# Revision History

|  |  |  |  |
| --- | --- | --- | --- |
| **Revision** | **Description** | **Date** | **Release** |
| 0 | Validation template as placed on the sharepoint |  |  |
| 1 | Revised 5.1 Line fluctuations and added 5.5 LED Driver compatibility | 2010/05/03 |  |
| 2 | Revised Section 6.5 to show Conducted and Radiated Emissions and list correct FCC part. Was 18 now 15. | 2010/06/24 |  |
| 3 | Revised Section 7.5 so that text matches table. | 2010/08/04 |  |
| 4 | Accepted changes and added tables for surge limits. | 2013/05/16 |  |
| 5 | Added Flicker and Driver Compatibility sections | 2013/05/21 |  |
| 6 | Added Driver Validation Tests | 2014/01/02 |  |
| 7 | Modified several tests to add driver output measurement parameters | 2014/02/26 |  |
| 8 | Added Immunity to Harmonic Disturbances test | 2014/04/28 |  |
| 9 | Added Frequency Variations test, Radiated RF EM field test, Conducted disturbances induced by RF fields test, Power frequency magnetic field test, Conducted CM disturbances test  Updated Surge test levels | 2014/05/29 |  |
| 10 | Updated 2.1 (Objective) and 2.2 (Scope) to cover all types of tests (Validation, Component Qualification, Engineering Verification, etc.) | 2014/08/22 |  |
|  |  |  |  |
|  |  |  |  |
|  |  |  |  |

**Approvals**

|  |  |  |  |
| --- | --- | --- | --- |
|  | **Title:** | **Signature:** | **Date:** |
| Created By: |  |  |  |
| Yelena Davis  Kellis Coffman | Principal Design Engineer  Sr. Electronics Engineer |  | 8/22/2014 |
| Reviewed By: |  |  |  |
| Mike Tanner | Director, Certification Testing |  |  |
| Approved By: |  |  |  |
| Yaser Abdelsamed | V.P., Light Engines - Outdoor |
| Approved By: |  |  |  |
| Yan Rodriguez | V.P., Light Engines - Indoor |  |  |
| Approved By: |  |  |  |
| Jim Hospordarsky | Director, Performance Testing |
| Approved By: |  |  |  |
| Fred Carpenter | V.P., Standards and Testing |  |  |

