BSR E1.69 - 20xx
Reporting the Dimming Performance of Entertainment Luminaires Using LED Sources

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a post-first review version

Approved as an American National Standard by the ANSI Board of Standards Review on _____.

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The Photometrics Working Group was the consensus body for the development of this standard. The working group's members with company affiliations and interest categories at the time the working group approved this standard on _____ are listed below:

Voting Members

xxx

Observer Members (Non-voting)

xxx

Interest category codes:

CP = custom-market producer DE = designer DR = dealer rental company G = general interest MP = mass-market producer U = user

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1 Introduction (informative)

1.1 Statement of the problem

Luminaires with LED sources sometimes exhibit dimming behavior that users find unacceptable or different from the dimming behavior of other luminaires. The dimming behavior is not necessarily objectively bad for all applications, but it is a problem if it is not what the user expects or if different luminaires dim to different levels when given the same Output Control Signal. For example, if one row of LED houselights dims to black when the controller is set at a nominal 10% but another row is still producing light, this can be a problem. Bringing the performance in line with user expectations after the equipment is installed can be expensive or impossible.

1.2 Approach taken in this standard

Some theatre consultants have been evaluating dimming behavior by dimming an LED luminaire from 100% output to 50% over 30 seconds, and then dimming it from 50% to 0% over 30 seconds, in each case while watching the illumination produced by the luminaire. This method gives a good subjective sense of whether a luminaire dims smoothly, but suffers from seeming to be too subjective. Furthermore, being done in real-time and not documented, it does not provide a way of comparing luminaires that can't be tested side-by-side. This standard is an attempt to standardize an ad hoc testing method now used in the field.

This standard only addresses the level of illumination or luminous flux produced. It does not address color changes in dimming, whether done deliberately as a product feature as an unintentional artifact of the dimming process.

Note: Clauses marked with an asterisk (*) have an explanatory note in the informative Annex A. The Annex A clause numbers mirror the clauses that reference them.

2 Scope (normative)

This standard applies to stage and studio luminaires falling within the scope of UL 1573 that use LED light sources, including phosphor-conversion white-light sources, phosphor-conversion colored sources, and narrow-band diode emitters. The luminaires within the scope of this standard have their light output level controlled by a digital signal conforming to ANSI E1.11, ANSI E1.17, ANSI E1.31, Art-Net, by an analog signal of nominally 0 to 10 volts per ANSI C137.1 or ANSI E1.3, by Mains-Dimming, or any combination of digital, analog, and Mains-Dimming.

3 Definitions (normative)

Definitions given in this standard are peculiar to this standard and are either not found in a common dictionary or are used in this standard with a meaning different from what might be found in a dictionary.

Far-field: The range of distances in front of the aperture of a luminaire in which the illumination produced by the luminaire on a surface varies proportionally to the inverse square of the distance from the aperture.

Mains-Dimming: A method of controlling the output level of a luminaire by controlling the average voltage of the electric power delivered to the luminaire without providing a separate control signal. Mains-dimming is the traditional method of dimming luminaires that use incandescent lamp light sources.

Output Control Signal: The signal applied to a luminaire to control its luminous output. The signal could be an analog voltage, a digital signal, or something else, but its purpose is to control the output of the luminaire. For Mains-Dimming the output control signal is the RMS voltage being supplied to power the luminaire. For digital control, the Output Control Signal is the digital signal to the luminaire. For analog

control, the Output Control Signal is the RMS control voltage supplied to the luminaire's control signal terminal.

4 Referenced standards and documents (normative)

ANSI C137.1-2019, American National Standard for Lighting Systems—0-10V Dimming Interface for LED Drivers, Fluorescent Ballasts, and Controls. Published by NEMA, the National Electrical Manufacturers Association, 1300 North 17th Street, Suite 900, Arlington, Virginia 22209, USA.

ANSI E1.3-2001 (R2016), Entertainment Technology - Lighting Control Systems - 0 to 10 V Analog Control Specification. Published by the Entertainment Services and Technology Association (ESTA), 271 Cadman Plaza, P.O. Box 23200, Brooklyn, NY 11202-3200, USA.

ANSI E1.11-2008 (R2018), Entertainment Technology -- USITT DMX512-A, Asynchronous Serial Digital Data Transmission Standard for Controlling Lighting Equipment and Accessories. Published by ESTA.

ANSI E1.17-2015, Entertainment Technology - Architecture for Control Networks (ACN). Published by ESTA.

ANSI E1.25-2012 (R2017), Recommended Basic Conditions for Measuring the Photometric Output of Stage and Studio Luminaires by Measuring Illumination Levels Produced on a Planar Surface. Published by ESTA.

ANSI E1.31-2018, Entertainment Technology - Lightweight streaming protocol for transport of DMX512 using ACN. Published by ESTA.

Art-Net versions 1 through 4. Published by Artistic Licence, The Mould Making Workshop, Soby Mews, Bovey Tracey TQ13 9JG, UK.

IES LM-78-17, Approved Method for Total Luminous Flux Measurement of Lamps Using an Integrating Sphere Photometer. Published by the Illuminating Engineering Society, 120 Wall Street, 17th Floor New York, NY 10005, USA.

IES LM-79-19, Approved Method: Optical and Electrical Measurements of Solid-State Lighting Products. Published by the Illuminating Engineering Society.

UL 1573, Stage and Studio Luminaires and Connector Strips (current edition). Published by Underwriters Laboratories, 333 Pfingsten Road, Northbrook, IL 60062-2096.

5 Requirements (normative)

5.1* Test setup

Any test setup and procedure may be used that can be reasonably said to quantify the luminous output of the luminaire being tested.

