance levels of Table 4 to Table 9 illustrate 5 possible dimming steps of an installed VMS in different ambient light conditions. These or more steps may be applied.

At short distances the individual light elements of a VMS will be visible. For an observer at a large distance the elements will blur due to imperfectness of the observer’s eyes and the area will be visible with a uniform luminance. For large areas the apparent luminance as perceived by the observer is equal to the average luminance for short and large distances. For lines and letter strokes the apparent luminance can differ from the average luminance.

When designing characters for a VMS the letter stroke should be filled with light elements in order to reach the required luminance. However, the letter will also be legible when the strokes are made of a single row of light elements with a smaller spacing or a higher luminous intensity per element. At a distance the light will be blurred and the observed luminance is lower and the observed stroke width will be larger. This effect is visualised in Figure M.1. When designing VMS with small lines one should take account of this effect.

Fonts with an optimal legibility (e.g., fonts for retro-reflective direction signs) have a stroke width close to 1/5 of the letter height and a legibility distance of at least 600 times the letter height. When these fonts are used for designing the legends on a VMS a single row of light elements can be used in the centre of the letter strokes. The luminous intensity (in cd) and the number of light elements should be chosen in such a way that

the average luminance of the area of the original letter is optimal. The average luminance of a small stroke with a single row of light elements should be larger than the average luminance of multi-row strokes.

NOTE The average luminance is determined using the equivalent area definition of a line of elements in A.3.1).

Therefore one should strive for a VMS font design that approaches the ideal font as close as possible. When the strokes have more than one row of elements or when the whole font area is filled with densely packed light elements the font will approach the ideal design. In that case the average luminance can be set to the luminance for large areas.

Figure M.1 — A legend seen at short (left), longer (centre), and very long distance (right)

M.2.2 Further technical explanation of Apparent luminance

A discontinuous VMS displays legends by means of light emitting elements. The legends are symbols and/or characters and are formed by areas displayed as fields of elements and strokes displayed as single or multiple rows of elements side by side.

Luminance ratio (ratio of active light distributed by the light source vs. light reflected by sun or external light sources, see 3.18) is an important parameter for legibility. Low reflection value will allow using low luminance with excellent legibility. Luminance ratio of the elements makes the legends appear with a luminance, which should be high enough for legibility and preferably also conspicuity, but not as high as to cause glare. The need for luminance depends on the ambient light and necessitates a regulation of the output of the elements.

Annex A defines an equivalent area for elements placed in an area or a stroke. The principle is that the equivalent area is the product of the element spacing. Refer to Annex A for details.

The equivalent area serves to provide an average luminance as the sum of the luminous intensities of the elements divided by the sum of the equivalent areas of the elements. This is the luminance that will be measured on a VMS / test module with the elements arranged in a matrix or on a matrix sign with all the elements turned on.

Concerning the apparent luminance seen by an observer, it has to be taken into account that the eye, due to imperfections introduces a blur and cannot discriminate details extending less than a certain angle. This angle depends on the visual acuity of the observer and on the lighting conditions, but can be approximated with about 1 min of arc for the average person in good conditions of luminance and contrast.

At short distances, the individual light sources of the elements can be discriminated and are seen with an apparently high luminance. This does not normally prevent legibility of a legend.

At a particular distance, where the distance between the light sources of adjacent elements forms the above-mentioned angle, the elements seem to merge and form a continuous legend. This happens, when the viewing distance is about 3 400 times the distance between the light sources of adjacent elements (see 3.9).

NOTE 1/tan(1 min of arc) ~ 3 400; the viewing distance to see adjacent elements as one light-dot can be estimated with 3 400 × (spacing between the light sources of adjacent elements).

At longer distances the apparent luminance of a stroke formed by double rows of elements is higher than the apparent luminance of a stroke formed by a single row of equivalent elements.

The ideal design of a character legend has a stroke width that is a substantial fraction of the character height, is filled with a considerable number of elements and achieves best luminance ratio values. Such a design minimises variation of apparent luminance and also produces the optimum legibility distances.

However, the ideal design is mostly not feasible for practical and economical reasons. In practice there are signs with relatively few elements and thin strokes that have a good legibility. For a good performance of this kind of signs a high luminance of the thin strokes is necessary.

M.3 VMS with colour inversion

In order to be clearly distinguished from the coloured border, the symbol to be inscribed within a “symbol area” requires a minimum clearance between the border and the symbol itself, the size of the symbol area is related to the overall legend size. The following physical parameters are, therefore, utilised for the following examples:

a) CIRCLE (see Figure M.2 and Figure M.3)

- circle height (*a*), measured as the equivalent diameter of the circle;
- stroke width (*b*), measured as the equivalent width of the red ring;
- stroke width (*c*), measured as the equivalent width of the lines which create the symbol;
- clearance (*d*), measured as the distance between the inner boundary of the equivalent surface of the red ring and the equivalent surface of the symbol area;
- diameter of maximum equivalent symbol area (*e*);
- equivalent height (*f*) of the symbol.

Symbols and formulae for these parameters are given in Table M.1.

Examples for calculation of dimensions of circular mandatory VMS are given in Figure M.2 and Figure M.3.

Table M.1 — Parameters for mandatory signs using a red circle

Parameter	Symbol	Formulae
Average element spacing of circle	s_c	-
Number of element-rows of circle	r_c	-
Average element spacing of symbol	s_s	-
Number of element-rows of symbol	r_s	-
Height of circle	a	-
Circle stroke width: $r_c = 1$ $r_c > 1$	b	$b = s_c$ $b = 0{,}5 \times s_c \times r_c \times \sqrt{3}$
Legend stroke width: $r_s = 1$ $r_s > 1$	c	$c = s_s$ $c = 0{,}5 \times s_s \times r_s \times \sqrt{3}$
Outer diameter of symbol	e	$e = 0{,}809 \times (a - 2 \times b)$
Minimum clearance	d	$d = 0{,}5 \times (a - 2 \times b - e)$
Character height within symbol area	f	$f = 0{,}36 \times e$

NOTE 1 The dimension a – f include equivalent area NOTE 2 The physical height of the circle (*h*) is calculated by : $h = a - 0{,}5 \times s_c \times \sqrt{3}$ or $h = a - s_c$ (for $r_c = 1$) NOTE 3 The number of elements of the circle (*P*) is calculated by: $P = (r_c \times h \times \pi) / s_c$ NOTE 4 Outer diameter of symbol (*e*) allowing tolerances of ± 8 %.

b) TRIANGLE (see Figure M.4)

- triangle side length (*a*), measured as the length of one side of the triangle;
- stroke width (*b*), measured as the equivalent width of the side of the triangle;
- stroke width (*c*), measured as the equivalent width of the lines which create the symbol;
- clearance (*d*), measured as the distance between the inner boundary of the equivalent surface of the triangle and the equivalent surface of the symbol area;
- height (*e*) of triangle, which forms the equivalent symbol area;
- equivalent height (*f*) of the symbol.

Table M.2 gives the symbol and formulae for these parameters.

An example of calculation dimensions of a triangular warning VMS is given in Figure M.4

Table M.2 — Parameters for mandatory signs using a red triangle

Parameter	Symbol	Formulae
Average element spacing of triangle	s_t	-
Number of element-rows of triangle	r_t	-
Average element spacing of symbol	s_s	-
Number of element-rows of symbol	r_s	-
Side length of triangle	A	-
Triangle stroke width $r_t = 1$ $r_t > 1$	b	$b = s_t$ $b = 0{,}5 \times s_t \times r_t \times \sqrt{3}$
Legend stroke width $r_s = 1$ $r_s > 1$	c	$c = s_S$ $c = 0{,}5 \times s_s \times r_s \times \sqrt{3}$
Height of symbol area in triangular shape	e	$e = 0{,}716 \times (0{,}5 \times a \times \sqrt{3} - 3 \times b)$
Minimum clearance	d	$d = (a \times \sqrt{3} - 6 \times b - 2 \times e) / 6$
Character height within symbol area	f	$f = 0{,}36 \times e$

NOTE 1 The dimensions *a-f* include equivalent area.

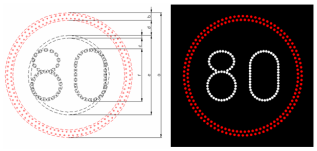
NOTE 2 The physical side length of the triangle (*h*) is calculated by:

$$h = a - d_t \times \sqrt{3}$$

NOTE 3 The number of elements of the triangle (*P*) is calculated by:

$$P = 3 \times \left(\frac{h}{s_t} \times r_t - r_t^2 - 1 \right)$$

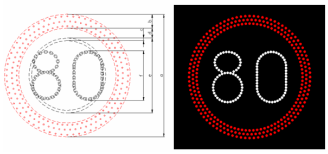
NOTE 4 Height of symbol area in triangular shape (*e*) allowing tolerances of ± 9 %.



Key

s_c	=	33,9 mm	s_s	=	30,9 mm
r_c	=	2	r_s	=	1
			a	=	999,4 mm
B	=	$0{,}5 \times s_c \times r_C \times \sqrt{3}$	b	=	58,7 mm
C	=	s_s	c	=	30,9 mm
E	=	$0{,}809 \times (a - 2 \times b) \pm 8\ \%$	e	=	730,0 mm
D	=	$0{,}5 \times (a - 2 \times b - e)$	d	=	75,8 mm
F	>	$0{,}36 \times e = 262{,}8$	f	=	380,0 mm
H	=	$a - 0{,}5 \times s_c \times \sqrt{3}$	h	=	970,0 mm
Elements p	=	$(r_c \times h \times \pi) / s_c$	p	=	176

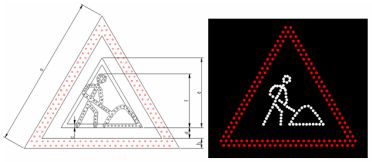
Figure M.2 — Example for calculation of dimensions of circular mandatory VMS



Key

s_c	=	40,9 mm	s_s	=	29,5 mm
r_c	=	3	r_s	=	1
			a	=	935,4 mm
b	=	$0{,}5 \times s_c \times r_c \times \sqrt{3}$	b	=	106,3 mm
c	=	s_s	c	=	29,5 mm
e	=	$0{,}809 \times (a - 2 \times b) \pm 8\ \%$	e	=	570,0 mm
d	=	$0{,}5 \times (a - 2 \times b - e)$	d	=	76,4 mm
f	>	$0{,}36 \times e = 205{,}2$	f	=	370,0 mm
h	=	$a - 0{,}5 \times s_c \times \sqrt{3}$	h	=	900,0 mm
Elements : p	=	$(r_c \times h \times \pi) / s_c$	p	=	192

Figure M.3 — Example for calculation of dimensions of circular mandatory VMS



Key

s_t	=	37,5 mm	s_s	=	26,1 mm
r_t	=	2	r_s	=	1
a	=	1 115,0 mm			
b	=	$0{,}5 \times s_t \times r_t \times \sqrt{3}$	b	=	65,0 mm
c	=	$0{,}5 \times s_s \times r_s \times \sqrt{3}$	c	=	22,6 mm
e	=	$0{,}716 \times (0{,}5 \times a\sqrt{3} - 3 \times b) \pm 9\ \%$	e	=	552,0 mm
d	=	$(a \times \sqrt{3} - 6 \times b - 2 \times e) / 6$	d	=	72,9 mm
h	=	$A - \sqrt{3} \times s_t$	h	=	1 050,0 mm
Elements : P	=	$3 \times (h / s_t \times r_t - r_t^2 - 1)$	P	=	153

Figure M.4 — Example for calculation of dimensions of a triangular warning VMS

The following examples apply to VMS, often referred to as “full colour graphic VMS”, consisting of displaying elements disposed in a regular orthogonal matrix, with equal horizontal and vertical element spacing, each formed by at least 3 light emitters, i.e. red, green and blue. In this way it is possible, by varying the luminosity and the colour of each VMS element, to display on the VMS any pictogram, of any colour.

Important aspects, besides those already regulated by this European Standard, regarding this type of VMS, are

— number of elements per unit surface area,

— single element luminance control.

Luminance control of each VMS light-emitting element is another important aspect to be considered, since there are a number of operational conditions where this feature is of the utmost importance.

Using colour inversion is providing best legibility due to high luminance and high luminance ratio between the different contents of the displayed image (e.g. red ring, background and speed limit figures), even during highest illuminance and at large viewing distance. Because only few elements are needed to display the message, other advantages on power consumption, availability and reduced faults are obvious.

The following examples Figure M.5 to Figure M.7 demonstrate the effect of colour inversion in a regular orthogonal system matrix.