**Table of Contents**

1. Revision History 1

2. Overview 3

2.1. Objective 3

2.2. Scope 3

2.3. Normative References 3

2.4. Associated Documents 4

3. General Requirements 5

3.1. Test Environmental Conditions 5

3.2. Compliance Criteria 5

3.3. Test Report 5

4. Device Characteristics and Operation 6

4.1. Functional Demonstration 6

4.2. Low-Current LED Test 7

5. Electromagnetic Compatibility Tests 8

5.1. Conducted and Radiated Emissions 8

5.2. Surge – 1.2/50 µs – 8/20 µs Combination Wave 9

5.3. Surge – 1.2/50 µs – 8/20 µs Combination Wave – Parameter Measurement 11

5.4. Surge – 0.5 µs – 100 kHz Ring Wave 13

5.5. Surge – 0.5 µs – 100 kHz Ring Wave – Parameter Measurement 15

5.6. Electrical Fast Transient (EFT) 17

5.7 Electrostatic Discharge (ESD) 18

5.8 Radiated, radio-frequency electromagnetic field immunity 20

5.9 Immunity to conducted disturbances, induced by radio-frequency fields 22

5.10. Power frequency magnetic field immunity 23

5.11. Immunity to conducted common-mode disturbances 25

6. Electrical Tests 27

6.2 Power Interrupt on Start-up 27

6.3. Line Fluctuations – Voltage Variation and Interrupts 28

6.4. Ramp Input Voltage 29

6.5. Leakage Current 30

6.6. Steady State Characteristics 31

6.7. Inrush Current 32

6.8. Immunity to harmonic disturbances 33

6.9. Steady State Characteristics – Min/Max Load 36

6.10. Steady State Characteristics – Dimming 38

6.11. LED Driver Overload 40

6.12. LED Driver Start-Up Characteristics 41

6.13. LED Driver Open Circuit 42

6.14. LED Driver Output Short Circuit 43

6.15. LED Driver Output Load Step 44

6.16. LED Driver Low Line Voltage Response 45

6.17. LED Driver High Potential Test 46

6.18. Immunity to Frequency Variations 47

7. Environmental Tests 49

7.1. Temperature/Voltage Cycle 49

7.2. Thermal Shock – Sub assembly - Operating 51

7.3. Condensing Humidity 52

7.4. Dust Ingress 54

7.5. Moisture Ingress 55

7.6. Corrosion 56

8. Mechanical Tests 57

8.1. Vibration 1 – Sub Assembly 57

8.2. Vibration 2 58

8.3. Mechanical Shock 59

8.4. Drop Test 60

9. Appendix 61

9.1. Surge Test Measurement Set-up – Driver Output 61

9.2. Surge Test Measurement Set-up – 0-10V Dimming Interface 61

# Overview

## Objective

This document specifies testing procedures required for qualification of LED luminaires, luminaire subassemblies, and electronic components with appropriate sections and test levels selected based on the intended application.

The purpose of this document is to standardize the test methods across ABL.

Selected sections of this document should be identified and used in the final validation, sub-system qualification, component qualification, or engineering verification testing as applicable.

The test specifications included in this document verify a product performance within the specification limits, including the tests for application environment. It does not include all testing required for regulatory requirements (UL, CSA, etc.) or for making reliability predictions.

## Scope

This document includes specifications for electrical, mechanical, environmental testing and electromagnetic compatibility testing. The document does not cover the photometric performance of the product.

Tests specified in this document may be performed by Acuity, or an outside testing facility.

Luminaire assemblies, sub-assemblies, and components provided for the testing per this specification shall meet the following requirements:

* Samples for the Product Validation shall be of final design and manufactured on the production line
* Samples for the Electrical Sub-system Qualification shall be of final design but not necessarily manufactured on the production line
* Samples for the Components Qualification shall be of final design but not necessarily manufactured on the production line
* Sample for the Engineering Verification can be of a preliminary design, not manufactured on the production line

Pass-fail criteria specific to the product shall be identified prior to testing by a Product Engineer.

Any non-conformances in the test results shall be evaluated by a Product Engineer.

## Normative References

The following standards are referenced in this document:

|  |  |
| --- | --- |
| **ANSI/IEEE C62.41.1** | Guide on the Surge Environment in Low-Voltage (1000 V and Less) AC Power Circuits |
| **ANSI/IEEE C62.41.2** | Recommended Practice on Characterization of Surges in Low-Voltage (1000 V and Less) AC Power Circuits |
| **ANSI C82.77** | Harmonic Emission Limits-Related Power Quality Requirements for Lighting Equipment |
| **ANSI C136.31** | American National Standard for Roadway Lighting Equipment – Luminaire Vibration |
| **ASTM B 117** | Standard Practice for Operating Salt Spray (Fog) Apparatus |
| **ASTM D 5276** | Standard Test Method for Drop Test of Loaded Containers by Free Fall |
| **FCC Title 47 CFR Part 15** | Federal Communications Commission |
| **IEC 60068-2-3** | Basic Environmental Testing Procedure, Part 2 – Tests, Damp Heat Steady State |
| **IEC 60068-2-6** | Basic Environmental Testing Procedure, Part 2 – Tests, Vibration |
| **IEC 60068-2-14** | Basic Environmental Testing Procedure, Part 2 – Tests, Change of Temperature |
| **IEC 60068-2-27** | Basic Environmental Testing Procedure, Part 2 – Tests, Shock |
| **IEC 60529** | Degrees of protection provided by enclosures (IP code) |
| **IEC 60598** | Luminaires – Part 1: General requirements and tests |
| **IEC 61000-4-2** | Electromagnetic Compatibility (EMC): Testing and measurement techniques – Electrostatic discharge immunity test |
| **IEC 61000-4-3** | Electromagnetic compatibility (EMC): Radiated electromagnetic field requirements |
| **IEC 61000-4-4** | Electromagnetic compatibility (EMC): Testing and measurement techniques – Electrical fast transient/burst immunity test |
| **IEC 61000-4-5** | Electromagnetic compatibility (EMC): Testing and measurement techniques – Surge immunity test |
| **IEC 61000-4-6** | Electromagnetic compatibility (EMC): Testing and measurement techniques – Immunity to conducted disturbances, induced by radio-frequency fields |
| **IEC 61000-4-8** | Electromagnetic compatibility (EMC): Testing and measurement techniques – Power frequency magnetic field immunity test |
| **IEC 61000-4-13** | Electromagnetic compatibility (EMC): Testing and measurement techniques – Harmonics and inter-harmonics including mains signaling at a.c. power port, low frequency immunity test |
| **IEC 61000-4-16** | Electromagnetic compatibility (EMC): Testing and measurement techniques – Test for immunity to conducted common mode disturbances in the frequency range 0 Hz to 150 kHz |
| **IEC 61000-4-28** | Electromagnetic compatibility (EMC): Testing and measurement techniques – Variation of power frequency, immunity test |
| **IEC 61547** | Electromagnetic compatibility (EMC): Equipment for general lighting purposes – EMC immunity requirements |
| **IEEE 519** | Recommended Practices and Requirements for Harmonic Control in Electric Power Systems |
| **NEMA 410** | Performance Testing for Lighting Controls and Switching Devices with Electronic Fluorescent Ballasts |
| **UL 991** | Tests for Safety-Related Controls Employing Solid-State Devices |
| **UL1012** | Power Units Other than Class 2 |
| **UL 1029** | High-Intensity-Discharge Lamp Ballasts |
| **UL1598** | Luminaires |
| **UL 8750** | Light Emitting Diode (LED) Equipment for Use in Lighting Products |