For luminaires using groups of differently colored emitters that can be separately controlled (e.g., emitters of different colors, such as red, blue, and green, or warm-white and cool-white), the test procedure shall be carried out for each emitter color group separately.

Two methods are suggested in the informative annex. For the purposes of E1.69, either will work, although they measure different photometric units. The integrating sphere method does not require a dark testing laboratory, but it requires an integrating sphere, which is a specialized testing apparatus, and some luminaires, such as spacelights, would require an extremely large integrating sphere.

Only one luminaire should be on branch circuit during the test. The goal is to avoid any interaction between luminaires due to one causing power line disturbances affecting the other.

5.2 Dimming measurements

5.2.1 The Output Control Signal shall be smoothly faded down along a straight-line function from the level producing 100% luminous output to 50% output over a period of 30 seconds. Measurements of the luminous output shall be taken every 0.5 seconds or more frequently.

5.2.2 The Output Control Signal shall be smoothly faded down along a straight-line function from the level producing 50% luminous output to 0% output (no output) over a period of 30 seconds. Measurements of the luminous output shall be taken every 0.5 seconds or more frequently.

5.2.3 The Output Control Signal shall be smoothly faded up along a straight-line function from the level producing 0% (no output) to 50% output over a period of 30 seconds. Measurements of the luminous output shall be taken every 0.5 seconds or more frequently.

5.2.4 The Output Control Signal shall be smoothly faded up along a straight-line function from the level producing 50% luminous output to 100% output over a period of 30 seconds. Measurements of the luminous output shall be taken every 0.5 seconds or more frequently.

5.2.5 If a luminaire may be controlled by more than one Output Control Signal, only one method should be used during a dimming test. For example, if a luminaire can be controlled by a 0 to 10 V analog signal and by Mains-Dimming, only one control method, analog or Mains-Dimming, should be used for the duration of a test.

5.3 Data presentation

5.3.1 The luminaire tested shall be clearly identified, including its software, firmware, and hardware version as appropriate.

5.3.2 The luminous output level as the luminaire is faded down and faded up per 5.2.1, 5.2.2, 5.2.3, and 5.2.4 shall be shown on a linear (not logarithmic) graph. The Y axis of the graph shall represent the measured luminous output. The X axis shall represent the Output Control Signal as it was varied over each 30-second test period.

The Output Control Signal for 0% output and 50% output when fading up and fading down shall be reported. The Output Control Signal for 50% output and 100% output when fading up and fading down shall be reported. The Output Control Signal shall be given in hexadecimal for digital control, as RMS control voltage for analog control, and as RMS voltage for Mains-Dimming. All voltages shall be reported with an accuracy to three significant digits.

5.3.3 Different dimming modes or different dimming curves, if they exist, shall be presented separately and clearly identified.

5.3.4 For luminaires using different color-groups of emitters that can be separately controlled, the data for each color-group shall be presented separately.

5.3.5 The luminaire's cooling mode used during the tests shall be specified, if there is a choice of cooling modes available. If no cooling mode choice is available, this shall be noted.

5.3.6 For luminaires in which the LED output intensity is controlled by pulse-width modulation (PWM), the PWM frequency of the driver used during the tests shall be specified. If LED output intensity is not determined by PWM, this shall be noted.

For luminaires offering a choice of PWM frequencies, the manufacturer shall present the results for at least one frequency. Presenting the results for several or all the available PWM frequencies is optional.

5.3.7 For Mains-Dimming, the dimming method used for the test (forward phase-control, reverse phase-control, voltage reduction, or other) shall be included in the test report. In addition, the manufacturer and model of the dimmer used for the test should be reported. Multiple graphs or tables will be needed to present the results if multiple dimming methods are used for the testing.

Annex A (Informative)

(Annex contains no requirements)

A.5.1 Test procedures

Two test procedures are described below. They do not measure the same thing, but either can work to quantify the output of a luminaire. The text below suggests how these test procedures might be done.

A.5.1.1 Flat wall illumination test setup

The flat wall method is useful when an integrating sphere is not available or not practical. The method involves the measurement of the illumination at a particular spot on a surface, assuming that the illumination at that spot is a reasonable sample of the total output of the luminaire. If this assumption is unreasonable, the integrating sphere method must be used.

The luminaire is mounted to illuminate a surface, per ANSI E1.25. The illumination level produced at the brightest spot on the surface when the Output Control Signal is set to produce the luminaire's maximum luminous output is measured with a photometer to establish the maximum illumination level. That Output Control Signal setting should be noted. Then, the Output Control Signal is reduced until that same spot on the surface is illuminated to 50% of the maximum. That establishes the 50% Output Control Signal level, and this control level should be noted. Then the Output Control Signal level is reduced until 0% of the maximum is reached at the test spot. That establishes the bottom of the Output Control Signal range. The Output Control Signal level for 0% output should be noted.

This method assumes that the brightest spot at 100% continues to be the brightest spot throughout the dimming range and is reasonably representative of the luminaire's output. If this is not so, the integrating sphere method in A.5.1.2 should be used.

A.5.1.2 Integrating sphere test setup

An integrating sphere is used per IES LM-79-19 and IES LM-78-17 to measure the total luminous flux from the luminaire.

The luminous flux produced when the Output Control Signal is set to produce the luminaire's maximum luminous output is measured with a photometer to establish the maximum luminous output level. That Output Control Signal setting should be noted. Then, the Output Control Signal is reduced until the luminous flux is 50% of the maximum. That establishes the 50% Output Control Signal level, and this Output Control Signal should be noted. Then the Output Control Signal level is reduced until the luminous flux is 0% of the maximum. That establishes the bottom of the Output Control Signal range. The Output Control Signal level for 0% output should be noted.