IEC TR 62977-5-2

Edition 1.0 2021-03

TECHNICAL REPORT

colour inside

Electronic displays –
Part 5-2: Visual assessment – Colour discrimination according to viewing direction

INTERNATIONAL
ELECTROTECHNICAL
COMMISSION

ICS 31.120

ISBN 978-2-8322-9514-4

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 8
4 Introduction to visual assessment 8
5 Standard measuring equipment and coordinate system 10
5.1 Light measuring devices 10
5.2 Viewing direction coordinate system 10
6 Test patterns 11
6.1 Geometrical construction 11
6.2 Colour assignment 12
6.3 Dots fill factor 14
7 Visual assessment method 15
7.1 General description of the assessment 15
7.2 Test room conditions 15
7.3 DUT parameters 16
7.4 Observers 16
7.5 Instructions for visual assessment method 17
7.6 Repeatability 18
7.7 Presentation and interpretation of the experimental assessment results 18
Annex A (informative) Fill factor dependency 26
Annex B (informative) Display white luminance dependency 29
Annex C (informative) Pattern generator 32
Bibliography 34

Figure 1 – Comparison between the proposed visual assessment and the conventional physical measurement 9
Figure 2 – Definition of viewing directions by the spherical angles of θ and φ 10
Figure 3 – Layout for horizontal viewing direction 11
Figure 4 – Pattern structures 12
Figure 5 – Colour assignment of test pattern 14
Figure 6 – Test environment 15
Figure 7 – Average CMF according to ethnic origin 17
Figure 8 – Assessment procedure 18
Figure 9 – Visual assessment results: statistical plot (upper figure) and mean recognition rates (lower figure) 19
Figure 10 – Statistical plot (upper) and mean of colour differences (lower) of test patterns 20
Figure 11 – Process of S-CIELAB transformation 21
Figure 12 – Contrast sensitivity function of HVS 21
Figure 13 – S-CIELAB results: statistical plot (upper) and mean colour difference (lower) 22

Figure 14 – Correlation between physical measures and S-CIELAB results 23
Figure 15 – Correlation between visual assessment and S-CIELAB method 23
Figure 16 – Pattern dependency 24
Figure 17 – Observer dependency 25
Figure A.1 – Fill factor variation 26
Figure A.2 – FF dependency 27
Figure A.3 – Colour difference relationship between pictorial image and test patterns with various FF 28
Figure B.1 – Colour reproduction performance of the DUT 30
Figure B.2 – White luminance dependency 31
Figure C.1 – Pattern generator user interface 33

Table 1 – Measurement directions for DUTs in living rooms 11
Table 2 – Reference colours of test pattern 13
Table 3 – Test room condition 15
Table 4 – Experimental setup of the DUT 16
Table 5 – Correlation coefficients 24
Table B.1 – Experimental setup and parameters 29

INTERNATIONAL ELECTROTECHNICAL COMMISSION

_____

ELECTRONIC DISPLAYS –

Part 5-2: Visual assessment – Colour discrimination according to viewing direction

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 TR 62977-5-2 has been prepared by IEC technical committee 110: Electronic displays. It is a Technical Report.

The text of this Technical Report is based on the following documents:

Draft	Report on voting
110/1227/DTR	110/1251A/RVDTR

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 Technical Report is English.

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 "http://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.

This publication contains attached files in the form of compressed Zip files (“Pattern generator” program in Annex C). These files are intended to be used as a complement and do not form an integral part of the publication.

"Disclaimer: The IEC disclaims liability for any personal injury, property or other damages of any nature whatsoever, whether special, indirect, consequential or compensatory, directly or indirectly resulting from this software and the document upon which its methods are based, use of, or reliance upon"

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.

INTRODUCTION

Current display measurement standards use mainly simple patterns for physical measurement methods to characterize display performance. Recent studies have introduced multiple colour test patterns to simulate real images based on physical measurements. Such types of physical measurements are commonly used and are an essential method of the industry. Often, humans can perceive a structural similarity [1][1] as much as physical factors (colour, luminance, etc.). This document describes a method of structural sensitivity assessment dependent on the viewing direction, interpretation of assessment results, and correlation between assessment results and physical measurements. This correlation value can be used as the basis for determining one aspect of the viewing direction range of a display, which has relevance from a visual quality point of view. However, it should be noted that several characteristics (e.g. contrast ratio, resolution, and colour shift) are simultaneously changing in the assessment of the viewing direction.

This visual assessment approach has the benefit of obtaining direct human response to variations for any given task. However, it can be challenging with this approach to get reproducible experimental results due to different colour matching functions (CMFs), differences in observer experience, observer fatigue, attitudes toward experiments, human adaptation to different experimental environments (including illumination conditions, surround, or other environmental factors), content-dependent differences, and other variables. Therefore, the uncertainty for these visual assessment methods can be higher compared to instrumentation-based evaluation methods. Accordingly, this document should be seen as a limited constrained model to help understand some of the various human responses to the experiment. It can be used as an indicator of such response and to provide a framework to guide the acquisition of performance data by way of reliable instrumentation-based measurement methods.

[1] Numbers in square brackets refer to the Bibliography.

ELECTRONIC DISPLAYS –

Part 5-2: Visual assessment – Colour discrimination according to viewing direction

1 Scope

This part of IEC 62977, which is a Technical Report, describes the visual assessment method of the viewing direction characteristics of display devices. This document reviews the visual assessment of viewing direction by using special test patterns to estimate colour changes, image structure, and image luminance.

Experimental results are shown to reveal the effectiveness of this kind of visual assessment.

This method is a valuable tool for identifying image quality issues, but physical measurements will be used to confirm display performance specifications.

NOTE The visual assessment results will depend on the test pattern parameters and display setup conditions. As the viewing direction changes, characteristics such as contrast ratio, resolution, and device colour-shift simultaneously change in the perceived image.

2 Normative references

There are no normative references in this document.