

TECHNICAL REPORT



**Electronic display devices –
Part 3-2: Evaluation of optical characteristics – Mura**

INTERNATIONAL
ELECTROTECHNICAL
COMMISSION

ICS 31.120; 31.260

ISBN 978-2-8322-3118-0

Warning! Make sure that you obtained this publication from an authorized distributor.

CONTENTS

FOREWORD.....	4
INTRODUCTION.....	6
1 Scope.....	7
2 Normative references	7
3 Terms and definitions	7
4 Standard measuring conditions.....	8
4.1 Standard measuring conditions	8
4.1.1 Standard measuring environmental conditions	8
4.1.2 Standard measuring darkroom conditions	8
4.2 Light measuring device (LMD).....	8
4.3 Measuring setup	9
4.4 Test signal	9
4.5 Measuring conditions	10
5 Standard evaluation method	10
5.1 Measurement data processing method.....	10
5.2 Measurement data processing flow	10
5.2.1 General	10
5.2.2 Median filter process	11
5.2.3 Transformation to opponent colour space from CIE XYZ.....	12
5.2.4 Convolution with the contrast sensitivity function (CSF) of the human visual system.....	12
5.2.5 Transformation to CIE XYZ from the opponent colour space	12
5.2.6 Transformation to CIELAB from CIE XYZ	12
5.2.7 a^* correction	13
5.3 Mura evaluation method.....	13
5.3.1 General	13
5.3.2 Lightness mura evaluation	13
5.3.3 Chroma mura evaluation.....	15
5.3.4 Mura evaluation.....	16
5.3.5 Measurement report	16
6 Actual example.....	17
6.1 General.....	17
6.2 Evaluation objects.....	17
6.3 Subjective evaluation	17
6.4 Evaluation by the method indicated in this document using apparatus.....	18
6.5 Correlation between subjective evaluation and mura evaluation value	19
Annex A (informative) S-CIELAB model	20
A.1 General.....	20
A.2 S-CIELAB model.....	20
A.3 Spatial sensitivity function model (two-dimensional CSF model).....	20
Annex B (informative) Type of mura	24
B.1 General.....	24
B.2 Classification of mura	24
Annex C (informative) Use case of a mura evaluation value.....	26
C.1 General.....	26

C.2	Example of a use case of a mura evaluation value	26
Annex D (informative)	Various mura measurement methods	27
D.1	General.....	27
D.2	Comparison of mura evaluation standards	27
Bibliography.....		28
Figure 1	– Measuring layout.....	9
Figure 2	– Example of input signal	10
Figure 3	– Measurement data processing flow adopting the S-CIELAB model	11
Figure 4	– Concept diagram of real-space information integration	14
Figure 5	– 3 × 3 neighbourhood domain	15
Figure 6	– Evaluation objects in a dark room	17
Figure 7	– CSF filter images in opponent colour space	18
Figure 8	– Correlation of mura evaluation value and ITU-R subjective evaluation values	19
Figure A.1	– Flowchart of S-CIELAB calculation.....	20
Figure A.2	– Two-dimensional CSF model	21
Figure A.3	– Examples of the convolution of a two-dimensional CSF filter for illusion.....	23
Figure B.1	– Classification of mura by forms and/or causes	25
Table 1	– Example of reported criteria of two-dimensional LMD	9
Table 2	– Example of measurement results for a display screen uniformity	16
Table 3	– ITU-R quality and impairment scales	17
Table 4	– Subjective evaluation results	18
Table 5	– Evaluation results by apparatus.....	19
Table A.1	– Parameters for each axis of the opponent colour space	21
Table C.1	– Example of a use case of a mura evaluation value	26
Table C.2	– Example of subjects to evaluate.....	26
Table D.1	– Comparison chart of various mura measurement standards	27