Figure M.5 — Example of VMS using (64 × 64) elements with colour inversion

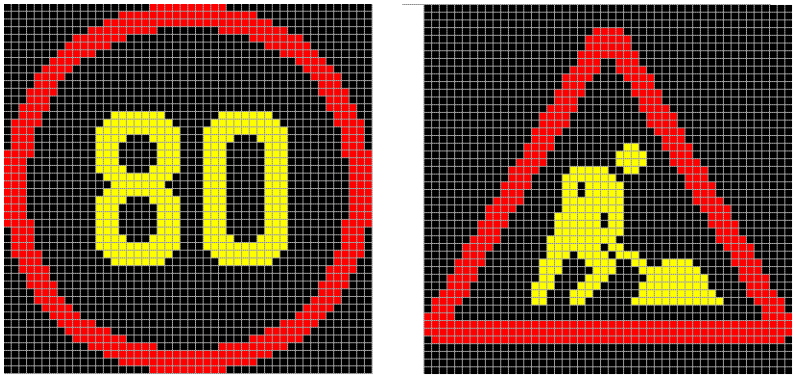


Figure M.6 — Example of VMS using (48 × 48) elements with colour inversion

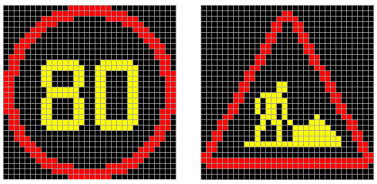


Figure M.7 — Example of VMS using (32 × 32) elements with colour inversion

M.4 VMS without colour inversion

To display discontinuous VMS in the same way, as continuous VMS with white background, it is necessary to take several circumstances into account. Some pictograms as used for continuous VMS, comprise thin black lines on a white background. When the luminous intensity of the white parts of them is very high (as during daytime hours, with sun in front of the display), the thin black line becomes partially reduced in dimension, due to the white component “invading” part of the black area. At night, instead, when low white intensity is required, the black line appears larger in dimension. In order to avoid this effect, it is necessary to control the luminous intensity of each element reducing, in certain situations, the luminance of the white elements near to black areas, respectively to other white elements that are far away.

This example is generally applicable to all borders with different colours and mainly when the adjacent colours belong to strong emissive colour (as white and yellow) and to background colours (black, blue, red).

NOTE When using a white background, the perceived character size is changing depending on the viewing distance.

The following examples in Figure M.8 to Figure M.10 demonstrate the effect of non colour inversion in a regular orthogonal system matrix.

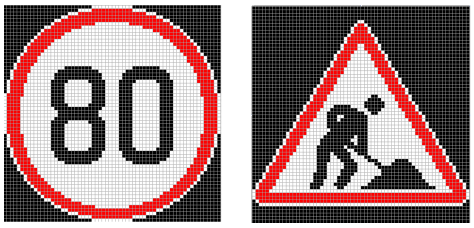


Figure M.8 — Example of VMS using (64 × 64) elements, no colour inversion

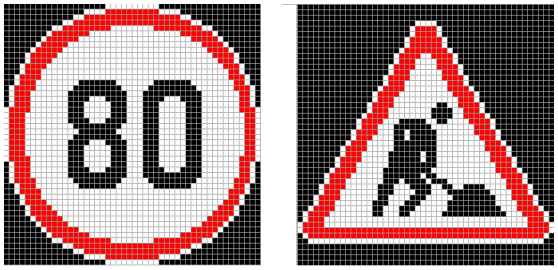


Figure M.9 — Example of VMS using (48 × 48) elements, no colour inversion

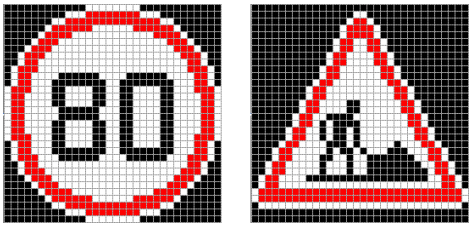


Figure M.10 — Example of VMS using (32 × 32) elements, no colour inversion

Annex N
(informative)

Guidance on dimensions , luminance, beam width, legibility and efficiency for discontinuous VMS

N.1 General

The aim of this annex is to provide the designer or purchaser with some typical values of dimensions and tolerances used on VMS in order to obtain an acceptable legibility.

Variable message traffic signs contribute to traffic safety by providing drivers with information about possible dangers and hazards. Therefore VMS should be designed in a way that road users have time enough to read the message and understand it.

Two basic figures have to be considered:

— the legibility distance, depending on the size and design of the message and it's visual performance (luminance, luminance ratio, beam width and colour) ;

— the recognition time (the duration of legibility), depending on the speed

The choice of the size range is determined by the required legibility distance and approach speed to the sign on site.

The legibility distance can be based on letter height times a factor. This factor is dependent on various environmental and human parameters and is typically given a value in the range between 500 and 620. The legibility of a font also depends heavily on its design. Standard text fonts are not always suited for VMS, because the radiation of the light emitting elements can easily close gaps (in letters like a, e etc.) that are too small. Some special fonts have been developed for use on VMS for this reason.

The recognition time, necessary to read and understand a message, is typically given in a range of at least 4 s - 6 s.

On many sites a gantry carries more than one VMS, which may be of different size and type, e.g. alphanumeric panels joined by graphical VMS to display pictograms, or several graphical VMS with attached text lines to support single lanes.

This annex relates to the definition of recognition time of messages, depending on horizontal and vertical beam width, size of characters and legends and on legibility distance of the VMS installed on gantries or cantilevers.

Examples are given for roads with two or more lanes, but all formulae can be used as well for single lane roads.

N.2 Dimensions

N.2.1 General

Dimensions for text, circles and triangles are based on experience and offered as general advice. Shapes of circles and triangles are usually defined by national legislation. Dimensions of other geometrical shapes can be derived from the figures in Table N.2 and Table N.3.

N.2.2 Text

Character fonts can either use fixed character width (e.g. 7 × 5 elements) or proportional characters, where the width depends on the shape of the character (e.g. “I”, “W”).

The minimum number of elements for an uppercase character (capital) is 7 × 5 (i.e. 7 elements in the vertical direction and 5 elements in the horizontal direction). The minimum number of elements for a text with a mix of uppercase (capitals) and lowercase alphanumeric characters is 9 × 5 (i.e. 9 elements in the vertical direction and 5 elements in the horizontal direction).

When choosing dimensions for the text used on VMS the intended use should be kept in mind. The main parameter to consider is the (minimum) time motorists will need to read a message. From this minimum time needed, and the speeds driven at the location of the VMS, the text size range needed can be derived. Guidance is given in Table N.1, Table N.2 and Table N.3.

Table N.1 — Minimum dimensions of text (mm)

Size range	Character height h	Character width [a] w	Character spacing [b] s_c	Word spacing [c] s_w	Line spacing [d] s_l	Backing board border distance [e]
A	100	71	28	71	57	100
B	160	114	46	114	91	160
C	240	171	68	171	137	240
D	320	228	91	228	182	320
E	400	285	114	285	228	400

a) If a fixed character dimension is used, the minimum character width is equal to 5/7 h. If a proportional character font is used, character width varies.

b) The minimum character spacing is equal to 2/7 h. If proportional character font is used, character spacing varies.

c) The minimum word spacing is equal to 5/7 h.

d) The minimum line spacing is equal to 4/7 h. The line spacing is the clear area between spaces assigned to the characters; see also Figure P.2, Figure P.3 and Figure P.4. Recommendation for line spacing when using lower case letters and descenders is given in Figure P.3 and Figure P.4.

e) The minimum backing board border distance is equal to h. This distance is measured from the border of text to the border of backing board.

When calculating the spacing (see Table N.1), the height (h) is defined by the height of an uppercase character.

The legibility of characters can be optimised by applying more than the minimum number of light elements. Compared to the optimal character fonts for direction signs the legibility distances can be improved by at least 30 %, when the number of elements is increased to such an extent that the equivalent areas of the characters approximate the outline of the optimal direction sign fonts. The best results can be achieved when the horizontal and the vertical element spacing are equal.

N.2.3 Circles

The different parameters of Table N.2 are defined in Annex M.

Table N.2 — Minimum dimensions of circles (mm)

Size range	height *a*	stroke width *b*
A	450	35 ± 3,5
B	650	50 ± 5
C	850	60 ± 6
D	1 050	75 ± 7,5
E	1 250	90 ± 9

The minimum number of elements for a matrix containing a circle is 32 × 32 (i.e. 32 elements in vertical direction and 32 elements in horizontal direction).

N.2.4 Triangles

The different parameters of Table N.3 are defined in Annex M.

Table N.3 — Minimum dimensions of triangles (mm)

Size range	side length *a*	stroke width *b*
A	500	30 ± 3
B	700	45 ± 4,5
C	1 000	60 ± 6
D	1 250	75 ± 7,5
E	1 500	90 ± 9

The minimum number of elements for a matrix containing a triangle is 29 × 32 (i.e. 29 elements in vertical direction and 32 elements in horizontal direction).

N.3 Luminance and beam width classes

The purpose of this annex is to provide guidance to those individuals charged with the responsibility for selecting the appropriate visual and physical performance classes from sub-clauses 4.4 and 4.5 respectively. The visual and physical parameters offer a variety of combinations and could be easily misinterpreted leading to an incorrect selection. This could result in a VMS which is not suitable for use.

For effective use the correct selection of combinations of beam width, luminance and luminance ratio is essential.

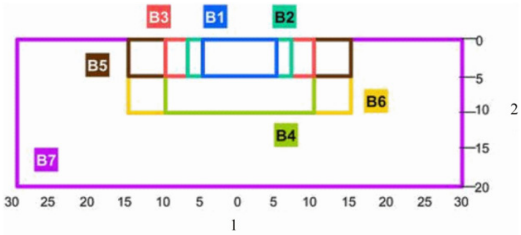
The minimum luminance and luminance ratio values as given in Table 4 to Table 10 reflect an intention to balance the defined colours in accordance with the visual impression of human eyes. Therefore, in case where more than one colour is used, only one combination of luminance and luminance ratio should be required (see also Clause 7).

Luminance class L3 is preferable to the lower luminance classes L2 and L1. In order to be able to cope with possible atmospheric conditions for long viewing distances, the selection of the highest (brightest) luminance class L3 has additional importance.

Beam width class should be sufficient for the necessary recognition time (refer to N.1), but in selecting the beam width class avoiding of light pollution and wasting of energy should be considered.

Seven beam width classes B1 to B7 are given in Table 11.

For better understanding of Table 11 Figure N.1 shows the relationship between classes graphically. It can be seen that B7 covers 24 times B1, if the area covered by B1 is considered as one unit.



Key

1 horizontal angle [°]

2 vertical angle [°]

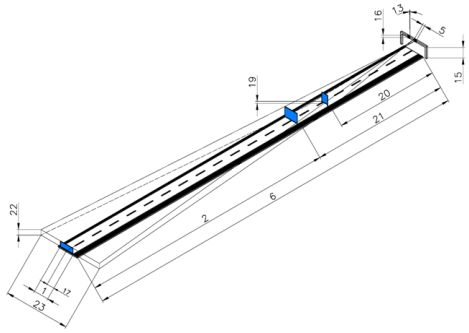
Figure N.1 — Relation between classes

The following Table N.4 gives examples of typical applications to assist in the correct selection of beam width class.

Table N.4 — Examples for applications of beam width classes

Beam width class	Typical application
B1	High speed road, two running plus one safety lanes, lane use sign mounted at gantry above traffic typically size ranges D and E of Table N.1, Table N.2 and Table N.3.
B2	High speed road, three running plus one safety lanes, lane use sign mounted at gantry above traffic typically size ranges D and E of Table N.1, Table N.2 and Table N.3.
B3	High speed road, four running plus one safety lanes, lane use sign or medium wide VMS mounted at gantry above traffic; VMS mounted at the side of the road and requiring a wider beam width to cover up to two lanes, typically size ranges D and E of Table N.1, Table N.2 and Table N.3.
B4	As B3 above, sign mounted at high level, typically size ranges D and E of Table N.1, Table N.2 and Table N.3.
B5	As B3, but extra wide sign covering more than two lanes, typically size ranges C, D and E of Table N.1, Table N.2 and Table N.3.
B6	As B5 above, sign mounted at high level.
B7	For special applications, where very wide horizontal and vertical beam widths are required. In urban areas B7 could account for the interests of cyclists and pedestrians.

Three dimensionally, the effect of horizontal and vertical beam widths can be seen clearly in Figure N.2 on an 1,2 m wide lane use sign, for example, for the use of beam width class B1. Accurate calculation is given in N.4.