## Associated Documents

The following documents are required for the reference during testing:

* Product Specification
* Pass-fail criteria specific to the device under test
* Acuity Brands Certification and Test Strategy (C&TS) Validation Checklist – for Product Validation Testing
* Electrical Sub-System Qualification Test Specification – for Electrical Sub-system Qualification testing
* Component Qualification Test Specification – for Component Qualification testing
* Verification Test Plan – for Engineering Verification testing

# General Requirements

## Test Environmental Conditions

Unless otherwise specified the environmental ranges for testing shall be:

|  |  |
| --- | --- |
| Ambient Temperature: | 25 +/- 5°C |
| Relative Humidity: | ≤ 75% |

## Compliance Criteria

|  |  |
| --- | --- |
| **Criterion A** | No discernible effects on the DUT’s (Device Under Test) operation. |
| **Criterion B** | The operation of the DUT may be affected but must recover with no lasting damage or operational effects if safety is not compromised by the failure mode. |
| **Criterion C** | Permanent damage may occur to the DUT if safety is not compromised by the failure mode. |

## Test Report

All test data shall be included in the Validation Test Report.

The test report shall include results of Functional Demonstration before and after each test (as required per individual test specifications).

If more than one test is performed on a single DUT, the report shall list the order in which the tests were executed.

# Device Characteristics and Operation

## Functional Demonstration

### Objective

The functional demonstration is intended to verify an operational integrity of the DUT before and after the DUT is subject to testing, as required by the test plan.

### Applicable Standards

NA

### Device under Test

Luminaire  Subassembly  Electronic Component

### Test Levels and Limits

Operating Voltage: Lowest Nominal Line Voltage (LNLV)      (e.g.120VAC)

Highest Nominal Line Voltage (HNLV)      (e.g.277VAC)

### Equipment List

Adjustable AC Voltage Source

Power Analyzer

### Procedure

An initial functional demonstration shall be performed to establish baseline characteristics that may be used for comparison after additional testing. Visual inspection shall be performed on the DUT. A visual inspection shall verify correct parts and placement as well as inspect for damage.

**Visual Inspection**

* Verify that all correct components are installed in the system.
* Verify system wiring and connectors polarity
* Inspect components for damage, corrosion and other defects

**Functional Test**

* Connect DUT to Programmable AC Power Supply.
* Apply power to the DUT
* Measure DUT parameters for the input voltages specified in the table below
* Verify that every emitter of the DUT’s LED Module is energized.

|  |  |  |  |
| --- | --- | --- | --- |
| Point of Measurement | Parameter | Operating Voltage (V AC) | |
| LNLV | HNLV |
| DUT Input | Current | X | X |
| Power | X | X |
| PF | X | X |
| % ITHD | X | X |
| LED Driver Output | Voltage | X | X |
| Current | X | X |

All measured parameters and observed conditions must be documented as test data.

