

NEMA 77-2017

Standard for Temporal Light Artifacts: Test Methods and Guidance for Acceptance Criteria



NEMA Standards Publication 77-2017

Temporal Light Artifacts: Test Methods and Guidance for Acceptance Criteria

Published by:

National Electrical Manufacturers Association

1300 North 17th Street, Suite 900

Rosslyn, Virginia 22209

www.nema.org

© 2017 National Electrical Manufacturers Association. All rights including translation into other languages, reserved under the Universal Copyright Convention, the Berne Convention for the Protection of Literary and Artistic Works, and the International and Pan American Copyright Conventions.

NOTICE AND DISCLAIMER

The information in this publication was considered technically sound by the consensus of persons engaged in the development and approval of the document at the time it was developed. Consensus does not necessarily mean that there is unanimous agreement among every person participating in the development of this document.

NEMA standards and guideline publications, of which the document contained herein is one, are developed through a voluntary consensus standards development process. This process brings together volunteers and/or seeks out the views of persons who have an interest in the topic covered by this publication. While NEMA administers the process and establishes rules to promote fairness in the development of consensus, it does not write the document and it does not independently test, evaluate, or verify the accuracy or completeness of any information or the soundness of any judgments contained in its standards and guideline publications.

NEMA 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 the publication, use of, application, or reliance on this document. NEMA disclaims and makes no guaranty or warranty, expressed or implied, as to the accuracy or completeness of any information published herein, and disclaims and makes no warranty that the information in this document will fulfill any of your particular purposes or needs. NEMA does not undertake to guarantee the performance of any individual manufacturer or seller's products or services by virtue of this standard or guide.

In publishing and making this document available, NEMA is not undertaking to render professional or other services for or on behalf of any person or entity, nor is NEMA undertaking to perform any duty owed by any person or entity to someone else. Anyone using this document should rely on his or her own independent judgment or, as appropriate, seek the advice of a competent professional in determining the exercise of reasonable care in any given circumstances. Information and other standards on the topic covered by this publication may be available from other sources which the user may wish to consult for additional views or information not covered by this publication.

NEMA has no power, nor does it undertake to police or enforce compliance with the contents of this document. NEMA does not certify, test, or inspect products, designs, or installations for safety or health purposes. Any certification or other statement of compliance with any health or safety-related information in this document shall not be attributable to NEMA and is solely the responsibility of the certifier or maker of the statement.

CONTENTS

Foreword	iv
1 General	1
1.1 Scope	1
1.2 References	1
2 Definitions	3
2.1 Flicker	3
2.2 Flicker Index	3
2.3 Jitter	3
2.4 Maximum Light Output Waveform (MLOW)	4
2.5 Modulation Depth	4
2.6 Percent Flicker	4
2.7 Phantom Array Effect	4
2.8 Short Term Flicker Indicator, P_{st}	4
2.9 Stroboscopic Effect	4
2.10 Stroboscopic Visibility Measure (SVM)	4
2.11 Temporal Light Artifact (TLA)	5
3 Background	5
3.1 TLA in Common Experience	5
3.2 Quantification of TLA	5
3.2.1 Modulation Depth and Flicker Index	6
3.2.2 Review of IEEE 1789 Metrics and Recommendations	7
3.2.3 Balancing TLA Requirements with Performance Requirements	8
3.2.4 Metrics for Objective Assessment of TLA Visibility	9
4 Selected Metrics	14
5 Measurement Method—Light Source	14
5.1 General	14

5.2	Testing Environment.....	15
5.3	Mains Supply	15
5.4	Test Equipment.....	15
5.5	Data Collection	16
5.6	Detailed Instructions	17
5.6.1	Equipment Setup for Light Source DUT.....	18
5.6.2	Test Procedure for Light Source DUT.....	18
5.6.3	Confirm Data Integrity	20
5.6.4	Evaluate Results	21
5.7	Conditions of Testing.....	22
6	Measurement Method—Dimmer.....	23
6.1	General.....	23
6.2	Testing Environment.....	23
6.3	Mains Supply	23
6.4	Test Equipment.....	23
6.5	Data Collection	24
6.6	Detailed Instructions	26
6.6.1	Equipment Setup for Dimmer DUT.....	26
6.6.2	Test Procedure for Dimmer DUT.....	27
6.6.3	Confirm Data Integrity	28
6.6.4	Evaluate Results	28
6.7	Conditions of Testing.....	29
7	Recommendations.....	29
Annex A	31

FIGURES

Figure 1	Definitions of Percent Flicker (Also called Modulation Depth or Modulation Percent) and Flicker Index	3
Figure 2	Example of Stroboscopic Effect.....	6
Figure 3	Comparison of IEEE 1789 Recommended Limits with Several Existing Light Sources and with SVM and Pst	7
Figure 4	Plot of ASSIST and IEC Pst metrics Calculated for a 30% Modulation Depth Single-Frequency Sine Wave Light Waveform.....	10
Figure 5	Plot of the Visibility Threshold	11
Figure 6	Plot of the SVM Metric, as a Function of Frequency, for Single Sine Wave Modulation.....	12
Figure 7	Plot of the SVM Metric.....	13
Figure 8	Equipment setup for TLA measurement of a light source.....	14
Figure 9	General Test Procedure for Light Sources.....	18
Figure 10	Setup Measurement Equipment and Light Source DUT	18
Figure 11	Procedure for Collecting Light Source TLA Data	20
Figure 12	Confirm Light Source Data Integrity	21
Figure 13	Procedure to Evaluate Light Source DUT Measurements	22
Figure 14	Equipment Setup for Dimmer Measurement.....	23
Figure 15	Output of Dimmer DUT.....	25
Figure 16	General Test Procedure for Dimmers	26
Figure 17	Setup Measurement Equipment and Dimmer DUT.....	26
Figure 18	Procedure to Collect Dimmer Data.....	27
Figure 19	Procedure to Confirm Dimmer Data Integrity	28
Figure 20	Procedure to Evaluate Dimmer DUT Measurements.....	29