Key

1 road width, width of required legibility area *(W)*

2 length of legibility area *(L)*

5 total width of display *(t_w)*

6 maximum legibility distance *(d_{max})*

13 vertical tilt *(φ)*

15 free height *(f_h)*

16 total height of display *(t_h)*

17 lane width *(l_w)*

19 height of drivers eye *(h_e)*

20 shortest legibility distance (dv_{min}), determined by vertical beam and lane covered by lane use signal

21 shortest legibility distance(dh_{min}), determined by horizontal beam and road width

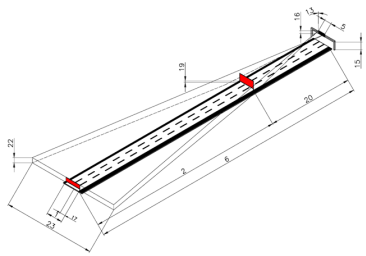
22 height of visibility area at maximum legibility distance *(hd_{max})*

23 width of illumination *(w_i)* at maximum legibility distance

Figure N.2 — Example of coverage by beam width class B1

NOTE By using W = 7,6 m, t_w = 1,2 m, d_{max} = 200 m, *(φ)* = 1°, f_h = 5 m, t_h = 1,2 m, l_w = 3,8 m and h_e = 1,2 m, the following distances result by using the formulae as explained in N.4: dv_{min} = 47,6 m, dh_{min} = 72,0 m, h_{dmax} = 2,7 m, w_i = 33,8 mm, recognition time at speed of 130 km/h will be 4,2 s on right lane, 3,5 s on left lane.

Three dimensionally, the effect of horizontal and vertical beam widths can be seen clearly in Figure N.3 on a 5 m wide information sign, for example, for the use of beam width class B3. Accurate calculation is given in N.4.



Key

1 road width, width of required legibility area *(W)*

2 length of legibility area *(L)*

5 total width of display *(t_w)*

6 maximum legibility distance *(d_{max})*

13 vertical tilt *(φ)*

15 free height *(f_h)*

16 total height of display *(t_h)*

17 lane width *(l_w)*

19 height of drivers eye *(h_e)*

20 shortest legibility distance(dv_{min}), determined by vertical beam and width of the road

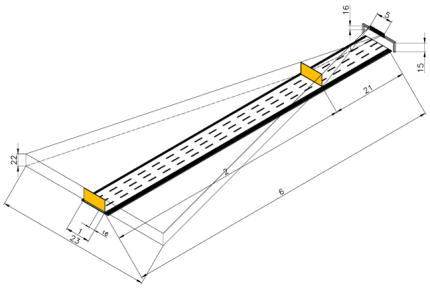
22 height of visibility area at maximum legibility distance *(hd_{max})*

23 width of illumination at maximum legibility distance *(w_i)*

Figure N.3 — Example of coverage by beam width class B3

NOTE By using W = 11,4 m, t_w = 5,0 m, d_{max} = 200 m, (φ) = 1°, f_h = 5 m, t_h = 2 m, l_w = 3,8 m and h_e = 1,2 m, the following distances result by using the formulae as explained in N.4: dv_{min} = 55,2 m, hd_{max} = 3,5 m, w_i = 65,5 m; recognition time at speed of 130 km/h will be 4,0 s on all lanes.

Three dimensionally, the effect of horizontal and vertical beam widths can be seen clearly in Figure N.4 on a 10 m wide information sign, for example, for the use of beam width class B6. Accurate calculation is given in N.4.



Key

1 road width, width of required legibility area *(W)*

2 length of legibility area *(L)*

5 total width of display *(t_w)*

6 maximum legibility distance *(d_{max})*

15 free height *(f_h)*

16 total height of display *(t_h)*

17 lane width *(l_w)*

19 height of drivers eye *(h_e)*

21 shortest legibility distance (dh_{min}), determined by horizontal beam and width of the road

22 height of visibility area at maximum legibility distance *(hd_{max})*

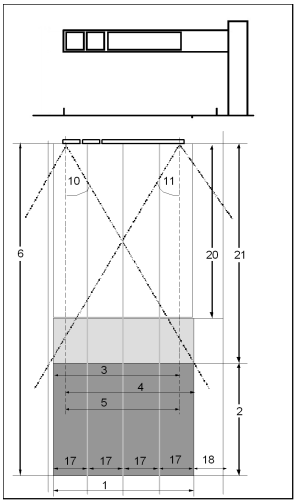
23 width of illumination at maximum legibility distance *(w_i)*

Figure N.4 — Example of coverage by beam width class B6

NOTE By using W = 15,2 m, t_w = 10,0 m, d_{max} = 200 m, *(φ)* = 0°, f_h = 5 m, t_h = 2 m, l_w = 3,8 m and h_e = 1,2 m, the following distances result by using the formulae as explained in N.4: dh_{min} = 47,0 m, hd_{max} = 7,0 m, w_i = 97,2 m; recognition time at speed of 130 km/h will be 4,2 s on all lanes.

N.4 Beam width and distances of legibility

N.4.1 Group of VMS, centred above the road



Key

1 road width, width of required legibility area *(W)*

2 length of legibility area *(L)*

3 shift left *(S_L)*

4 shift right *(S_R)*

5 total width of display *(t_w)*

6 maximum legibility distance *(d_{max})*

10 left horizontal distribution angle *(α)*

11 right horizontal distribution angle *(β)*

17 lane width *(l_w)*

18 width of emergency lane *(e_w)*

20 shortest legibility distance ($dv_{\min}$), determined by vertical beam and width of the road

21 shortest legibility distance ($dh_{\min}$), determined by horizontal beam and width of the road

Figure N.5 — Legibility of group of VMS, centred on gantry above the road

Maximum legibility distance d_{max} (key 6 of Figure N.2, Figure N.3, Figure N.4 and Figure N.5) is determined by design of VMS (e.g. character height), visual performance (luminance and luminance ratio) and various environmental and human parameters (see N.1).

Calculation of shortest legibility distance dv_{min}, determined by vertical beam (key 20 of Figure N.2, Figure N.3, and Figure N.5), is shown in N.4.4.

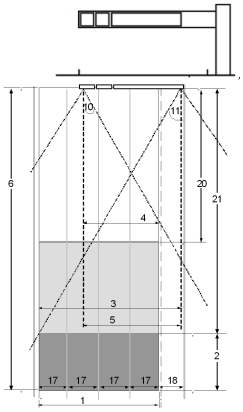
In Figure N.5 the area out of vertical beam is shown as $W \times dv_{min}$; the area out of horizontal beam is shown as $W \times dh_{min}$. The legibility area is shown as $W \times L$.

The shortest legibility distance of H_{min} evaluated of S_R in combination with α or S_L in combination with β, determined by horizontal beam (key 21 of Figure N.2), Figure N.4 and Figure N.5), can be calculated as

$$H_{min} = S_R / \tan\alpha \quad \text{(N.1)}$$

$$H_{min} = S_L / \tan\beta \quad \text{(N.2)}$$

N.4.2 Group of VMS, not centred above the road



Key

1 road width, width of required legibility area *(W)*

2 length of legibility area *(L)*

3 shift left *(S_L)*

4 shift right *(S_R)*

5 total width of display *(t_w)*

6 maximum legibility distance *(d_{max})*

10 left horizontal distribution angle *(α)*

11 right horizontal distribution angle *(β)*

17 lane width *(l_w)*

18 width of emergency lane *(e_w)*

20 shortest legibility distance (dv_{min}), determined by vertical beam and width of the road

21 shortest legibility distance (dh_{min}), determined by horizontal beam and width of the road

Figure N.6 — Legibility of group of VMS, mounted on cantilever aside the road

Maximum legibility distance (key 6 of Figure N.2, Figure N.3, Figure N.4 and Figure N.5) is determined by design of VMS (e.g. character height), visual performance (luminance and luminance ratio) and various environmental and human parameters (see N.1).

Calculation of shortest legibility distance (dv_{min}), determined by vertical beam (key 20 of Figure N.2, Figure N.3, and Figure N.5), is shown in N.4.4.

In Figure N.6 the area, out of vertical beam is shown as $W \times dv_{min}$; the area out of horizontal beam is shown as $W \times dh_{min}$. The legibility area is shown as $W \times L$.

The shortest legibility distance of H_{min} evaluated of S_R in combination with α or S_L in combination with β, determined by horizontal beam (key 21 of Figure N.2, Figure N.4 and Figure N.5), can be calculated as

$$H_{min} = S_R / \tan\alpha \qquad \text{(N.1)}$$

$$H_{min} = S_L / \tan\beta \qquad \text{(N.2)}$$

When the group of panels is not centred with respect to the traffic lanes, the value of S_L (left shift) increases and consequently reduces the area of legibility.

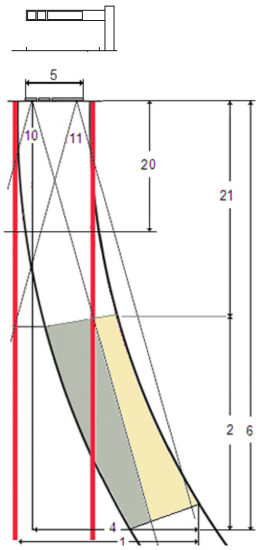
The shift value should be reduced to a minimum, to avoid that the time available for reading messages (recognition time) is reduced to values which do not allow the complete reading of messages.

These issues depend significantly on the choice of support - types and their location; rotation of the cantilever towards to the left lane might help to reduce left shift value.

N.4.3 Curved road sections

For VMS installed in road sections that are not straight, the designer should take the radius of curvature of the road into account and should identify the distribution angle to compensate for the curve; rotation of the cantilever towards to the curve might help to reduce shift value.

In particular, this should be determined by the value of S_L respectively S_R by analysing the track.



Key

1 road width, width of required legibility area *(W)*

2 length of legibility area *(L)*

4 shift right *(S_R)*

5 total width of display *(t_w)*

6 maximum legibility distance *(d_{max})*

10 left horizontal distribution angle *(α)*

17 right horizontal distribution angle *(β)*

20 shortest legibility distance (dv_{min}), determined by vertical beam and width of the road

21 shortest legibility distance (dh_{min}), determined by horizontal beam and width of the road

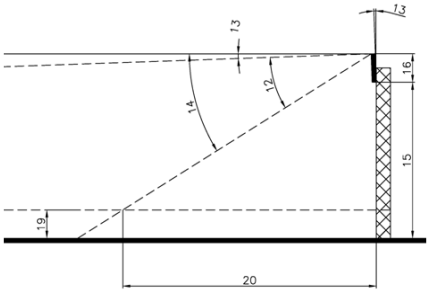
Figure N.7— Legibility of group of VMS, mounted on cantilever aside the road

N.4.4 Limits of legibility due to vertical beam

In addition to the limits of legibility due to horizontal beam width the vertical beam width should be considered as well to calculate the minimum legibility distance; the VMS will only be legible only if the reading distance is larger than each of the calculated distances.

To ensure complete visibility of the VMS group, the upmost elements of the VMS have to be considered.

In the following example the eye height *(h_e)* of the observer is considered at 1 m from the ground, allowing for the driving position of motorcyclists. The eye height might be different according to national regulations.



Key

7 height of the upmost element to the drivers eye *(H_R)*

12 vertical beam width *(ε)*

13 vertical tilt *(φ)*

14 vertical distribution angle (σ)

15 free height *(f_h)*

16 total height of display *(t_h)*

19 height of drivers eye *(h_e)*

20 shortest legibility distance (dv_{min}), determined by vertical beam and width of the road

Figure N.8— Legibility of group of VMS, mounted on cantilever aside the road

Distances are calculated as following:

$$H_R = f_h + t_h - h_e \quad \text{(N.3)}$$

$$dv_{min} = H_R / \tan\varepsilon \quad \text{(N.4)}$$

Tilting of the VMS towards to the road surface might help to reduce minimum legibility distance.

Character height is limiting the maximum legibility distance, vertical and horizontal beam width, as well as height of the upmost element; tilting (rotating) the VMS is influencing the minimum legibility distance. The recognition time is a function of the road user's speed and the legibility distance. Typical values for recognition times larger than 4 s depending on character height speed limit and vertical beam width are given in Table N.5. The values may vary depending on above mentioned parameters,

For examples with detailed calculation including also the limits of horizontal beam width see Table N.5.

Table N.5 — Examples for recognition time depending on character height, speed and vertical beam width

Size range	Character height *h* [mm]	Min. legibility distance d_{min} [m]	Possible recognition time in seconds [s] at speed [km/h], depending on vertical beam width						
			40	50	60	80	100	110	130
A	**100**	**5**	5,0	4,0					
B	**160**	**15**	7,3	5,8	4,9				
C	**240**	**30**	10,3	8,2	6,8	5,1	4,1		
D	**320**	**45**	13,2	10,6	8,8	6,6	5,3	4,8	4,1
E	**400**	**60**	16,2	13,0	10,8	8,1	6,5	5,9	5,0

N.4.5 Calculation of recognition time

N.4.5.1 General

To determine the recognition time, depending to the beam width class examined, the following procedure is recommended:

— calculate the road width *W* and the length of legibility area *L;*

— calculate maximum shift of S_L *and* S_R inside the legibility area;

— calculate the minimum distance reading angle, depending on S_L *and* S_R and the limit angles *α* and *β*.

