



BSI Standards Publication

**Road vehicles — Ergonomic and performance
aspects of Camera Monitor Systems —
Requirements and test procedures**

National foreword

This British Standard is the UK implementation of ISO 16505:2019+A1:2021. It supersedes BS ISO 16505:2019, which is withdrawn.

The start and finish of text introduced or altered by amendment is indicated in the text by tags. Tags indicating changes to ISO text carry the number of the ISO amendment. For example, text altered by ISO amendment 1 is indicated by A1 A1.

The UK participation in its preparation was entrusted to Technical Committee AUE/1, Vehicle Lighting & Visibility.

A list of organizations represented on this committee can be obtained on request to its committee manager.

Contractual and legal considerations

This publication has been prepared in good faith, however no representation, warranty, assurance or undertaking (express or implied) is or will be made, and no responsibility or liability is or will be accepted by BSI in relation to the adequacy, accuracy, completeness or reasonableness of this publication. All and any such responsibility and liability is expressly disclaimed to the full extent permitted by the law.

This publication is provided as is, and is to be used at the recipient's own risk.

The recipient is advised to consider seeking professional guidance with respect to its use of this publication.

This publication is not intended to constitute a contract. Users are responsible for its correct application.

© The British Standards Institution 2021
Published by BSI Standards Limited 2021

ISBN 978 0 539 06568 8

ICS 13.180; 43.040.10

Compliance with a British Standard cannot confer immunity from legal obligations.

This British Standard was published under the authority of the Standards Policy and Strategy Committee on 31 August 2019.

Amendments/corrigenda issued since publication

Date	Text affected
31 August 2021	Implementation of ISO amendment 1:2021

**INTERNATIONAL
STANDARD**

**ISO
16505**

Second edition
2019-07-15

**Road vehicles — Ergonomic and
performance aspects of Camera
Monitor Systems — Requirements and
test procedures**

*Véhicules routiers — Aspects ergonomiques et de performance des
caméras embarquées — Exigences et procédures d'essai*



Reference number
ISO 16505:2019(E)

© ISO 2019



COPYRIGHT PROTECTED DOCUMENT

© ISO 2019, Published in Switzerland

All rights reserved. Unless otherwise specified, no part of this publication may be reproduced or utilized otherwise in any form or by any means, electronic or mechanical, including photocopying, or posting on the internet or an intranet, without prior written permission. Permission can be requested from either ISO at the address below or ISO's member body in the country of the requester.

ISO copyright office
Ch. de Blandonnet 8 • CP 401
CH-1214 Vernier, Geneva, Switzerland
Tel. +41 22 749 01 11
Fax +41 22 749 09 47
copyright@iso.org
www.iso.org

Contents

	Page
Foreword	v
Introduction	vi
1 Scope	1
2 Normative references	1
3 Terms and definitions	1
3.1 Vehicle related terms and definitions.....	1
3.2 Mirror related terms and definitions.....	2
3.3 Camera related terms and definitions.....	12
3.4 Monitor related terms and definitions.....	15
3.5 Camera Monitor System based terms and definitions.....	23
4 Symbols and abbreviated terms	33
5 General information and use case definitions	36
6 Requirements	40
6.1 System documentation.....	40
6.2 Intended use.....	41
6.2.1 Default view.....	41
6.2.2 Adjusted default view.....	41
6.2.3 Temporary modified view.....	41
6.2.4 Luminance and contrast adjustment.....	42
6.2.5 Overlays.....	42
6.3 Operating readiness (system availability).....	42
6.4 Field of view.....	43
6.5 Magnification and resolution.....	43
6.5.1 Average magnification factor.....	43
6.5.2 Minimum magnification factor.....	43
6.5.3 Resolution (MTF).....	44
6.6 Magnification aspect ratio.....	45
6.7 Monitor integration inside the vehicle.....	45
6.8 Image quality.....	46
6.8.1 Monitor isotropy.....	46
6.8.2 Luminance and contrast rendering.....	46
6.8.3 Colour rendering.....	47
6.8.4 Artefacts.....	48
6.8.5 Sharpness and depth of field.....	49
6.8.6 Geometric distortion.....	49
6.8.7 Further image quality requirements.....	49
6.9 Time behaviour.....	50
6.9.1 Frame rate.....	50
6.9.2 Image formation time.....	50
6.9.3 System latency.....	50
6.10 Failure behaviour.....	50
6.11 Quality and further ergonomic requirements.....	50
6.11.1 Needs of older persons.....	50
6.12 Influences from weather and environment.....	51
7 Test methods	51
7.1 System documentation.....	51
7.2 Intended use.....	51
7.2.1 Default view.....	51
7.2.2 Adjusted default view.....	51
7.2.3 Temporary modified view.....	51
7.2.4 Luminance and contrast adjustment.....	51
7.2.5 Overlays.....	52