INTERNATIONAL ELECTROTECHNICAL COMMISSION

ELECTRONIC DISPLAY DEVICES –

Part 3-2: Evaluation of optical characteristics – Mura

FOREWORD

- 1) The International Electrotechnical Commission (IEC) is a worldwide organization for standardization comprising all national electrotechnical committees (IEC National Committees). The object of IEC is to promote international co-operation on all questions concerning standardization in the electrical and electronic fields. To this end and in addition to other activities, IEC publishes International Standards, Technical Specifications, Technical Reports, Publicly Available Specifications (PAS) and Guides (hereafter referred to as "IEC Publication(s)"). Their preparation is entrusted to technical committees; any IEC National Committee interested in the subject dealt with may participate in this preparatory work. International, governmental and non-governmental organizations liaising with the IEC also participate in this preparation. IEC collaborates closely with the International Organization for Standardization (ISO) in accordance with conditions determined by agreement between the two organizations.
- 2) The formal decisions or agreements of IEC on technical matters express, as nearly as possible, an international consensus of opinion on the relevant subjects since each technical committee has representation from all interested IEC National Committees.
- 3) IEC Publications have the form of recommendations for international use and are accepted by IEC National Committees in that sense. While all reasonable efforts are made to ensure that the technical content of IEC Publications is accurate, IEC cannot be held responsible for the way in which they are used or for any misinterpretation by any end user.
- 4) In order to promote international uniformity, IEC National Committees undertake to apply IEC Publications transparently to the maximum extent possible in their national and regional publications. Any divergence between any IEC Publication and the corresponding national or regional publication shall be clearly indicated in the latter.
- 5) IEC itself does not provide any attestation of conformity. Independent certification bodies provide conformity assessment services and, in some areas, access to IEC marks of conformity. IEC is not responsible for any services carried out by independent certification bodies.
- 6) All users should ensure that they have the latest edition of this publication.
- 7) No liability shall attach to IEC or its directors, employees, servants or agents including individual experts and members of its technical committees and IEC National Committees for any personal injury, property damage or other damage of any nature whatsoever, whether direct or indirect, or for costs (including legal fees) and expenses arising out of the publication, use of, or reliance upon, this IEC Publication or any other IEC Publications.
- 8) Attention is drawn to the Normative references cited in this publication. Use of the referenced publications is indispensable for the correct application of this publication.

The main task of IEC technical committees is to prepare International Standards. However, a technical committee may propose the publication of a technical report when it has collected data of a different kind from that which is normally published as an International Standard, for example "state of the art".

IEC TR 62977-3-2, which is a technical report, has been prepared by IEC technical committee 110: Electronic display devices.

The text of this technical report is based on the following documents:

Enquiry draft	Report on voting
110/674A/DTR	110/701A/RVC

Full information on the voting for the approval of this technical report can be found in the report on voting indicated in the above table.

This publication has been drafted in accordance with the ISO/IEC Directives, Part 2.

A list of all parts in the IEC 62977 series, published under the general title *Electronic display devices*, can be found on the IEC website.

The committee has decided that the contents of this publication will remain unchanged until the stability date indicated on the IEC website under "<http://webstore.iec.ch>" in the data related to the specific publication. At this date, the publication will be

- reconfirmed,
- withdrawn,
- replaced by a revised edition, or
- amended.

A bilingual version of this publication may be issued at a later date.

IMPORTANT – The 'colour inside' logo on the cover page of this publication indicates that it contains colours which are considered to be useful for the correct understanding of its contents. Users should therefore print this document using a colour printer.

Withdrawn

INTRODUCTION

Electronic displays, for example liquid crystal displays (LCDs), plasma display panels (PDPs), organic light emission displays (OLEDs), and so on, have grown popular as displays for high-quality images. It is therefore increasingly important to measure the image quality of electronic displays. One factor degrading the image quality is non-uniformity, known as 'mura'. The mura is classified into three types. The first is luminance mura, the second is colour mura. The third is called merely "mura" and includes luminance mura and colour mura simultaneously. It is impossible to recognize luminance mura and colour mura as completely separate objects.

Various measurement methods about luminance mura and colour mura have been reported in various academic conferences. There are also some standards for these mura. For example, uniformity of luminance and chromaticity are specified in IEC IEC 61747-30-1, SEMU (SEMI mura) is specified in SEMI D31-0213 and uniformity measurement is specified in IDMS ver.1.03 sec. 8. However there is no report which clearly provides the quantitative method for the mura that is called merely "mura" (see Annex D).

Therefore the majority of electronic display manufacturers are still using the limit sample for visual inspection.

This Technical Report, which intends to verify one mura measurement method, shows the detailed mura measurement method and its inspection experiment results.

The International Electrotechnical Commission (IEC) draws attention to the fact that it is claimed that compliance with this document may involve the use of a patent.

IEC takes no position concerning the evidence, validity and scope of this patent right.

The holder of this patent right has assured the IEC that he/she is willing to negotiate licences either free of charge or under reasonable and non-discriminatory terms and conditions with applicants throughout the world. In this respect, the statement of the holder of this patent right is registered with IEC. Information may be obtained from:

Sony Corporation
1-7-1 Konan, Minato-ku, Tokyo, 108-0075 Japan

Attention is drawn to the possibility that some of the elements of this document may be the subject of patent rights other than those identified above. IEC shall not be held responsible for identifying any or all such patent rights.

ISO (www.iso.org/patents) and IEC (<http://patents.iec.ch>) maintain on-line database of patents relevant to their standards. Users are encouraged to consult the databases for the most up to date information concerning patents.

ELECTRONIC DISPLAY DEVICES –

Part 3-2: Evaluation of optical characteristics – Mura

1 Scope

This part of IEC 62977, which is a Technical Report, provides an optical measuring method of mura for electronic displays. It defines general measuring procedures for mura measurement and an evaluation method of electronic displays.

2 Normative references

The following documents, in whole or in part, are 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.

Void.

Withdrawn