N.4.5.2 Distances in metres per second at various speeds

Table N.6 — Conversion from speed unit km/h to m/s

km/h	50	60	80	100	120	130
m/s	13,9	16,7	22,2	27,8	33,3	36,1

To convert speeds from km/h to m/s, use the formula

$v_{(m/s)} = v_{(km/h)} / 3,6$

N.4.5.3 Example of calculation of the recognition time

N.4.5.3.1 General

The following example is based on

— a straight road,

— three lanes

— all lanes of 3,8 m width (l_w),

— a maximum speed of 130 km/h,

— a group of VMS on a gantry aligned to the right lane,

— dimensions of the text in accordance with class E of Table N.1 (h = 400 mm),

— a total width of the VMS of 11,0 m (t_w)

— a free height of the VMS of 5,5 m above the surface (f_h),

— a height of the display area of 2,0 m (t_h),

— a height of driver's eye of 1,0 m (h_e),

— without tilt of the VMS vertically towards the road (φ =0 °),

— without rotation of the VMS horizontally (χ = 0 °).

The height of the upmost element to the driver's eye will be

$$H_R = 5,5 \text{ m} + 2,0 \text{ m} – 1,0 \text{ m} = 6,5 \text{ m} \quad (N.5)$$

Based on the number of lanes and the size per lane the width of the legibility area can be calculated with

$$W = 3 \times 3,8 = 11,4 \text{ m} \quad (N.6)$$

Maximum legibility distance of the alphanumeric character, based on the guidance given in N.1 will be calculated within the range

$d_{max}(500)$ = 0,4 × 500 = 200 m (N.7)

and

$d_{max}(620)$ = 0,4 × 620 = 248 m (N.7b)

Because of high speed road for safety reasons the shorter distance according to Formula (N.7a) is considered for further calculation.

N.4.5.3.2 Using beam width class B2

Selecting beam width class B2 with horizontal half angle δ = ± 7 °, vertical half angle ε = 5 °

Rotating the sign horizontally towards the road with an angle χ would result in horizontal distribution angles

$\alpha = \delta + \chi$ and $\beta = \delta - \chi$

without horizontal rotation:

$\alpha = \beta = \delta = 7$ ° (N.8a)

Tilting the sign vertically towards the road surface with an angle φ would result in vertical distribution angle

$\sigma = \varepsilon + \varphi$

without vertical tilting towards the road surface:

$\sigma = \varepsilon = 5$ (N.8b)

Because alignment of the VMS with the right lane shift values can be calculated with

$S_L = W$ = 11,4 m (N.9a)

$S_R = t_w$ = 11,0 m (N.9b)

The minimum legibility distance as a function of vertical angle can be calculated following Formulae (N.4) and (N.5):

$dv_{min} = H_R / tan\varepsilon$ = 74,3 m (N.10)

The minimum legibility distance as a function of horizontal angle and the maximum of the shift values, following Formulae (N.2) and (N.9a):

$dh_{min} = S_L / tan\beta$ = 93 m (N.11)

This example shows, that based on the physical and optical configuration dh_{min} (Formula (N.11)) > dv_{min} (Formula (N.10)), why a minimum legibility distance of 93 m (dh_{min}) has to be considered for the further calculation of recognition time.

Recognition time (RT) has to be calculated with the difference of maximum legibility distance (Formula (N.7a)) and minimum legibility distance (Formula (N.11)) and the allowed maximum speed (see Table N.6).

$RT = (d_{max} – dh_{min}) / v$ (N.12)

The VMS will be legible from a distance of 200 m until approaching the VMS to a distance of 93 m, means during 107 m. Following Formula (N.12) the recognition time can be calculated with

RT_{B2} = (200 m – 93 m) / 36,1 m/s = 3,0 s (N.13)

N.4.5.3.3 Using beam width class B4

Selecting beam width class B4 with horizontal half angle δ = ± 10 °, vertical half angle ε = 10 °

Rotating the sign horizontally towards the road with an angle χ would result in horizontal distribution angles

$\alpha = \delta + \chi$ and $\beta = \delta - \chi$

without horizontal rotation:

$\alpha = \beta = \delta = 10$ ° (N.14a)

Tilting the sign vertically towards the road surface with an angle φ would result in vertical distribution angle

$\sigma = \varepsilon + \varphi$

without vertical tilting towards the road surface:

$\sigma = \varepsilon = 10$ (N.14b)

Because alignment of the VMS with the right lane shift values can be calculated with

$S_L = W = 11{,}4$ m (N.9a)

$S_R = t_w = 11{,}0$ m (N.9b)

The minimum legibility distance as a function of vertical angle can be calculated following Formulae (N.4) and (N.5):

$dv_{min} = H_R / tan\varepsilon = 36{,}9$ m (N.15)

The minimum legibility distance as a function of horizontal angle and the maximum of the shift values, following Formulae (N.2) and (N.9a):

$dh_{min} = S_L / tan\beta = 65$ m (N.16)

This example shows, that based on the physical and optical configuration dh_{min} (Formula (N.16)) > dv_{min} (Formula (N.15)), why a minimum legibility distance of 65 m (dh_{min}) has to be considered for the further calculation of recognition time.

Recognition time *(RT)* has to be calculated with the difference of maximum legibility distance (Formula (N.7a)) and minimum legibility distance (Formula (N.11)) and the allowed maximum speed (see Table N.6).

$RT = (d_{max} – dh_{min}) / v$ (N.12)

The VMS will be legible from a distance of 200 m until approaching the VMS to a distance of 65 m, means during 135 m. Following Formula (N.12)) the recognition time can be calculated with

RT_{B4} = (200 m – 65 m) / 36,1 m/s = 3,7 s (N.17)

N.4.5.3.4 Using beam width class B6

Selecting beam width class B6 with horizontal half angle δ = ± 15 °, vertical half angle ε = 10°.

Rotating the sign horizontally towards the road with an angle χ would result in horizontal distribution angles

$\alpha = \delta + \chi$ and $\beta = \delta - \chi$

without horizontal rotation:

$\alpha = \beta = \delta = 15\ °$ (N.18a)

Tilting the sign vertically towards the road surface with an angle φ would result in vertical distribution angle

$\sigma = \varepsilon + \varphi$

without vertical tilting towards the road surface:

$\sigma = \varepsilon = 10$ (N.18b)

Because alignment of the VMS with the right lane shift values can be calculated with

$S_L = W = 11{,}4$ m (N.9a)

$S_R = t_w = 11{,}0$ m (N.9b)

The minimum legibility distance as a function of vertical angle can be calculated following Formulae (N.4) and (N.5):

$dv_{min} = H_R / \tan\varepsilon = 36{,}9$ m (N.19)

The minimum legibility distance as a function of horizontal angle and the maximum of the shift values, following Formulae (N.2) and (N.9a):

$dh_{min} = S_L / \tan\beta = 43$ m (N.20)

This example shows, that based on the physical and optical configuration dh_{min} (Formula (N.20)) > dv_{min} (Formula (N.19)), why a minimum legibility distance of 43 m *(dh_{min})* has to be considered for the further calculation of recognition time.

Recognition time *(RT)* has to be calculated with the difference of maximum legibility distance (Formulae (N.7a), (N.7b)) and minimum legibility distance (Formula (N.11)) and the allowed maximum speed (see Table N.6).

$RT = (d_{max} - dh_{min}) / v$ (N.12)

The VMS will be legible from a distance of 200 m until approaching the VMs to a distance of 43 m, means during 157 m. Following Formula (N.12) the recognition time can be calculated with

$RT_{B6} = (200\ \text{m} - 43\ \text{m}) / 36{,}1\ \text{m/s} = 4{,}3$ s (N.21)

N.4.5.4 Conclusions after calculation of recognition time

The recognition time is strongly influenced by the beam width.

Due to the fact, that recognition time of at least 4,0 s is recommended to be able to read and understand the provided message, a configuration as shown in the example above is demanding beam width class B6. Class B2 would only allow 3,0 s to read the message and also B4 will provide the message only 3,7 s.

N.4.6 Luminance and luminance ratio

Taking into consideration driver's needs and the possibility of unfavourable environmental conditions it may be best to select classes L3(*) / R3. However other luminance / luminance ratio class combinations could be appropriate in context with beam width requirements.

Luminance ratio is an almost linear function of luminance. L3/L3(*) is balanced with R3, L2/L2(*) is balanced with R2 and L1/L1(*) is balanced with R1. It is recommended to use only these combinations.

Values on luminance and luminance ratio are balanced with the colours. Where more than one colour is used, it is highly recommended to use the same visual performance class combination (see Table 1) for all colours.

EXAMPLE	wC1 L2 R2 B3	(white)
	rC2 L2 R2 B3	(red)
	yC2 L2 R2 B3	(yellow)
	gC1 L2 R2 B3	(green)

N.4.7 Beam width

If the VMS is consisting of different parts (e.g. a full colour graphical section and a monochromatic section for text information), it is recommended to use only one class combination of visual performance classes for all sections.

N.5 Energy efficiency

Selecting the correct parameters for a given application has a direct impact on the energy consumption of the VMS. Insisting on beam widths that are too wide for the location costs money, wastes energy and creates light pollution.

For a long range viewing application of 200 m for lane use signs, where size range E is required, class B1 is probably the right choice depending on the number of lanes to be covered (see Figure N.2 and Table N.4). If B7 is incorrectly selected this requires 24 times the light output wasting 23 times or 96 % of the light output and energy.

Annex O
(informative)

Specific design issues

O.1 Finish

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

O.2 Front panels

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

O.3 Front screens

When front screens are used they should be securely fitted to the VMS enclosure. They should be made of UV and scratch resistant materials and may be removable to facilitate maintenance. Detailed measures should be taken to prevent condensation on the front screen.

O.4 Appearance

Measures should be taken to ensure the homogenous appearance of the complete VMS with particular attention paid to the display surface, because in this specification the uniformity is only measured on the test module.

O.5 Electrolytic compatibility

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

O.6 Protection against thermal overload

Special applications may require that VMS should be provided with active and/or passive protection against thermal overload.

O.7 Physical security against unauthorised access

Suitable measures should be taken to prevent unauthorised access to the VMS or its interior.

O.8 Interfaces between VMS, control, and higher order equipment

VMS with incorporated control devices should be provided with means for connecting maintenance and testing equipment to the control system if test devices are not incorporated in the product. As far as possible a standard interface should be used. Data communication equipment should be designed in accordance with requirements specified by the purchaser.

O.9 Diagnostic

Measures should be taken to enable the monitoring of the main components of the VMS and the diagnosis of faults, in order to guarantee the performance of the product, i.e.:

— power supply;

— logic supply;

— element integrity;

— fans and heaters;

— communication.

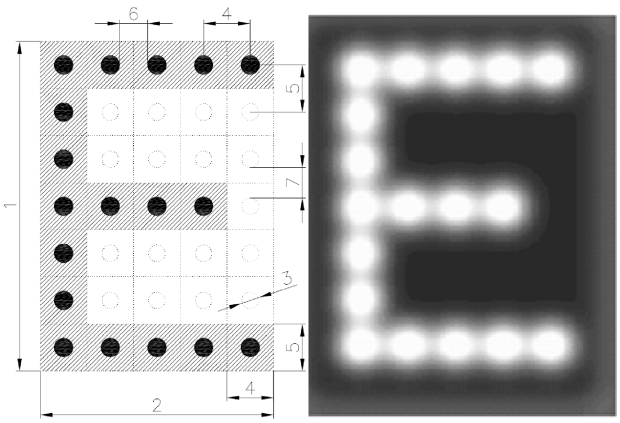
Annex P
(informative)

Guidance for design of VMS messages

P.1 Design of VMS messages

For the design of a VMS message that should be perceived from a long distance the equivalent element area rather than the actual physical element size shall be considered. This has consequences for the perceived dimensions of message. In general the perceived size is larger than the physical size. This will be illustrated in the next example.

The left hand side of Figure P. 1 shows an example of the letter “E” consisting of elements on a regular matrix with equal horizontal and vertical element spacing. The square area around each element is the equivalent element area. The shaded area is the equivalent area of the letter. The physical dimensions are smaller than the equivalent dimensions! For the design of a VMS-message, which should be perceived from a long distance, the equivalent element area rather than the actual physical element size shall be considered. This has consequences for the perceived dimensions of messages. In general the perceived size is larger than the physical size. This will be illustrated in the next example.



Key

1 equivalent height *(h_e)*

2 equivalent width *(w_e)*

3 physical diameter of the element *(D_{ph})*

4 horizontal element spacing *(s_h)*

5 vertical element spacing *(s_v)*

6 horizontal distance between the light sources of adjacent elements

7 vertical distance between the light sources of adjacent elements

Figure P.1 — Example of the design of the letter E in a regular orthogonal matrix

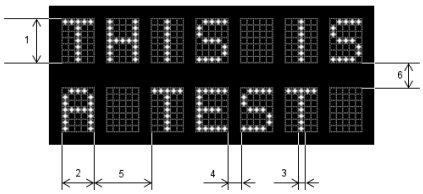
In reality the light of one element does not spread out equally over the square equivalent element area. For the observer the light is blurred around the centre of the element. As a consequence of this the letter does not have a sharp outline. This is illustrated in the right hand side of Figure P.1 for the case that each element contains one circular light source. When the elements have more than one light source or have non-circular light sources the blurring may be slightly different.

