IEC 62977-3-7

Edition 1.0 2022-01

INTERNATIONAL STANDARD

This document is a preview generated by EVS

colour inside

Electronic displays –
Part 3-7: Evaluation of optical performance – Tone characteristics



IEC 62977-3-7:2022-01(en)

THIS PUBLICATION IS COPYRIGHT PROTECTED
Copyright © 2022 IEC, Geneva, Switzerland

All rights reserved. Unless otherwise specified, no part of this publication may be reproduced or utilized in any form or by any means, electronic or mechanical, including photocopying and microfilm, without permission in writing from either IEC or IEC's member National Committee in the country of the requester. If you have any questions about IEC copyright or have an enquiry about obtaining additional rights to this publication, please contact the address below or your local IEC member National Committee for further information.

IEC Secretariat
3, rue de Varembé
CH-1211 Geneva 20
Switzerland

Tel.: +41 22 919 02 11
info@iec.ch
www.iec.ch

About the IEC
The International Electrotechnical Commission (IEC) is the leading global organization that prepares and publishes International Standards for all electrical, electronic and related technologies.

About IEC publications
The technical content of IEC publications is kept under constant review by the IEC. Please make sure that you have the latest edition, a corrigendum or an amendment might have been published.

IEC publications search - webstore.iec.ch/advsearchform
The advanced search enables to find IEC publications by a variety of criteria (reference number, text, technical committee, …). It also gives information on projects, replaced and withdrawn publications.

IEC Just Published - webstore.iec.ch/justpublished
Stay up to date on all new IEC publications. Just Published details all new publications released. Available online and once a month by email.

IEC Customer Service Centre - webstore.iec.ch/csc
If you wish to give us your feedback on this publication or need further assistance, please contact the Customer Service Centre: sales@iec.ch.

IEC Products & Services Portal - products.iec.ch
Discover our powerful search engine and read freely all the publications previews. With a subscription you will always have access to up to date content tailored to your needs.

Electropedia - www.electropedia.org
The world's leading online dictionary on electrotechnology, containing more than 22 300 terminological entries in English and French, with equivalent terms in 19 additional languages. Also known as the International Electrotechnical Vocabulary (IEV) online.

This document is a preview generated by EVS

IEC 62977-3-7

Edition 1.0 2022-01

INTERNATIONAL STANDARD

This document is a preview generated by EVS

colour inside

Electronic displays –
Part 3-7: Evaluation of optical performance – Tone characteristics

INTERNATIONAL
ELECTROTECHNICAL
COMMISSION

ICS 31.120

ISBN 978-2-8322-1070-7

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

® Registered trademark of the International Electrotechnical Commission

CONTENTS

FOREWORD 4
INTRODUCTION 6
1 Scope 7
2 Normative references 7
3 Terms, definitions and abbreviated terms 7
3.1 Terms and definitions 7
3.2 Abbreviated terms 9
4 Standard measuring equipment 9
4.1 Video signal generator 9
4.2 Measuring equipment and conditions 10
4.3 Test equipment setup 10
5 Standard measuring conditions 11
5.1 Standard measuring environmental conditions 11
5.2 Standard measuring darkroom conditions 11
5.3 Adjustment of display 12
5.4 Starting conditions of measurement 12
5.5 Standard test pattern 12
5.5.1 General 12
5.5.2 Test pattern for grey and colour tone measurement 13
5.5.3 Test pattern for colour saturation tone measurement 16
6 Measurements and evaluation of tone characteristics 16
6.1 EOTF and display gamma 16
6.1.1 Measured data 16
6.1.2 Measuring method 17
6.1.3 Average gamma calculation 18
6.1.4 Log-log gamma calculation 20
6.1.5 Grey scale tracking accuracy 22
6.1.6 Directional EOTF 22
6.2 Colour saturation tone accuracy 23
6.2.1 Measured data 23
6.2.2 Measuring method 23
6.2.3 Evaluation of colour saturation tone accuracy 24
6.3 Tone additivity function 26
6.4 Functional tone quantization 27
6.4.1 Measuring method 27
6.4.2 Evaluation of functional tone quantization 28
7 Reporting 30
7.1 Required reporting 30
7.2 Measurement results 31
Annex A (informative) Interlevel gamma 32
A.1 General 32
A.2 Interlevel gamma calculation 33
Bibliography 36

