Designation: E1336 – 11 (Reapproved 2023)

Standard Test Method for Obtaining Colorimetric Data From a Visual Display Unit by Spectroradiometry[1]

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INTRODUCTION

The fundamental procedure for characterizing the color and luminance of a visual display unit (VDU) is to obtain the spectroradiometric data under specified measurement conditions, and from these data to compute CIE chromaticity coordinates and absolute luminance values based on the 1931 CIE Standard Observer. The considerations involved and the procedures to be used to obtain precision colorimetric data for this purpose are contained in this test method. The values and procedures for computing CIE chromaticity coordinates are contained in Practice E308. The procedures for obtaining spectroradiometric data are contained in Practice E1341. This test method includes some modifications to the procedures given in Practice E308 that are necessary for computing the absolute luminance values of VDUs. This procedure is intended to be generally applicable to any VDU device, including but not limited to cathode ray tubes (CRT), liquid crystal displays (LCD), and electroluminescent displays (ELD).

1. Scope

1.1 This test method prescribes the instrumental measurements required for characterizing the color and brightness of VDUs.

1.2 This test method is specific in scope rather than general as to type of instrument and object.

1.3 The values stated in SI units are to be regarded as standard. No other units of measurement are included in this standard.

1.4 *This standard does not purport to address all of the safety concerns, if any, associated with its use. It is the responsibility of the user of this standard to establish appropriate safety, health, and environmental practices and determine the applicability of regulatory limitations prior to use.*

1.5 *This international standard was developed in accordance with internationally recognized principles on standardization established in the Decision on Principles for the Development of International Standards, Guides and Recommendations issued by the World Trade Organization Technical Barriers to Trade (TBT) Committee.*

2. Referenced Documents

2.1 *ASTM Standards:*[2]

E284 Terminology of Appearance

E308 Practice for Computing the Colors of Objects by Using the CIE System

E1341 Practice for Obtaining Spectroradiometric Data from Radiant Sources for Colorimetry

2.2 *CIE Publications:*

Publication CIE No. 18 Principles of Light Measurements[3]

Publication CIE No. 15.2 Colorimetry, 2nd ed., 1986[3]

Publication CIE No. 63 Spectroradiometric Measurement of Light Sources, 1984[3]

2.3 *IEC Publications:*

Publication No. 441 Photometric and Colorimetric Methods of Measurement of the Light Emitted by a Cathode-Ray Tube Screen, 1974[4]

3. Terminology

3.1 The definitions of appearance terms in Terminology E284 are applicable to this test method.

[1] This test method is under the jurisdiction of ASTM Committee E12 on Color and Appearance and is the direct responsibility of Subcommittee E12.06 on Display, Imaging and Imaging Colorimetry.

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[2] For referenced ASTM standards, visit the ASTM website, www.astm.org, or contact ASTM Customer Service at service@astm.org. For *Annual Book of ASTM Standards* volume information, refer to the standard's Document Summary page on the ASTM website.

[3] Available from CIE (International Commission on Illumination), http://www.cie.co.at or http://www.techstreet.com.

[4] Available from International Electrotechnical Commission (IEC), 3 rue de Varembé, Case postale 131, CH-1211, Geneva 20, Switzerland, http://www.iec.ch.

4. Summary of Test Method

4.1 Procedures are given for obtaining spectroradiometric data and for the calculation of CIE tristimulus values and other color coordinates to describe the colors of VDUs. Modifications to the standard calculation procedures of Practice E308 are described.

5. Significance and Use

5.1 The most fundamental method for obtaining CIE tristimulus values or other color coordinates for describing the colors of visual display units (VDUs) is by the use of spectroradiometric data. (See CIE No. 18 and 63.) These data are used by summation together with numerical values representing the 1931 CIE Standard Observer and normalized to K_m, the maximum spectral luminous efficacy function.

5.2 The special requirements for characterizing VDUs possessing narrow or discontinuous spectra are presented and discussed. Modifications to the requirements of Practice E308 are given to correct for the unusual nature of narrow or discontinuous sources.