P.2 Specifying text dimensions

For the specification of VMS message dimensions the equivalent dimensions rather than the physical dimensions should be used. Examples in Figure P.2, Figure P.3 and Figure P.4 are following the recommendations for ratio of dimensions given in Table N.1.

The areas on the grid in Figure P.2, Figure P.3 and Figure P.4 are the equivalent areas of the text. The dots (white = ON, black = OFF) indicate the physical size of the elements.

Figure P.2 shows - in an example of a fixed character width - the most important text dimensions, when only upper case characters are used, namely character height, character width, stroke width, character spacing, word spacing and line spacing, specified using equivalent dimensions.



Key

1 character height *(h)*

2 character width *(w)*

3 stroke width *(s)*

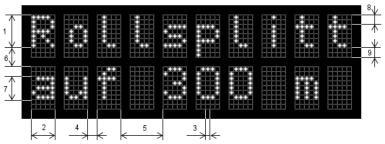
4 character spacing *(s_c)*

5 word spacing *(s_w)*

6 line spacing *(s_l)*

Figure P.2 — Equivalent text dimensions using uppercase characters

Figure P.3 shows - in an example of a fixed character width - the most important text dimensions, when upper- and lower case characters are used, namely character height, character width, stroke width, character spacing, word spacing, and line spacing specified using equivalent dimensions.



Key

1 character height *(h)*

2 character width *(w)*

3 stroke width *(s)*

4 character spacing *(s_c)*

5 word spacing *(s_w)*

6 line spacing *(s_l)*

7 height of lower case character *(h_l)*

8 ascender *(a)*

9 descender *(d)*

Figure P.3 — Equivalent text dimensions using upper- and lower-case characters

Figure P.4 shows a full matrix display area, using proportional, two stroke font. The width of proportional characters and character spacing is variable and depend on shape and combination of characters. This results in more uniform appearance and may also reduce the width of text messages. Full matrix displays may also be used to show graphical symbols.

Key

1 character height *(h)*

2 character width *(w)*

3 stroke width *(s)*

4 character spacing *(s_c)*

5 word spacing *(s_w)*

6 line spacing *(s_l)*

7 height of lower case character *(h_l)*

8 ascender *(a)*

9 descender *(d)*

10 height of upper case umlaut character *(h_u)*

Figure P.4 — Equivalent text dimensions of full matrix display using proportional character spacing

Depending on the font, spaces for ascenders and descenders have to be considered for special characters.

Annex Q
(informative)

Technical documentation

It is recommended that the technical documentation should include at least:

Q.1 Sign enclosure

Material identification

Manufacturer(s)

Physical properties (e.g. static approvals)

Dimensions

Engineering drawings

Visual performance properties (e.g. test reports)

Q.2 Electrical equipment

Component details

Manufacturer(s)

Physical and electrical properties (datasheets)

Engineering drawings

Q.3 Mounting devices (if applicable)

Material specifications

Manufacturer(s)

Physical properties

Dimensions

Engineering drawings

Q.4 Retro-reflective and non retro-reflective components

Materials designation full technical details

Trademarks

Manufacturer(s)

Identification code / grade

Classification

Surface design

Surface finishes full technical and component details

Substrate - full technical and component details

Annex R
(informative)
Example of recommended summary of class combinations

VMS offer the possibility for huge variety of design, especially in respect of visual performance. This informative annex offers guidance how to provide the essential characteristics and present an understandable summary and overview of class combinations on examples of discontinuous VMS, using LED-technology. Other technologies may use it as well, as applicable.

Figure R. 1 is showing an example of the summary of characteristics and test methods for release of dangerous substances, structural performances and durability of the VMS

Recommended summary of class combinations

Datexxxx 20xx

spreadsheet 1: Characteristics of products determined by the product-type on the basis of type testing and FPC

Essential characteristic	Clause	Assessment method	Declaration of results	
			LED single colour	RGB-LED mixed colour
RELEASE OF DANGEROUS SUBSTANCES	4.6	In accordance with the national regulation of the member state of destination	-	-
RESISTANCE TO HORIZONTAL LOADS, for				
- temporary deflections caused by wind loads	4.5.2.5.2	EN 12899-1:2007, 5.3.1	*WL6*	*WL6*
- permanent deflections caused by dynamic snow loads	4.5.2.5.3	EN 12899-1:2007, 5.3.2	*DSL2*	*DSL3*
- temporary bending deflections	4.5.2.5.2	EN 12899-1:2007, 5.4.1	*TDB2*	*TDB1*
PERFORMANCE UNDER IMPACT, as				
- impact resistance	4.5.2.5.4	5.4.3 Table 18	*CCM*	*CCM*
VISIBILITY CHARACTERISTICS, by				
- CHROMATICITY CO-ORDINATES, as				
- Colour	4.4.2	5.5.3	*See spread-sheets 2 to 3*	*See spread-sheets 4 to 5*
- LUMINANCE, dealt with following visual characteristics				
- luminance	4.4.3	5.5.4	*See spread-sheets 2 to 3*	*See spread-sheets 4 to 5*
- luminance ratio	4.4.4	5.5.4		
- beam width	4.4.5	5.5.5		
- uniformity	4.4.6	5.5.6		
- visible flicker	4.4.7	5.5.7		
DURABILITY, of				
- MECHANICAL CHARACTERISTICS, against				
- vibration	4.5.2.5.5	5.4.3 Table 19	*CCM*	*CCM*
- corrosion	4.5.2.3.2	Table 20	*CCM*	*CCM*
- extreme temperature	4.5.2.1	Table 13 and Table 23	*T3, T4*	*T2*
- ingress of water and dust	4.5.2.4	Table 14 Table 21 and	*IP55*	*IP56*

Recommended summary of class combinations

Datexxxx 20xx

spreadsheet 1: Characteristics of products determined by the product-type on the basis of type testing and FPC

Essential characteristic	Clause	Assessment method	Declaration of results	
			LED single colour	RGB-LED mixed colour
		Table 22		
- VISIBILITY CHARACTERISTICS, against				
- colour, luminance, luminance ratio	4.4.8	5.1 pt 8)	*CCM*	*CCM*

NOTE Figures and text written in *italic style* are meant as example

Figure R.1— Example of summary of the characteristics of products

Figure R.2 is showing an example for summary of visual performance class combinations of a VMS for outdoor and tunnel application, using LED-technology with monochrome colours.

Recommended summary of class combinations
Datexxxx 20xx

CLASS COMBINATIONS TESTED IN ACCORDANCE WITH 5.5 OF EN 12966:2014

Spreadsheet 2: class combinations for LED-VMS for outdoor and tunnel use, colours of elements created by singular monochrome LEDs

LED- based VMS using single colours
See details at test report *abc* dated *ddmmyy*

element spacing ***20.0 mm***

colour	offset of optical axis [°]	dimming mode	illuminance / angle [lx] / [°]	declared classes in accordance with 4.4.3 L	4.4.4 LR	4.4.2 C	4.4.5 B	4.4.6 U	4.4.7 F	operating current [mA]	ratio of maximum allowed LED-current
white	*2.0*	*pulse*	**40 000 / 10**	*L2(*)*	*R2*[1]	*wC1*[2]	*B3*	*CCM*	*CCM*	*20,0*	*66 %*
			10 000 / 5							*18,0*	*60 %*
			400 / 10	*L2(*), L2(T)*				*CCM*		*1,5*	*5,0 %*
			< 4 / 10			*wC1*				*0,1*	*0,33 %*
yellow	*2.0*	*pulse*	**40 000 / 10**	*L2(*)*	*R2*[1]	*yC2*[2]	*B3*	*CCM*	*CCM*	*15,0*	*50 %*
			10 000 / 5							*15,0*	*50 %*
			400 / 10	*L2(*), L2(T)*				*CCM*		*1,0*	*3,3 %*
			< 4 / 10			*yC2*				*0,06*	*0,2 %*
orange	*2.0*	*pulse*	**40 000 / 10**	*L2(*)*	*R2*[1]	*oC2*[2]	*B3*	*CCM*	*CCM*	*22,0*	*44 %*
			10 000 / 5							*20,0*	*40%*
			400 / 10	*L2(*), L2(T)*				*CCM*		*1,8*	*3,6%*
			< 4 / 10			*oC2*				*0,15*	*0,3%*
green	*2.0*	*pulse*	**40 000 / 10**	*L2(*)*	*R2*[1]	*gC1*[2]	*B3*	*CCM*	*CCM*	*10,0*	*33%*
			10 000 / 5							*10,0*	*33%*
			400 / 10	*L2(*), L2(T)*				*CCM*		*0,8*	*2,7%*
			< 4 / 10			*gC1*				*0,03*	*0,1%*
red	*2.0*	*pulse*	**40 000 / 10**	*L2(*)*	*R2*[1]	*r2*[2]	*B3*	*CCM*	*CCM*	*11,0*	*22%*
			10 000 / 5							*11,0*	*22%*
			400 / 10	*L2(*), L2(T)*				*CCM*		*0,9*	*1,8%*
			< 4 / 10			*rC2*				*0,05*	*0,1%*
blue	*2.0*	*pulse*	**40 000 / 10**	*L2(*)*	*R2*[1]	*bC2*[2]	*B3*	*CCM*	*CCM*	*21,0*	*70&*
			10 000 / 5							*18,0*	*60%*
			400 / 10	*L2(*), L2(T)*				*CCM*		*1,8*	*6,0%*
			< 4 / 10			*bC2*				*0,12*	*0,4%*

NOTE All white cells in above table 2 are filled in accordance with the results of the test report referred to in the header; figures and text written in *italic style* are meant as example

[1] Luminance ratio classes are equal for both illumination adjustments; if values *LR* and *LR(*)* are different, the lower value determines the LR class

[2] Colour classes per colour are equal for all illumination adjustments; if different values are shown in the test report, the less restrictive one applies.

Figure R.2 — Example 1 for visual performance class combination

Figure R.3 is showing an example for the summary of visual performance class combinations of a VMS for tunnel application, using LED-technology with monochrome colours.

Recommended summary of class combinations
Datexxxx 20xx

CLASS COMBINATIONS TESTED IN ACCORDANCE WITH 5.5 OF EN 12966:2014

Spreadsheet 3: class combinations for LED-VMS designed for tunnel use, colours of elements created by singular monochrome LEDs

LED- based VMS using single colours, tunnel application only
See details at test report *def* **dated** *ddmmyy*

element spacing ***16.0 mm***

colour	offset of optical axis [°]	dimming mode	illuminance / angle [lx] / [°]	declared classes in accordance with 4.4.3 L	4.4.4 LR	4.4.2 C	4.4.5 B	4.4.6 U	4.4.7 F	operating current [mA]	ratio of maximum allowed LED-current
white	*0.0*	*analogue dimming*	**400 / 10**	*L3(T)*		*C1*[3]	*B6*	*CCM*	*CCM*	*1,5*	*5,0 %*
			< 4 / 10							*0,1*	*0,33 %*
yellow	*0.0*	*analogue dimming*	**400 / 10**	*L3(T)*		*C1*[3]	*B6*	*CCM*	*CCM*	*1,8*	*6,0 %*
			< 4 / 10							*0,12*	*0,4 %*
orange	*0.0*	*analogue dimming*	**400 / 10**	*L3(T)*		*C1*[3]	*B6*	*CCM*	*CCM*	*1,2*	*4,0 %*
			< 4 / 10							*0,09*	*0,3 %*
green	*0.0*	*analogue dimming*	**400 / 10**	*L3(T)*		*C1*[3]	*B6*	*CCM*	*CCM*	*0,9*	*3,0 %*
			< 4 / 10							*0,06*	*0,2 %*
red	*0.0*	*analogue dimming*	**400 / 10**	*L3(T)*		*C1*[3]	*B6*	*CCM*	*CCM*	*2,1*	*7,0 %*
			< 4 / 10							*0,18*	*0,6 %*
blue	*0.0*	*analogue dimming*	**400 / 10**	*L3(T)*		*C1*[3]	*B6*	*CCM*	*CCM*	*2,4*	*8,0 %*
			< 4 / 10							*0,15*	*0,5 %*

NOTE All white cells in table 3 above are filled in accordance with to the results of the test report referred to in the header; figures and text written in italic style are meant as example

[3] Colour classes per colour are equal for all illumination adjustments per colour; if different values are shown in the test report, the less restrictive one applies.

Figure R.3 — Example 2 for visual performance class combination

Figure R.4 is showing an example for the summary of visual performance class combinations of a VMS for out-door and tunnel application, using LED-technology with mixed colours.