Figure 1 – Hue saturation lightness (HSL) colour model 6
Figure 2 – Measuring layout for non-close-up measurement 10

This document is a preview generated by EVS

Figure 3 – Measuring layout for close-up type LMD 10
Figure 4 – Setup for viewing directional measurements 11
Figure 5 – RGB input ranges for 7 tones and 6 colour saturations 13
Figure 6 – Multi-colour pattern for grey tone measurement 14
Figure 7 – Multi-colour pattern for colour tone measurement (example for red tone) 15
Figure 8 – Equivalent pattern for APL calculation of multi-colour pattern (example for grey tone) 15
Figure 9 – Multi-colour pattern for colour saturation tone measurement (example for red saturation) 16
Figure 10 – Example of a measured EOTF compared with ideal power law curves 20
Figure 11 – Example of linear regression formula and plot for log-log gamma 21
Figure 12 – Example of colour saturation tone evaluation 25
Figure 13 – Examples of tone additivity functions for non-additive displays with (solid line) and without (dashed line) tone clipping 27
Figure 14 – Minimum luminance difference between neighbouring inputs 28
Figure 15 – Graphic result for the bit depth evaluation in Table 9 30
Figure A.1 – Example of EOTF variation by enhancement processing 33
Figure A.2 – Example of interlevel gamma graph 35

Table 1 – RGB input level for 11 steps and 17 steps 14
Table 2 – RGB input composition for grey tone and colour tone 15
Table 3 – RGB input composition for colour saturation tone 16
Table 4 – Selected measured data for display gamma from the 602-point measurement 17
Table 5 – Example of average gamma calculation 19
Table 6 – Example of log-log gamma calculation 21
Table 7 – Selected measured data for colour saturation tone function from the 602-point measurement 23
Table 8 – Example of colour saturation tone evaluation (cyan saturation) 25
Table 9 – Example of bit depth evaluation 29
Table A.1 – Example of Interlevel gamma calculation 34

This document is a preview generated by EVS

INTERNATIONAL ELECTROTECHNICAL COMMISSION

_____

ELECTRONIC DISPLAYS –

Part 3-7: Evaluation of optical performance – Tone characteristics

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.
9) Attention is drawn to the possibility that some of the elements of this IEC Publication may be the subject of patent rights. IEC shall not be held responsible for identifying any or all such patent rights.

IEC 62977-3-7 has been prepared by IEC technical committee 110: Electronic displays. It is an International Standard.

The text of this International Standard is based on the following documents:

Draft	Report on voting
110/1371/FDIS	110/1397/RVD

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

The language used for the development of this International Standard is English.

This document is a preview generated by EVS

This document was drafted in accordance with ISO/IEC Directives, Part 2, and developed in accordance with ISO/IEC Directives, Part 1 and ISO/IEC Directives, IEC Supplement, available at www.iec.ch/members_experts/refdocs. The main document types developed by IEC are described in greater detail at www.iec.ch/standardsdev/publications.

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

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

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

IMPORTANT – The "colour inside" logo on the cover page of this document 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.

This document is a preview generated by EVS

INTRODUCTION

Images as formed by electronic displays have lateral variations of for example hue, saturation and intensity of visual stimuli. For displays of gradual smooth transitions no unwanted contours and no quantization artefacts should be visible. Therefore, the displays should render the required gradation of an image through tone reproduction. Tone is the variation in luminance, ideally with constant hue and saturation, at (r, g, b) input (n, 0, 0), (0, n, 0), (0, 0, n), and (n, n, n), respectively, where n:{0, 1,…N}, and N + 1 is the number of quantization levels. Similarly, colour saturation tone is defined as the luminance variation, ideally with constant hue, but with varying saturation of the input (= 1 – min (r, g, b) / max (r, g, b)), for input (N, n, n), (n, N, n), and (n, n, N). Tone can also be defined for complementary colour (r, g, b) input (0, n, n), (n, 0, n), (n, n, 0) and (n, N, N), (N, n, N), and (N, N, n), respectively. This is conceptually shown in Figure 1 which is the hue saturation lightness/intensity (HSL or HSI) model with RGB inputs for single colour tone, grey tone and colour saturation tone signal, where the lightness is defined as 0,5 × ((max (r, g, b) + min (r, g, b)). Note that this colour space is different from the device RGB colour space. Grey and RGB tone reproduction, and their additive relation, are fundamental optical properties of displays since they affect the fidelity with which colour is rendered from the input code values.