7.3	Operating readiness (system availability).....	52
7.4	Field of view	53
7.5	Magnification and resolution.....	53
	7.5.1 Average magnification factor	53
	7.5.2 Minimum magnification factor	54
	7.5.3 Resolution (MTF)	56
7.6	Magnification aspect ratio.....	59
7.7	Monitor integration inside the vehicle	59
7.8	Image quality	59
	7.8.1 Monitor isotropy.....	59
	7.8.2 Luminance and contrast rendering	62
	7.8.3 Colour rendering.....	70
	7.8.4 Artefacts	73
	7.8.5 \overline{A}_T Sharpness and depth of field \overline{A}_T	74
	7.8.6 Geometric distortion	76
	7.8.7 Further Image quality requirements.....	76
7.9	Time behaviour	76
	7.9.1 Frame rate.....	76
	7.9.2 Image formation time	76
	7.9.3 System latency	76
7.10	Failure behaviour.....	77
7.11	Quality and further ergonomic requirements.....	78
	7.11.1 Needs of older persons.....	78
7.12	Influences from weather and environment	78
8	Functional safety	78
Annex A (normative) Standard application on UN Regulation No. 46 class II and IV mirrors in commercial vehicles		79
Annex B (informative) Formula applications, explanations, and guidelines		84
Annex C (informative) Calculation of the dimensional magnification and of a correction factor to obtain the angular magnification		118
Annex D (informative) Complementary information for resolution measurement		123
Annex E (informative) Correlation between Resolution (MTF) and spatial frequency measured using SFR method for depth of field evaluation or sharpness evaluation		132
Annex F (informative) Complementary charts and method for long distance measurements		137
Annex G (informative) Distortion measurement.....		140
Bibliography		147

Foreword

ISO (the International Organization for Standardization) is a worldwide federation of national standards bodies (ISO member bodies). The work of preparing International Standards is normally carried out through ISO technical committees. Each member body interested in a subject for which a technical committee has been established has the right to be represented on that committee. International organizations, governmental and non-governmental, in liaison with ISO, also take part in the work. ISO collaborates closely with the International Electrotechnical Commission (IEC) on all matters of electrotechnical standardization.

The procedures used to develop this document and those intended for its further maintenance are described in the ISO/IEC Directives, Part 1. In particular, the different approval criteria needed for the different types of ISO documents should be noted. This document was drafted in accordance with the editorial rules of the ISO/IEC Directives, Part 2 (see www.iso.org/directives).

Attention is drawn to the possibility that some of the elements of this document may be the subject of patent rights. ISO shall not be held responsible for identifying any or all such patent rights. Details of any patent rights identified during the development of the document will be in the Introduction and/or on the ISO list of patent declarations received (see www.iso.org/patents).

Any trade name used in this document is information given for the convenience of users and does not constitute an endorsement.

For an explanation of the voluntary nature of standards, the meaning of ISO specific terms and expressions related to conformity assessment, as well as information about ISO's adherence to the World Trade Organization (WTO) principles in the Technical Barriers to Trade (TBT) see www.iso.org/iso/foreword.html.

This document was prepared by Technical Committee ISO/TC 22, *Road vehicles*, Subcommittee SC 35, *Lighting and visibility*.