6. Requirements When Using Spectroradiometry

6.1 When describing the measurement of VDUs by spectroradiometry, the following must be specified:

6.1.1 The radiometric quantity determined, such as the irradiance (W/m^2) or radiance (W/m^2-sr), or the photometric quantity determined, such as illuminance (lm/m^2) or luminance (lm/m^2-sr or cd/m^2). The use of older, less descriptive names or units such as phot, nit, stilb is not recommended.

6.1.2 The geometry of the measurement conditions, including, whether a diffuser was used and the material from which it was constructed, the distances from the VDU, the size of the area to be measured on the VDU, the uniformity of the VDU across the area to be measured, the microstructure of the VDU picture elements, and the presence of any special intermediate optical devices such as integrating spheres.

6.1.3 The spectral parameters, including the spectral region, wavelength measurement interval, and spectral bandwidth. These must be specified since the various VDU technologies may demand more or less stringent requirements.

6.1.4 The type of standard used to calibrate the system, a standard lamp, a calibrated source, or a calibrated detector, and the source of the calibration.

6.1.5 The physical and temporal characteristics of the VDU including, refresh or field rate, convergence and purity adjustments (if the manufacturer allows such), luminance level, and any spectral line character in the emission from the VDU. The integration time of the detector system should be noted in relation to the refresh or field rate of the VDU. (See IEC No. 441.)

7. Apparatus

7.1 The basic instrument requirement is a spectroradiometric system designed for the measurement of spectral radiance or irradiance of light sources. See Practice E1341 for details on each of the parts of a spectroradiometer and how to calibrate and use the instrument.

7.2 *Calibration Sources:*

7.2.1 The standard calibration source for spectroradiometry is a tungsten-filament lamp operated at a specified current. It is preferable to have more than one standard lamp to permit cross-checks and to allow calibration at a range of luminance levels.

7.2.2 Monochromatic emission sources such as a low-pressure mercury arc lamp or tunable laser should also be available for use in calibrating the wavelength scale.

7.2.3 The electrical supplies for the calibration sources should be of the constant current type. The supply should be linear and not a switching supply. Current regulation should be maintained to better than 0.1 %. At this level the radiant flux from the calibration source is at least an order of magnitude more stable than the flux from a VDU.

7.2.4 There should be a standard for length measurements available (such as a high-quality metric rule) since absolute irradiance calibration must be performed at an exact distance from the filament of the calibration lamp.

7.3 *Receiving Optics*—To maximize the light throughput the number of optical surfaces between the source of light should be kept to a minimum. In extended diffuse sources (such as VDUs) only a set of limiting apertures will be needed. In some instances, it may be desirable to image the VDU with an intermediate focusing lens or mirror assembly. Care should be taken to use a magnification that will adequately fill the entrance slit when viewing both the calibration and test source.

8. Calibration and Verification

8.1 Calibration and its verification are essential steps in ensuring that precise and accurate results are obtained by spectroradiometric measurements. They require the use of physical standards, some of which may not be normally supplied by commercial instrument manufacturers. It remains the user's responsibility to obtain and use the physical standards necessary to keep his instrument in optimum working condition.

8.2 *Radiometric Scale:*

8.2.1 *Zero Calibration or Its Verification*—All photometric devices have some inherent photocurrent, even in the absence of light. This so called "dark current" must be measured and subtracted from all subsequent readings either electrically or computationally.

8.2.2 *Radiometric Scale Calibration*—A physical standard of spectral irradiance is normally used for calibration. After the dark current has been measured, the calibration source is positioned in front of the receiving optics at the specified distance and operated at the specified electric current. This provides a good approximation to a Plankian radiator across the visible spectrum. The calibration source is measured and the values of the dark-current-corrected photocurrent are recorded. These photocurrents are then related to the calibration values of spectral irradiance that were provided by the standardizing laboratory. The ratio of spectral irradiance to photocurrent becomes the instrument calibration factor. All subsequent measurements are multiplied by this ratio.