Recommended summary of class combinations
Datexxxx 20xx

CLASS COMBINATIONS TESTED IN ACCORDANCE WITH 5.5 OF EN 12966:2014

spreadsheet 4: class combinations for LED-VMS designed for outdoor and tunnel use, colours created by mixing colours of monochrome LEDs

LED- based VMS using mixed colours
See details at test report *ghi* **dated** *ddmmyy*

element spacing ***25.5 mm***

colour	offset of optical axis [°]	dimming mode	illuminance / angle [lx] / [°]	declared classes in accordance with 4.4.3 L	4.4.4 LR	4.4.2 C	4.4.5 B	4.4.6 U	4.4.7 F	operating current [mA]	ratio of maximum allowed LED-current Red	green	blue	yellow
white	*1.0*	*pulse*	**40 000 / 10**	*L3(*)*	*R3*[4]	*C2*[5]	*B4*	*CCM*	*CCM*	*53,5*	*46,2 %*	*51,7 %*	*35,1 %*	-
			10 000 / 5							*46,5*	*40,2 %*	*45,0 %*	*30,6 %*	-
			400 / 10	*L3(*), L3(T)*				*CCM*		*2,8*	*2,4 %*	*2,7 %*	*1,8 %*	-
			< 4 / 10			*C2*				*0,6*	*0,5 %*	*0,5 %*	*0,4 %*	-
yellow	*1.0*	*pulse*	**40 000 / 10**	*L3(*)*	*R3*[4]	*C2*[5]	*B4*	*CCM*	*CCM*	*18,3*	-	-	-	*61,0 %*
			10 000 / 5							*16,5*	-	-	-	*54,9 %*
			400 / 10	*L3(*), L3(T)*				*CCM*		*1,0*	-	-	-	*3,3 %*
			< 4 / 10			*C2*				*0,2*	-	-	-	*0,7 %*
orange	*1.0*	*pulse*	**40 000 / 10**	*L3(*)*	*R3*[4]	*C2*[5]	*B4*	*CCM*	*CCM*	*26,3*	*46,2 %*	-	-	*10,7 %*
			10 000 / 5							*23,9*	*42,0 %*	-	-	*9,7 %*
			400 / 10	*L3(*), L3(T)*				*CCM*		*1,4*	*2,5 %*	-	-	*0,6 %*
			< 4 / 10			*C2*				*0,3*	*0,5 %*	-	-	*0,1 %*
green	*1.0*	*pulse*	**40 000 / 10**	*L3(*)*	*R3*[4]	*C2*[5]	*B4*	*CCM*	*CCM*	*11,2*	-	*32,0 %*	-	-
			10 000 / 5							*10,6*	-	*30,4 %*	-	-
			400 / 10	*L3(*), L3(T)*				*CCM*		*0,6*	-	*1,8 %*	-	-
			< 4 / 10			*C2*				*0,1*	-	*0,4 %*	-	-
red	*1.0*	*pulse*	**40 000 / 10**	*L3(*)*	*R3*[4]	*C2*[5]	*B4*	*CCM*	*CCM*	*23,1*	*46,2 %*	-	-	-
			10 000 / 5							*21,5*	*43,0 %*	-	-	-
			400 / 10	*L3(*), L3(T)*				*CCM*		*1,3*	*2,6 %*	-	-	-
			< 4 / 10			*C2*				*0,3*	*0,5 %*	-	-	-
blue	*1.0*	*pulse*	**40 000 / 10**	*L3(*)*	*R3*[4]	*C2*[5]	*B4*	*CCM*	*CCM*	*15,1*	-	-	*43,1 %*	-
			10 000 / 5							*13,1*	-	-	*37,5 %*	-
			400 / 10	*L3(*), L3(T)*				*CCM*		*0,8*	-	-	*2,3 %*	-
			< 4 / 10			*C2*				*0,2*	-	-	*0,5 %*	-

NOTE All white cells in table 4 above have to be filled in accordance with the test report referred to in the header; figures and text written in *italic style* are meant as example

[4] Luminance ratio classes have to be equal for both illumination adjustments; if values *LR* and *LR(*)* are different, the lower value determines the declared LR class

[5] Colour classes have to be equal for both illumination adjustments; if different values are shown in the test report, the less restrictive one applies.

Figure R.4 — Example 3 for visual performance class combination

Figure R.5 is showing an example for the summary of visual performance class combinations of a VMS for tunnel application, using LED-technology with mixed colours (RGB).

Recommended summary of class combinations
Datexxxx 20xx

CLASS COMBINATIONS TESTED IN ACCORDANCE WITH 5.5 OF EN 12966:2014

spreadsheet 5: class combinations for LED-VMS designed for tunnel use, colours of elements created by mixing colours of monochrome LED

LED- based VMS using single colours, tunnel application only
See details at test report *def* dated *ddmmyy*

element spacing ***18,0 mm***

colour	offset of optical axis [°]	dimming mode	illuminance / angle [lx] / [°]	declared classes in accordance with 4.4.3 L	4.4.4 LR	4.4.2 C	4.4.5 B	4.4.6 U	4.4.7 F	operating current [mA]	ratio of maximum allowed LED-current Red	green	blue
white	*0.0*	*pulse*	**400 / 10**	*L1(T)*		wC1[6]	*B3*	*CCM*	*CCM*	*11,2*	*10,2 %*	*12,7 %*	*7,7 %*
			< 4 / 10							*1,7*	*1,5 %*	*1,9 %*	*1,2 %*
yellow	*0.0*	*pulse*	**400 / 10**	*L1(T)*		yC2[6]	*B3*	*CCM*	*CCM*	*6,6*	*10,2 %*	*5,1 %*	-
			< 4 / 10							*1,0*	*1,5 %*	*0,8 % %*	-
orange	*0.0*	*pulse*	**400 / 10**	*L1(T)*		oC2[6]	*B3*	*CCM*	*CCM*	*8,3*	*10,2 %*	*2,5 %*	-
			< 4 / 10							*0,9*	*1,5 %*	*0,4 %*	-
green	*0.0*	*pulse*	**400 / 10**	*L1(T)*		gC1[6]	*B3*	*CCM*	*CCM*	*3,0*	-	*10,1 %*	-
			< 4 / 10							*0,3*	-	*1,0 %*	-
red	*0.0*	*pulse*	**400 / 10**	*L1(T)*		rC2[6]	*B3*	*CCM*	*CCM*	*5,1*	*10,2 %*	-	-
			< 4 / 10							*0,8*	*1,5 %*	-	-
blue	*0.0*	*pulse*	**400 / 10**	*L1(T)*		bC1[6]	*B3*	*CCM*	*CCM*	*3,2*	-	-	*10,7 %*
			< 4 / 10							*0,5*	-	-	*1,6 %*

NOTE All white cells in table 5 above have to be filled in accordance with the test report referred to in the header; figures and text written in *italic style* are meant as example

[6] Colour classes have to be equal for both illumination adjustments; if different values are shown in the test report, the less restrictive one applies.

Figure R.5 — Example 4 for visual performance class combination

Annex ZA
(informative)

Clauses of this European Standard addressing the provisions of the EU Construction Products Regulation

ZA.1 Scope and relevant characteristics

This European Standard has been prepared under Mandate M/111 given to CEN by the European Commission and the European Free Trade Association.

If this European Standard is cited in the Official Journal of the European Union (OJEU), the clauses of this standard, shown in this annex, are considered to meet the provisions of the relevant mandate, under the Regulation (EU) No. 305/2011.

This annex deals with the CE marking of the VMS intended for the uses indicated in Table ZA.1.1 and in Table ZA.1.2 and shows the relevant clauses applicable.

This annex has the same scope as Clause 1 of this standard, related to the aspects covered by the mandate, and is defined by Table ZA.1.1 and Table ZA.1.2.

Table ZA.1.1 — Relevant clauses for continuous VMS

Construction product: Continuous variable message traffic signs (continuous VMS) **Intended use**: Mobile, temporary or permanently installed VMS, used in circulation areas on public or private land including tunnels, for the information, guidance, warning and/or direction of traffic.			
Essential Characteristics	**Clauses in this and other European Standard(s) related to essential characteristics**	**Regul-atory classes**	**Notes**
Release of dangerous substances	4.6	–	as relevant in accordance with 4.6
Resistance to horizontal loads, for:			
- temporary deflections caused by wind loads	4.5.2.5.2	–	tested and declared in accordance with EN 12899-1:2007, 5.3.1
- Permanent deflections caused by dynamic snow loads	4.5.2.5.3	–	tested and declared in accordance with EN 12899-1:2007, 5.3.2
- Temporary bending deflection	4.5.2.5.2	–	tested and declared in accordance with EN 12899-1:2007, 5.4.1
Performance under impact, dealt with by:			
- Impact resistance	4.5.2.5.4	–	tested in acc. with 5.4.3 Table 18 and declared as “CCM“
Visibility characteristics, by:			
- Chromaticity coordinates and luminance, dealt with by:			
Daylight chromaticity &	4.3	–	tested and declared in acc. with EN 12899-1:2007, 4 [a)]

Construction product: Continuous variable message traffic signs (continuous VMS)

Intended use: Mobile, temporary or permanently installed VMS, used in circulation areas on public or private land including tunnels, for the information, guidance, warning and/or direction of traffic.

Essential Characteristics		Clauses in this and other European Standard(s) related to essential characteristics	Regul-atory classes	Notes
luminance factor			–	tested and declared in accordance with EN 12899-1:2007, 7.2.2.1.3 [b)]
			–	tested and declared in acc. with EN 12899-1:2007, 7.3.1.3 [c)]
Mean	luminance		–	tested and declared in acc. with EN 12899-1:2007, 7.3.1.4 [c)]
	illuminance		–	tested and declared in acc. with EN 12899-1:2007, 7.4.1.2 [d)]
Luminance contrast			–	tested and declared in acc. with EN 12899-1:2007, 7.3.1.5 [c)]
Uni-formity	luminance		–	tested and declared in acc. with EN 12899-1:2007, 7.3.1.6 [c)]
	illuminance		–	tested and declared in acc. with EN 12899-1:2007, 7.4.1.3 [d)]
Retro reflectivity		4.3	–	tested and declared in acc. with EN 12899-1:2007, 4 [e)]
Durability, of:				
- Mechanical characteristics, against:				
vibration		4.5.2.5.5	–	tested in accordance with Table 19 and declared as “CCM“
corrosion		4.5.2.3.1	–	declared the material, system of protection and class in accordance with EN 12899-1:2007, 7.1.7 Table 15
extreme temperature		4.5.2.1		tested and declared in accordance with Table 13 and the requirements in Table 23
ingress of water and dust		4.5.2.4	–	tested in accordance with Table 21 and Table 22, and declared as selected class in Table 14
- Visibility characteristics, against:				
accelerated weathering		4.3	–	refer to EN 12899-1:2007 4.1.1.5, 7.2.2.1.4 or 7.3.1.8 as applicable and declared as “CCM“

a) VMS externally illuminated or using retro-reflective sign-face material.
b) VMS externally illuminated or using non-retro-reflective sign-face material.
c) VMS using trans-illuminated technology.
d) VMS externally illuminated.
e) VMS using retro-reflective sign-face material.

Table ZA.1.2 — Relevant clauses for discontinuous VMS

Construction product: Discontinuous variable message traffic signs (discontinuous VMS) **Intended use**: Mobile, temporary or permanently installed VMS, used in circulation areas on public or private land including tunnels, for the information, guidance, warning and/or direction of traffic.			
Essential Characteristics	**Clauses in this and other European Standard(s) related to essential characteristics**	**Regul-atory classes**	**Notes**
Release of dangerous substances	4.6	–	as relevant in accordance with 4.6
RESISTANCE TO HORIZONTAL LOADS, for:			
- temporary deflections caused by wind loads	4.5.2.5.2	–	declared as appropriate class selected from EN 12899-1:2007, 5.3.1
– permanent deflections caused by dynamic snow loads	4.5.2.5.3	–	declared as appropriate class selected from EN 12899-1:2007, 5.3.2
– temporary bending deflection	4.5.2.5.2	–	declared as appropriate class selected from EN 12899-1:2007, 5.4.1
PERFORMANCE UNDER IMPACT, dealt with by:			
– impact resistance	4.5.2.5.4	–	tested in acc. with 5.4.3 Table 18 and declared as “CCM“
VISIBILITY CHARACTERISTICS, by:			
– Chromaticity coordinates, dealt with by:			
Colour	4.4.2	–	tested in accordance with 5.5.3 and declared as appropriate class Cx in accordance with Table 1
– Luminance, dealt with following visual characteristics:			
Luminance	4.4.3	–	tested in accordance with 5.5.4 and declared as appropriate class Lx in accordance with Table 1
luminance ratio	4.4.4	–	tested in accordance with 5.5.4 and declared as appropriate class Rx in accordance with Table 1
beam width	4.4.5	–	tested in accordance with 5.5.5 and declared as appropriate class Bx in accordance with Table 1
uniformity	4.4.6	–	tested in accordance with 5.5.6 and declared as “compliance with tests A and B”
visible flicker	4.4.7	–	assessed in accordance with 5.5.7 and declared in accordance with 4.4.7
DURABILITY, of:			
– Mechanical characteristics, against:			
vibration	4.5.2.5.5	–	tested in accordance with Table 19 and declared as “CCM“
corrosion	4.5.2.3.2	–	tested in accordance with Table 20 and declared as “CCM“
extreme temperature	4.5.2.1		tested and declared in accordance with Table 13 and requirements in Table 23

Construction product: Discontinuous variable message traffic signs (discontinuous VMS) **Intended use**: Mobile, temporary or permanently installed VMS, used in circulation areas on public or private land including tunnels, for the information, guidance, warning and/or direction of traffic.			
Essential Characteristics	**Clauses in this and other European Standard(s) related to essential characteristics**	**Regul-atory classes**	**Notes**
ingress of water and dust	4.5.2.4	–	tested in accordance with Table 21 and Table 22, and declared as selected class in Table 14
– Visibility characteristics, against:			
cause for degradation of colour, luminance and luminance ratio	4.4.8	–	tested in accordance with 5.1 point 8) and declared as “CCM“

The declaration of the product performance related to certain essential characteristics is not required in those Member States (MS) where there are no regulatory requirements on these essential characteristics for the intended use of the product.