Any feedback or questions on this document should be directed to the user's national standards body. A complete listing of these bodies can be found at www.iso.org/members.html.

This second edition cancels and replaces the first edition (ISO 16505:2015), of which it constitutes a minor revision.

The main changes compared to the previous edition are as follows:

- [6.1](#) has been added, and all subsequent subclauses in [Clause 6](#) have been renumbered, in order to align with the subclause structure in [Clause 7](#).

Any feedback or questions on this document should be directed to the user's national standards body. A complete listing of these bodies can be found at www.iso.org/members.html.

Introduction

The purpose of this document is to give minimum safety, ergonomic, and performance requirements and test methods for Camera Monitor Systems (CMS) to replace mandatory inside and outside rearview mirrors for road vehicles (e.g. classes I to IV as defined in UN Regulation No. 46). This document can follow updates of referred national regulations that influence the included contents.

Where possible, the requirements established for a CMS providing a specific legally prescribed field of view are based on the properties of conventional state of the art mirror systems providing that field of view.

The CMS is treated as a functional system in regard to requirement definitions and performance tests.

This document outlines general requirements and test methods regarding the basic aspects of CMS; e.g. intended use, operating readiness, field of view, magnification, etc.

Furthermore, this document outlines requirements and test methods regarding the necessary object size and resolution provided by the CMS. Besides the properties of the mirror system to be replaced, those requirements are also based on physical aspects of the human operator (e.g. visual acuity).

The given requirements follow the assumption, that the CMS provides an ideal mapping of the real-world scene. To correspond to reality, this document also provides requirements and test methods for all relevant parameters that worsen the ideal mapping (e.g. isotropy or artefacts).

Finally, this document gives requirements and test methods regarding the aspects of time behaviour and failure behaviour.

All requirements are established to be as generic as possible, i.e. that these are possible to apply to any of the covered rearview mirrors. If additional or specific information is required for certain mirrors, these are provided in separate annexes.

This document declares that CMS replacing legally prescribed mirrors have to be considered as safety-relevant systems and therefore, relevant safety standards (e.g. ISO 26262) have to be considered.

Road vehicles — Ergonomic and performance aspects of Camera Monitor Systems — Requirements and test procedures

1 Scope

This document gives minimum safety, ergonomic, and performance requirements for Camera Monitor Systems to replace mandatory inside and outside rearview mirrors for road vehicles (e.g. classes I to IV as defined in UN Regulation No. 46). It addresses Camera Monitor Systems (CMS) that will be used in road vehicles to present the required outside information of a specific field of view inside the vehicle. These specifications are intended to be independent of different camera and display technologies unless otherwise stated explicitly. Advanced driver assistance systems (ADAS), such as parking aids, are not part of this document.

NOTE 1 Mirror classes V and VI (as defined in UN Regulation No. 46) are not in scope of this document since the requirements are already defined in UN Regulation No. 46.

NOTE 2 The definitions and requirements in this document are formulated with regard to a system structure, where one camera captures one legally prescribed field of view and one monitor displays one legally prescribed field of view. Of course, also other system structures (e.g. with one monitor displaying two legally prescribed fields of view) are within the scope of this document. For those systems, either the system supplier or the vehicle manufacturer has to prove that the resulting system fulfils the requirements given in [Clause 6](#).

NOTE 3 Whenever the phrases “field of view” or “field of vision” are used, then both have the same meaning and are to be used in parallel.

2 Normative references

There are no normative references in this document.

3 Terms and definitions

For the purposes of this document, the following terms and definitions apply.

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

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

3.1 Vehicle related terms and definitions

3.1.1 vehicle

vehicle with a combustion engine and/or electric driving motor, intended for use on the road, with or without external body components added, having a permissible maximum mass of at least 400 kg and a maximum design speed equal to or exceeding 50 km/h

Note 1 to entry: Vehicles of categories M1, M2, M3, N1, N2 and N3 (see UN Regulation No. 46).

[SOURCE: ISO 13043:2011, 3.1]