ANSI C78.377-2024

American National Standard for Electric Lamps—Specifications for the Chromaticity of Solid State Lighting Products

Secretariat:

National Electrical Manufacturers Association

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American National Standards Institute, Inc.

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Foreword

(This foreword is not a part of ANSI C78.377-2024)

Suggestions for improvement of this standard are welcomed. They should be sent to;

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This standard was processed and approved for submittal to ANSI by the C78 Consensus Body. Approval of the standard is not meant to imply that all Committee members voted to approve it.

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Introduction

The purposes of this standard are, first, to specify the range of chromaticities recommended for general lighting with solid-state lighting products to ensure high-quality light near the Planckian locus and, second, to categorize chromaticities with given tolerances so that the chromaticity of the products can be communicated to consumers.

This standard provides a basis for specifying chromaticity (quadrangles based on 4-step and 7-step MacAdam ellipses), explanation of a nominal CCT, target CCT, Duv, and details of SSL chromaticity requirements. The use of quadrangles to specify the chromaticities comprising the nominal CCTs increases the overall yield complying with this standard while acknowledging that chromaticities within the quadrangles but outside of the corresponding MacAdam ellipses may nonetheless be useful in many applications.

The annexes in this document provide the background information, tables, and graphical representations of the specifications in this standard.

Brief History

The first ANSI standard for chromaticity specification for LED products was published in 2008 (ANSI C78.377-2008) and was developed to establish alignment with the existing fluorescent lamp standards (ANSI C78.376), enabling the consistent appearance of various light sources within architectural spaces where multiple technologies are employed. Quadrangles were used to reflect the color binning processes commonly used in the manufacturing of LEDs. The form and structure of the nominal CCTs of ANSI C78.376—i.e., the chromaticity ranges for nominal CCTs (2700K, 3000K, 3500K, 4000K, 5000K, and 6500K) were carried through, while nominal CCTs of 4500K and 5700K were added to create a continuous chromaticity range for LED products. Descriptions such as “Warm White” (3000K), “Cool White” (4100K), and “Daylight” (6500K) from ANSI C78.376 were abandoned in C78.377.

In 2011, ANSI C78.377 was revised (ANSI C78.377-2011) to remove the small discontinuities in boundary lines of quadrangles at different CCT locations. In 2015, ANSI C78.377 was revised (ANSI C78.377-2015) to include specifications for nominal CCTs of 2200K and 2500K to cover some indoor lighting applications where lower CCT products are used. This version contained a total of 10 quadrangles.

In 2017, ANSI C78.377 was revised (ANSI C78.377-2017) to include Extended Specifications for all nominal CCTs. These *extended* specifications have centers substantially below the Planckian locus and were developed to provide options for products designed with chromaticity points that may be suitable for some lighting applications. This update to the standard was not intended to render a judgment on the preference or perception of white or natural light; instead, the Extended Specifications were developed as a straightforward mathematical construct to expand the ANSI chromaticity specification to include chromaticity regions that are suitable for some lighting applications. See **Annex E** for the background and further information.

In this 2024 revision to ANSI C78.377 (ANSI C78.377-2024), specifications for nominal CCTs of 2000K and 1800K are added to cover LED products for some outdoor and special indoor applications, based on the proposed *expanded* quadrangles of Esposito and Radetsky [2023]. These additions are driven by market needs for standard chromaticity specifications in this chromaticity region. See **Annex F** for more information.

1 Scope

The purpose of this standard is to specify the range of chromaticity for general lighting with solid-state lighting (SSL) products, as well as to ensure that the chromaticity of the products can be communicated to consumers. This standard applies to LED lamps, LED light engines, and LED luminaires for general lighting applications and may apply more broadly.

This document does not apply to lighting fixtures sold without a light source. This standard also does not apply to SSL products for some indoor applications that intentionally produce colored light.

1.1 Patent Disclaimer

At the time of publication, it is possible that some of the elements of this document may be the subject of patent rights. When this standard was approved for publication, the C78 Consensus Body and the National Electrical Manufacturers Association (NEMA) did not know of any patent applications, patents pending, or existing patents. C78 shall not be held responsible for identifying any or all such patent rights.

2 Normative References

All standards are subject to revision, and parties to agreements based on this American National Standard are encouraged to investigate the possibility of applying the most recent editions of the standards indicated below.

CIE 15	Commission Internationale de l'Eclairage, *Colorimetry*
ANSI/IES LS-1	*Lighting Science: Nomenclature and Definitions for Illuminating Engineering*
ANSI/IES LM-79	Illuminating Engineering Society, *Optical and Electrical Measurements of Solid State Lighting Products*

3 Definitions

Terms used in this document such as "LED lamp" and "LED luminaire" are defined in ANSI/IES LS-1.

4 Chromaticity

4.1 Basis

The chromaticity coordinates and correlated color temperature (CCT) values used in this standard are based on the CIE colorimetry system (CIE 15, 2018). While the chromaticity of light is expressed by chromaticity coordinates such as (*x, y*) and (*u', v'*), the chromaticity of nominally white light can also be expressed by CCT and the distance from the Planckian locus. CCT is a more intuitive measure of the shade of white light than (*x, y*) or (*u', v'*).

Since chromaticity is two-dimensional, another parameter is needed to specify a chromaticity. For this purpose, distance from the Planckian locus on the CIE (*u*', 2/3 *v*') diagram, abbreviated as Duv in this standard, with symbol D_{uv} (defined in CIE 15, 2018), is used. Duv is the shortest distance from the chromaticity of a given light to the Planckian locus, with "+" sign for above and "-" sign for below the Planckian locus. The two values of CCT and Duv can be used together to specify the chromaticity of light.