In this case, manufacturers placing their products on the market of these MS are not obliged to determine nor declare the performance of their products with regard to these essential characteristics and the option “No performance determined” (NPD) in the information accompanying the CE marking and in the declaration of performance (see ZA.3) may be used for those essential characteristics.

ZA.2 Procedure for AVCP of VMS

ZA.2.1 System of AVCP

The system of AVCP of VMS defined in Table ZA.1.1 (continuous VMS) or Table ZA.1.2 (discontinuous VMS) in accordance with the decision of the European Commission 96/579/EC of 1996-06-24 (*see OJEU L254 of 1996-10-08*), as amended by 1999/453/EC of 1999-06-18 (*see OJEU L178 of 1999-07-14*), is shown in Table ZA.2 for the indicated intended use and relevant level or class.

Table ZA.2 — System of AVCP

Product(s)	**Intended use(s)**	**Level(s) or class(es)**	**AVCP system**
Road traffic signs and traffic control devices installed for vehicular and pedestrian traffic uses: - variable message traffic signs	For circulation areas	-	1
System 1: See Regulation (EU) No. 305/2011 (CPR) Annex V, 1.2 .			

The attestation of conformity of the variable message traffic signs defined in Table ZA.1.1 (continuous VMS) or Table ZA.1.2 (discontinuous VMS), shall be in accordance with the assessment and verification of constancy of performance (AVCP) procedure indicated in Table ZA.3 resulting from application of the clauses of this European Standard indicated herein.

The AVCP of the VMS in Table ZA.1.1 (continuous VMS) or Table ZA.1.2 (discontinuous VMS) shall be in accordance with the AVCP procedures indicated in Table ZA.3 resulting from application of the clauses of this or other European Standard indicated therein. The content of tasks of the notified body shall be limited to those essential characteristics as provided for, if any, in Annex III of the relevant mandate and to those that the manufacturer intends to declare.

Table ZA.3 — Assignment of AVCP tasks for VMS under system 1

Tasks		Content of the task	AVCP clauses to apply
Tasks for the manufacturer	Factory production control (FPC)	Parameters related to characteristics of Table ZA.1.1 (continuous VMS) or Table ZA.1.2 (discontinuous VMS), relevant for the intended use, the performances of which are declared	6.3
	Further testing of samples taken at the factory in accordance with the prescribed test-plan	Characteristics of Table ZA.1.1 (continuous VMS) or Table ZA.1.2 (discontinuous VMS) relevant for the intended use, the performances of which are declared	6.3.2.6
Tasks for the Notified Product certification Body	determination of the product-type on the basis of type testing (including sampling), type calculation, tabulated values or descriptive documentation of the product	Characteristics of Table ZA.1.1 (continuous VMS) or Table ZA.1.2 (discontinuous VMS), relevant for the intended use, the performances of which are declared	6.2
	Initial inspection of factory and of FPC	Parameters related to characteristics of Table ZA.1.1 (continuous VMS) or Table ZA.1.2 (discontinuous VMS), relevant for the intended use, the performances of which are declared. Documentation of FPC	6.3.4
	Continuous surveillance, assessment and evaluation of FPC	Parameters related to characteristics of Table ZA.1.1 (continuous VMS) or Table ZA.1.2 (discontinuous VMS), relevant for the intended use, the performances of which are declared. Documentation of FPC	6.3.5

ZA.2.2 Declaration of performance (DoP)

ZA.2.2.1 General

The manufacturer draws up the DoP and affixes the CE marking on the basis of the different AVCP systems set out in Annex V of the Regulation (EU) No 305/2011:

— the factory production control and further testing of samples taken at the factory in accordance with the prescribed test plan, carried out by the manufacturer; and

— the certificate of constancy of performance issued by the notified product certification body on the basis of determination of the product type on the basis of type testing (including sampling), type calculation, tabulated values or descriptive documentation of the product; initial inspection of the manufacturing plant and of factory production control and continuous surveillance, assessment and evaluation of factory production control.

ZA.2.2.2 Content

The model of the DoP is provided in Annex III of the Regulation (EU) No 305/2011.

According to this Regulation, the DoP shall contain, in particular, the following information:

— the reference of the product-type for which the declaration of performance has been drawn up;

— the AVCP system or systems of the construction product, as set out in Annex V of the CPR;

— the reference number and date of issue of the harmonised standard which has been used for the assessment of each essential characteristic;

— where applicable, the reference number of the Specific Technical Documentation used and the requirements with which the manufacturer claims the product complies.

The DoP shall in addition contain:

(a) the intended use or uses for the construction product, in accordance with the applicable harmonised technical specification;

(b) the list of essential characteristics, as determined in the harmonised technical specification for the declared intended use or uses;

(c) the performance of at least one of the essential characteristics of the construction product, relevant for the declared intended use or uses;

(d) where applicable, the performance of the construction product, by levels or classes, or in a description, if necessary based on a calculation in relation to its essential characteristics determined in accordance with the Commission determination regarding those essential characteristics for which the manufacturer shall declare the performance of the product when it is placed on the market or the Commission determination regarding threshold levels for the performance in relation to the essential characteristics to be declared.

(e) the performance of those essential characteristics of the construction product which are related to the intended use or uses, taking into consideration the provisions in relation to the intended use or uses where the manufacturer intends the product to be made available on the market;

(f) for the listed essential characteristics for which no performance is declared, the letters "NPD" (No Performance Determined);

Regarding the supply of the DoP, article 7 of the Regulation (EU) No 305/2011 applies.

The information referred to in Article 31 or, as the case may be, in Article 33 of Regulation (EC) No 1907/2006, (REACH) shall be provided together with the DoP.

ZA.2.2.3 Example of DoP

The following gives an example of a filled-in DoP for VMS

DECLARATION OF PERFORMANCE

No. nnn yyyy

1. Unique identification code of the product-type:

Discontinuous variable message traffic sign

Product no. ABC987

2. Type, batch or serial number or any other element allowing identification of the construction product as required under Article 11 (4):

Project no. XYZ123

Serial no. 12345

3. Intended use or uses of the construction product, in accordance with the applicable harmonised technical specification, as foreseen by the manufacturer:

Mobile, temporary or permanently installed VMS, used in circulation areas on public or private land including tunnels, for the information, guidance, warning and/or direction of traffic

4. Name, registered trade name or registered trade mark and contact address of the manufacturer as required under Article 11 (5):

AnyCo SA,

PO Box 21

B-1050 Brussels, Belgium

Tel. +32987654321

Fax: +32123456789

Email: anyco.sa@manufacturer.be

5. Where applicable, name and contact address of the authorised representative whose mandate covers the tasks specified in Article 12 (2):

Anyone Ltd

Flower Str. 24

West Hamfordshire

UK-589645 United Kingdom

Tel. +44987654321

Fax: +44123456789

e-mail: anyone.ltd@ manufacturer.uk

6. System or systems of assessment and verification of constancy of performance of the construction product as set out in CPR, Annex V:

System 1

7. In case of the declaration of performance concerning a construction product covered by a harmonised standard:

Notified product certification body No. 5678 performed the determination of the product type on the basis of type testing as well as the initial inspection of the manufacturing plant and of factory production control and the continuous surveillance, assessment and evaluation of factory production control and issued the certificate of constancy of performance of the above sited VMS.

8. Not applicable

9. Declared performance

Essential characteristics	Performance	Harmonised technical specification
Release of dangerous substances	-	EN 12966:2014
RESISTANCE TO HORIZONTAL LOADS, for:		
- Temporary deflections caused by wind loads	WL7	

– Permanent deflections caused by dynamic snow loads	DSL2	
– Temporary bending deflection	TDB0	
PERFORMANCE UNDER IMPACT, dealt with by:		
– Impact resistance	CCM	
VISIBILITY CHARACTERISTICS, by:		
– Chromaticity coordinates, dealt with by:		
Colour	C2	
– Luminance, dealt with following visual characteristics:		
Luminance	L3(*)	
Luminance ratio	R3	
Beam width	B6	
Uniformity	CCM	
Visible flicker	CCM	
DURABILITY, of:		
– Mechanical characteristics, against:		
vibration	CCM	
corrosion	CCM	
extreme temperature	T1, T3	
ingress of water and dust	IP55	
– Visibility characteristics, against:		
Cause for degradation of colour, luminance and luminance ratio	CCM	

10. The performance of the product identified in points 1. and 2. is in conformity with the declared performance in point

This declaration of performance is issued under the sole responsibility of the manufacturer identified in point 4.

Signed for and on behalf of the manufacturer by:

……..…. …….. ……

(name and function). (place and date of issue) (signature)

ZA.3 CE marking and labelling

The CE marking symbol shall be in accordance with the general principles set out in Article 30 of Regulation (EC) No 765/2008 and shall be affixed visibly, legibly and indelibly:

- to the VMS

or

- to a label attached to it.

Where this is not possible or not warranted on account of the nature of the product, it shall be affixed:

- to the packaging

or

- to the accompanying documents.

NOTE Due to the size it is always possible to affix CE-marking to the VMS. This standard provides examples for the affixing of CE-marking to the VMS.

The CE marking shall be followed by:

a) the last two digits of the year in which it was first affixed,

b) the name and the registered address of the manufacturer, or the identifying mark allowing identification of the name and address of the manufacturer easily and without any ambiguity,

c) the unique identification code of the product-type

d) the reference number of the declaration of performance

e) the level or class of the performance declared

e1) **for continuous VMS:**

1) release of dangerous substances, as relevant in accordance with 4.6

2) resistance to horizontal loads, expressed as

- o temporary deflections caused by wind loads, declared as appropriate class selected of EN 12899-1:2007, 5.3.1;
- o permanent deflections caused by dynamic snow loads, declared as appropriate class selected of EN 12899-1:2007, 5.3.2;
- o temporary bending deflection, declared as appropriate class selected of EN 12899-1:2007, 5.4.1;

3) performance under impact, expressed as

- o impact resistance, tested acc. to 5.4.3 Table 18 and declared as “no damage observed”; abbreviation CCM (compliance criterion met) is used as declaration code;

4) visibility characteristics, expressed as

- o Chromaticity coordinates and luminance, dealt with by:
  - Daylight chromaticity & luminance factor, declared as appropriate class selected of EN 12899-1:2007, [a)], declared as appropriate class selected of EN 12899-1:2007, 7.2.2.1.3 [b)], declared as appropriate class selected of EN 12899-1:2007, 7.3.1.3 [c)]
  - Mean luminance, declared as appropriate class selected of EN 12899-1:2007, 7.3.1.4 [c)]
  - Mean illuminance, declared as appropriate class selected of EN 12899-1:2007, 7.4.1.2 [d)]
  - Luminance contrast, declared as appropriate class selected of EN 12899-1:2007, 7.3.1.5 [c)]
  - Uniformity luminance, declared as app. class selected of EN 12899-1:2007, 7.3.1.6 [c)]
  - Uniformity illuminance, declared as app. class selected of EN 12899-1:2007, 7.4.1.3 [d)]
- o retro-reflectivity, declared as appropriate class selected of EN 12899-1:2007, Clause 4 [e)]

NOTE For footnotes refer to footnotes in Table ZA.1.1.