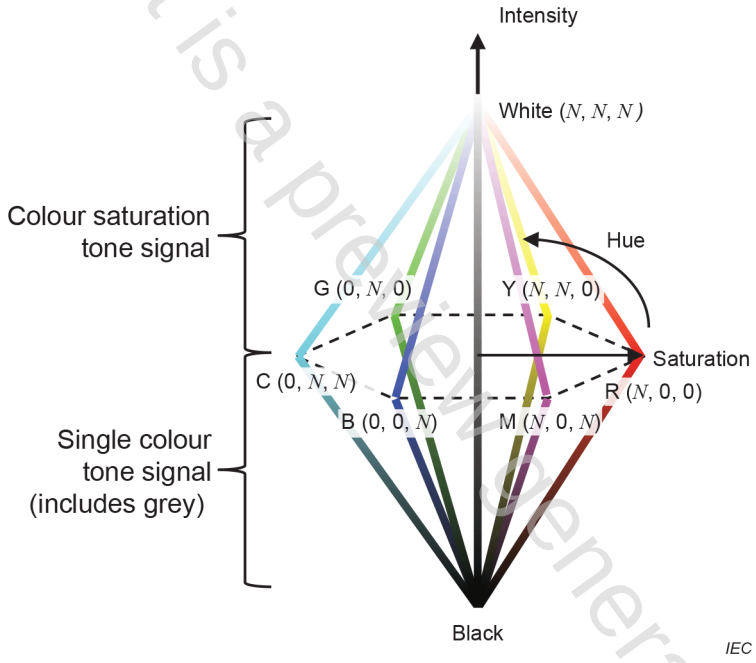


Figure 1 – Hue saturation lightness (HSL) colour model

In contemporary displays, nonlinear transformations into perceptually equidistant spaces are required to reduce visual artefacts while maintaining data economy. Also, the transformations linearize the opto-electrical transfer function, the nonlinearity of which is beneficial for reduction of artefacts such as quantization noise, banding, contouring, as well as for quantization efficiency.

The variation of electro-optical transfer functions (EOTFs) with viewing direction introduces further complications. The resulting impact omnidirectional image quality is more multifaceted compared to the viewing direction dependence of contrast, peak luminance, and colour of a limited number of patches.

This document describes methods for the measurement of EOTF and evaluation, and points out necessary precautions and diagnostics. The document is a reference for forthcoming standards to make the work of the involved experts more efficient and to avoid duplication of efforts.

This document is a preview generated by EVS

ELECTRONIC DISPLAYS –

Part 3-7: Evaluation of optical performance – Tone characteristics

This document is a preview generated by EVS

1 Scope

This part of IEC 62977 specifies the standard measurement and evaluation of optical performance for grey and colour tone reproduction of electronic displays under darkroom conditions. This document describes the measuring methods and evaluation of tone rendering of neutral grey, primary and secondary input colours. This document applies to displays with unbounded input signals.

2 Normative references

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

IEC 62977-2-1:2021, *Electronic displays – Part 2-1: Measurements of optical characteristics – Fundamental measurements*

IEC TS 62977-3-1:2019, *Electronic displays – Part 3-1: Evaluation of optical performances – Colour difference based viewing direction dependence*

IEC 62341-6-3, *Organic light emitting diode (OLED) displays – Part 6-3: Measuring methods of image quality*

IEC 61966-2-1, *Multimedia systems and equipment – Colour measurement and management – Part 2-1: Colour management – Default RGB colour space – sRGB*

3 Terms, definitions and abbreviated terms

3.1 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:

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