TABLES

Table 1	Equipment Requirements for TLA Measurement.....	16
Table 2	Data Sampling Scheme.....	17
Table 3	Column Headings for Measurement Data Map.....	17
Table 4	Equipment Requirements for Dimmer TLA Measurement.....	24
Table 5	Format for Data Results Table	25
Table 6	Guidelines for Pst and SVM Acceptance Criteria.....	30

Foreword

A NEMA working group formed by a compilation of the Lighting, Lighting Controls, and Luminaire Sections has prepared this standard, *Temporal Light Artifacts: Test Methods and Guidance for Acceptance Criteria*. This standard provides measurement methods for metrics that address temporal light artifacts (TLA) for light sources, as well as measurement methods for leading-edge phase cut dimmers. It provides initial broad guidelines for limits on these metrics.

Inquiries, comments, and proposed or recommended revisions should be submitted to:

Senior Technical Director, Operations
National Electrical Manufacturers Association
1300 North 17th Street, Suite 900
Rosslyn, Virginia 22209

Section approval of the standard does not necessarily imply that all section members voted for its approval or participated in its development.

At the time the standard was approved, the Lighting Controls, Light Source and Luminaire sections were composed of the following members:

Acuity Brands, Inc.
Appleton Group
Atlas Lighting Products, Inc.
Coleman Cable LLC
Cree, Inc.
Current, powered by GE
Dialight
Eaton Lighting Solutions
EiKO Global, LLC
Energy Focus, Inc.
Enerlites Inc.
EYE Lighting International of N.A., Inc.
Feit Electric Company, Inc.
Focal Point LLC
General Electric Lighting
Halco Lighting Technologies
Hubbell Lighting, Inc.
Intense Lighting
LEDVANCE LLC
Legrand/Pass & Seymour
Leviton Lighting & Energy Solutions
Light Sources Inc.
Litetronics International, Inc.
Lucidity Lights, Inc.
Lumileds LLC
Lutron Electronics Company, Inc.
Mallite
OSRAM SYLVANIA Inc.
OttLite Technologies Inc.
Philips Lighting
RAB Lighting
Satco Products, Inc.
Schneider Electric

TCP International Holdings Ltd.
TerraLUX INC.
Thomas & Betts, A Member of the ABB Group
Universal Lighting Technologies
Ushio America, Inc.
Venture Lighting International

Currently in preview, click buy full version

< This page intentionally left blank.

Currently in preview, click buy full version

1 General

1.1 Scope

The purpose of the standard is to recommend a method of quantifying the visibility of temporal light artifacts (TLA) and to recommend initial, broad application-dependent limits on TLA.

The photometric recommendations and measurement methods are applicable to any lighting equipment (e.g., luminaires, light engines, self-ballasted lamps, drivers, and sensors) with any control system. Specific recommendations and measurement methods for controls are only included for phase-cut dimming.

The standard applies to visibility of TLA to human observers in applications with limited speeds of motion, such as an office environment. It does not address interference with optical equipment such as cameras and bar-code scanners. It does not address the potential for adverse stroboscopic effect in high-speed environments, such as machine shops. It does not address the phantom array effect.

1.2 References

The following references are noted throughout the document within square brackets: []

1. CIE TN 006:2016, "Visual Aspects of Time-Modulated Lighting Systems—Definitions and Measurement Models."
2. IES RP-16-2010 "Nomenclature and Definitions for Illuminating Engineering," 2010.
<https://www.ies.org/standards/ansi-ies-rp-16-10/>
3. IEC TR 61547-1, "Equipment for general lighting purposes—EMC immunity requirements—Part 1: An objective voltage fluctuation immunity test method," 1st edition, 2015.
4. IEC 61000-3-3, "Electromagnetic compatibility (EMC)—Part 3-3: Limits—Limitation of voltage changes, voltage fluctuations and flicker in public low-voltage supply systems, for equipment with rated current ≤ 16 A per phase and not subject to conditional connection", 3rd edition, 2013.
5. IEC 61000-4-15, "Electromagnetic compatibility (EMC)—Part 4-15: Testing and measurement techniques—Flickermeas— Functional and design specifications", 2nd edition, 2010.
6. M. Poplawski, "What You Need to Know about LED Flicker and Dimming," Presentation at Lightfair 2012.
https://www1.eere.energy.gov/buildings/publications/pdfs/ssl/poplawski_dimming_lightfair2012.pdf
7. U.S. Department of Energy Factsheet "Flicker," PNNL-SA-94791, 2013.
https://www1.eere.energy.gov/buildings/publications/pdfs/ssl/flicker_fact-sheet.pdf
8. IEEE 1789, "IEEE Recommended Practices for Modulating Current in High-Brightness LEDs for Mitigating Health Risks to Viewers," 2015. <http://grouper.ieee.org/groups/1789/>
9. Brad Lehman, Arnold J. Wilkins, "Designing to Mitigate Effects of Flicker in LED Lighting: Reducing risks to health and safety," Power Electronics Magazine (September 2014): 18-26.
10. California Title 24, "2016 Building Energy Efficiency Standards for Residential and Nonresidential Buildings" See appendices JA-8 and JA-10.
<http://www.energy.ca.gov/title24/2016standards/index.html>