5) durability, of

- o Mechanical characteristics, against

  - vibration, tested in accordance with Table 19 and declared “no alterations observed” ; abbreviation CCM (compliance criterion met) is used as declaration code;

  - corrosion, surface protection declared by the material and the system of protection and class in accordance with EN 12899-1:2007, 7.1.7 Table 15

  - extreme temperature, declared as appropriate class selected of Table 13 in accordance with requirements in Table 23

  - ingress of and dust (IP) provided by enclosures, tested in accordance with EN 60529, and declared as selected class in Table 14

- o Visibility characteristics, against

  - accelerated weathering, refer to EN 12899-1:2007, 4 to respectively to EN 12899-1:2007, 7.2.2.1.4 or to EN 12899-1:2007, 7.3.1.8 and declared as “no deviation observed”; abbreviation CCM (compliance criterion met) is used as declaration code;

e2) **for discontinuous VMS:**

1) release of dangerous substances, as relevant in accordance with 4.6

2) resistance to horizontal loads, expressed as

- o temporary deflections caused by wind loads loads, declared as appropriate class selected of EN 12899-1:2007, 5.3.1;

- o permanent deflections caused by dynamic snow loads, declared as appropriate class selected of EN 12899-1:2007, 5.3.2;

- o temporary bending deflection, declared as appropriate class selected of EN 12899-1:2007, 5.4.1;

3) performance under impact, expressed as

- o impact resistance, tested acc. to 5.4.3 Table 18 and declared as “no damage observed” ; abbreviation CCM (compliance criterion met) is used as declaration code;

4) visibility characteristics, by:

- o Chromaticity coordinates, dealt with by:

  - Colour, tested in accordance with 5.5.3 declared as appropriate class selected of Table 1

- o Luminance, dealt with the following visual characteristics:

  - Luminance, tested in accordance with 5.5.4 declared as appropriate class selected of Table 1

  - Luminance ratio, tested in accordance with 5.5.4 declared as appropriate class selected of Table 1

  - Beam width, tested in accordance with 5.5.5 declared as appropriate class selected of Table 1

- Uniformity, tested in accordance with 5.5.6 and declared as “compliance with Tests A and B”; abbreviation CCM (compliance criterion met) is used as declaration code;

- Visible flicker, visually checked and declared as “no flicker observed” ; abbreviation CCM (compliance criterion met) is used as declaration code;

5) durability, of

o Mechanical characteristics, against

- vibration, tested in accordance with Table 19 and declared as “no alteration observed” ; abbreviation CCM (compliance criterion met) is used as declaration code;

- corrosion, tested in accordance with Table 20 and declared as “no corrosion observed” ; abbreviation CCM (compliance criterion met) is used as declaration code;

- extreme temperature, declared as appropriate class selected of Table 13 in accordance with requirements in Table 23

- ingress of water and dust (IP) provided by enclosures, tested in accordance with EN 60529, and declared as selected class in Table 14

o Visibility characteristics, against

- cause for degradation of colour, luminance and luminance ratio, tested in accordance with 5.1 point 8) declared as “No change of classification” ; abbreviation CCM (compliance criterion met) is used as declaration code;

f) the dated reference to the harmonised technical specification applied

g) the identification number of the notified body

h) the intended use as laid down in the harmonised technical specification applied.

The CE marking shall be affixed before the construction product is placed on the market. It may be followed by a pictogram or any other mark notably indicating a special risk or use.

Figure ZA.1 to Figure ZA.6 present examples of the information related to products subject to AVCP system 1 to be affixed to the VMS.

Figure ZA.1 and Figure ZA.4 give examples of such CE marking affixed to a continuous retro-reflective VMS, Figure ZA.2 and Figure ZA.5 give examples of such CE marking affixed to a continuous, externally illuminated retro-reflective VMS, Figure ZA.3 and Figure ZA.6 give examples of such CE marking affixed to a discontinuous VMS.

CE 4321 AnyCo Ltd, Address 14 No. nnn yyyy EN 12966:2014 Continuous retro-reflective VMS, mobile, temporary or permanently installed, used in circulation areas on public or private land including tunnels, for the information, guidance, warning and/or direction of traffic **Product no. DEF987**		*CE conformity marking symbol given in Directive 93/68/EEC* *Identification number of the notified product certification body* *Name or identifying mark of the manufacturer and the registered address allowing identification of the manufacturer easily and without any ambiguity* *Last two digits of the year in which the marking was first affixed* *the reference number of the declaration of performance* *Number of the European Standard and the year of its publication* *Description of the product and its intended use* *Unique identification code of the product-type*
Release of dangerous substances(*): substance x	0,02ppm	*(*) Needs only to be declared if there is at least one required dangerous substance which obliges the manufacturer to declare, as relevant in accordance with 4.6*
Resistance to horizontal loads, for:		*Performances of the following essential characteristics, which are to be declared*
- temporary deflections caused by wind loads	WL7	
- permanent deflections caused by dynamic snow loads	DSL2	
- temporary bending deflection	TDB3	
Performance under impact, as:		
- impact resistance	No damage observed (CCM)	
Visibility characteristics, as:		
a) CHROMATICITY COORDINATES AND LUMINANCE AS:		
- daylight chromaticity & luminance factor:	CR1	
b) RETRO REFLECTIVITY:		
- application classes / coefficient of retro-reflection	RA2	
Durability, of		
a) MECHANICAL CHARACTERISTICS, AGAINST:		

- vibration	No alterations observed (CCM)	
- corrosion	SP1	
- extreme temperature	T1	
- ingress of water and dust	IP56	
b) VISIBILITY CHARACTERISTICS, AGAINST:		
- accelerated weathering (natural, 3 years)	No deviation observed (CCM)	

Figure ZA.1 — Example of CE marking affixed to a continuous retro-reflective VMS

CE		*CE conformity marking symbol given in Directive 93/68/EEC*
4321		*Identification number of the notified product certification body*
AnyCo Ltd, Address		*Name or identifying mark of the manufacturer and the registered address allowing identification of the manufacturer easily and without any ambiguity*
14		*Last two digits of the year in which the marking was first affixed*
No. nnn yyyy		*the reference number of the declaration of performance*
EN 12966:2014		*Number of the European Standard and the year of its publication*
Continuous, externally illuminated retro-reflective VMS, mobile, temporary or permanently installed, used in circulation areas on public or private land including tunnels, for the information, guidance, warning and/or direction of traffic		*Description of the product and its intended use*
Product no. GHI987		*Unique identification code of the product-type*
Release of dangerous substances(*): substance x	0,02ppm	*(*) Needs only to be declared if there is at least one required dangerous substance which obliges the manufacturer to declare, as relevant in accordance with 4.6*
Resistance to horizontal loads, for:		*Performances of the following essential characteristics, which are to be declared*
- temporary deflections caused by wind loads	WL7	
- permanent deflections caused by dynamic snow loads	DSL2	
- temporary bending deflection	TDB3	
Performance under impact, as:		
- impact resistance	No damage observed (CCM)	
Visibility characteristics, as:		

a) CHROMATICITY COORDINATES AND LUMINANCE AS:	
- daylight chromaticity & luminance factor:	CR1
- mean illuminance	E3
- uniformity illuminance	UE2
b) RETRO REFLECTIVITY:	
- application classes / coefficient of retro-reflection	RA2
Durability, of	
a) MECHANICAL CHARACTERISTICS, AGAINST:	
- vibration	No alterations observed (CCM)
- corrosion	SP1
- extreme temperature	T1
- ingress of water and dust	IP56
b) VISIBILITY CHARACTERISTICS, AGAINST:	
- accelerated weathering (natural, 3 years)	No deviation observed (CCM)

Figure ZA.2 — Example of CE marking affixed to a continuous, externally illuminated retro-reflective VMS

CE		*CE conformity marking symbol given in Directive 93/68/EEC*
4321		*Identification number of the notified product certification body*
AnyCo Ltd, Address		*Name or identifying mark of the manufacturer and the registered address allowing identification of the manufacturer easily and without any ambiguity*
14		*Last two digits of the year in which the marking was first affixed*
No. nnn yyyy		*the reference number of the declaration of performance*
EN 12966:2014		*Number of the European Standard and the year of its publication*
Discontinuous VMS, mobile, temporary or permanently installed, used in circulation areas on public or private land including tunnels, for the information, guidance, warning and/or direction of traffic		*Description of the product and its intended use*
Product no. ABC987		*Unique identification code of the product-type*
Release of dangerous substances(*): substance x	-	*(*) Needs only to be declared if there is at least one required dangerous substance which obliges the*

		manufacturer to declare, as relevant in accordance with 4.6
resistance to horizontal loads, for:		*Performances of the following essential characteristics, which are to be declared*
- temporary deflections caused by wind loads	WL7	
- permanent deflections caused by dynamic snow loads	DSL2	
- temporary bending deflection	TBD0	
Performance under impact, as:		
- impact resistance	No damage observed (CCM)	
Visibility characteristics, as:		
- colour:	wC1, yC2, oC2, gC1, rC2, bC2	
- luminance	L3(*)	
- luminance ratio	R3	
- beam width	B6	
- uniformity of luminous intensity	Compliance with tests A and B (CCM)	
- visible flicker	No flicker observed (CCM)	
Durability, of		
a) MECHANICAL CHARACTERISTICS, AGAINST:		
- vibration	No alterations observed (CCM)	
- corrosion	No corrosion observed (CCM)	
- extreme temperature	T1, T3	
- ingress of water and dust	IP55	
b) VISIBILITY CHARACTERISTICS, AGAINST:		
cause for degradation of colour, luminance and luminance ratio	No change in classification (CCM)	

Figure ZA.3 — Example of CE marking affixed to a discontinuous VMS

Alternatively the same information as given in Figure ZA.1 to Figure ZA.3 can be affixed to the VMS, using the code system established in Annex B.

CE 4321 AnyCo Ltd, Address 14 No. nnn yyyy **EN 12966:2014** Continuous retro-reflective VMS, mobile, temporary or permanently installed, used in circulation areas on public or private land including tunnels, for the information, guidance, warning and/or direction of traffic **Product no. DEF987**												*CE conformity marking symbol given in Directive 93/68/EEC* *Identification number of the notified product certification body* *Name or identifying mark of the manufacturer and the registered address allowing identification of the manufacturer easily and without any ambiguity* *Last two digits of the year in which the marking was first affixed* *the reference number of the declaration of performance* *Number of the European Standard and the year of its publication* *Description of the product and its intended use* *Unique identification code of the product-type*
0,02 ppm	WL7	DSL2	TDB3	CCM	CR1	RA2	CCM	SP1	T1	IP56	CCM	*Performance of the essential characteristics, which are declared, following the criteria of Annex I*

Figure ZA.4 — Example of CE marking affixed to a continuous retro-reflective VMS

CE 4321 AnyCo Ltd, Address 14 No. nnn yyyy **EN 12966:2013** Continuous, externally illuminated retro-reflective VMS, mobile, temporary or permanently installed, used in circulation areas on public or private land including tunnels, for the information, guidance, warning and/or direction of traffic **Product no. GHI987**														*CE conformity marking symbol given in Directive 93/68/EEC* *Identification number of the notified product certification body* *Name or identifying mark of the manufacturer and the registered address allowing identification of the manufacturer easily and without any ambiguity* *Last two digits of the year in which the marking was first affixed* *the reference number of the declaration of performance* *Number of the European Standard and the year of its publication* *Description of the product and its intended use* *Unique identification code of the product-type*
0,02 ppm	WL7	DSL2	TDB3	CCM	CR1	E3	UE2	RA2	CCM	SP1	T1	IP56	CCM	*Performance of the essential characteristics, which are declared, following the criteria of Annex I*

Figure ZA.5 — Example of CE marking affixed to a continuous, externally illuminated retro-reflective VMS

CE 4321 AnyCo Ltd, Address 14 No. nnn yyyy **EN 12966:2014** Discontinuous VMS, mobile, temporary or permanently installed, used in circulation areas on public or private land including tunnels, for the information, guidance, warning and/or direction of traffic **Product no. ABC987**																*CE conformity marking symbol given in Directive 93/68/EEC* *Identification number of the notified product certification body* *Name or identifying mark of the manufacturer and the registered address allowing identification of the manufacturer easily and without any ambiguity* *Last two digits of the year in which the marking was first affixed* *the reference number of the declaration of performance* *Number of the European Standard and the year of its publication* *Description of the product and its intended use* *Unique identification code of the product-type*
-	WL7	DSL2	TBD0	CCM	wC1, yC2, oC2 gC1, rC2, bC2	L3(*)	R3	B6	CCM	CCM	CCM	CCM	T1, T3	IP55	CCM	*Performance of the essential characteristics, which are declared, following the criteria of Annex I*

Figure ZA.6 — Example of CE marking affixed to a discontinuous VMS

Bibliography

List of references used in the text and of useful test methods.

[1] *Regulation (EU) No 305/2011 of the European Parliament and of the Council of 9 March 2011 laying down harmonised conditions for the marketing of construction products and repealing Council Directive 89/106/EEC*, OJ L 88, 4.4.2011, p. 5–43

[2] EN ISO 9001:2008, *Quality management systems - Requirements (ISO 9001:2008)*

[3] CIE S 004/E-2001, *Colours of Light Signals*

[4] CIE 018.2-1983, *The basis of physical photometry*

[5] *Vienna Convention on Road Signs and Signals*