### Compliance

All measured characteristics must comply with Product Specification.

## Low-Current LED Test

### Objective

The functional demonstration is intended to verify an operational integrity of the DUT (LED Module) before and after the DUT is subjected to testing, as required by the test plan.

Testing LED at low current (5mA or below for discrete LED) is required to detect component damage related to EOS (Electrical OverStress). EOS-damaged LED will not light-up at low current, but may light-up at higher current.

COB (Chip On Board) LED components may have minimum light-up current higher than discrete LED due to series-parallel configuration of COB dies.

LED or COB specification should be consulted to determine the minimum light-up current.

### Applicable Standards

NA

### Device under Test

Subassembly  Electronic Component

### Test Levels and Limits

Operating Current: minimum light-up current per LED/COB specification

### Equipment List

DC Power Supply

Oscilloscope

### Procedure

* Set the DC Power Supply current to a required minimum light-up level
* Connect DUT (LED Module) to a Power Supply.
* Apply power to the DUT
* Verify that every emitter of the LED Module is lit
* Remove power from DUT

### Compliance

All LEDs and COB dies in the Module shall be lit at the minimum light-up current.

## 

# Electromagnetic Compatibility Tests

## Conducted and Radiated Emissions

### Objective

This test ensures that the DUT does not electrically interfere with other electronic devices via power line or radiated.

### Applicable Standards

FCC Title 47 CFR Part 15

### Device under Test

Luminaire  Subassembly  Electronic Component

### Test Levels and Limits

Lowest Nominal Line Voltage (LNLV)       (e.g.120VAC)

Highest Nominal Line Voltage (HNLV)       (e.g.277VAC)

Class A (Non-consumer)  Class B (Consumer)  as defined in FCC Title 47 CFR Part 15.

### Procedure

This test shall be performed in accordance with FCC Title 47 CFR Part 15.

A test report, provided by the testing laboratory, shall include the test setup, test conditions, test procedure, and test results.

### Compliance

Conducted emissions from the DUT shall comply with the limits specified by FCC Title 47 CFR Part 15 with at least 3 dB margin (on average) for luminaire and subassembly, at least 6 dB margin for a stand-alone electronic component.

## Surge – 1.2/50 µs – 8/20 µs Combination Wave

### Objective

This test will demonstrate the ability for an electronic product to survive surge transients in typical operating environments.

### Applicable Standards

ANSI/IEEE C62.41.1

ANSI/IEEE C62.41.2

IEC 61000-4-5

### Device under Test

Luminaire  Subassembly  Electronic Component

### Test Levels and Limits

Select the surge levels by selecting use and location check boxes.

* **Luminaire and Subassembly:**

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| **Category** | | **Sub-Category** | | **Voltage, kV** | **Current, kA** |
| Residential |  | Indoor |  | NA | NA |
| Exterior Building -Mounted |  | NA | NA |
| Outdoor |  | 6 | 3 |
| Commercial |  | Indoor |  | 2 | 1 |
| Exterior Building-Mounted |  | 2 | 1 |
| Outdoor |  | 6 | 3 |
| Highbay |  | 2 | 1 |
| Industrial |  | Indoor |  | 6 | 3 |
| Exterior Building-Mounted (non-roadway) |  | 6 | 3 |
| Highbay |  | 6 | 3 |
| Sport Arenas & Convention Centers |  |  | | 6 | 3 |
| Roadway |  |  | | 10 | 5 |
| Stage & Studio |  |  | | 6 | 3 |

* **Electronic Component**:

Maximum surge level per component specification

Operating Voltage: Lowest Nominal Line Voltage (LNLV)       (e.g.120VAC)

Highest Nominal Line Voltage (HNLV)       (e.g.277VAC)

### Equipment List

Surge Generator

### Procedure

The test area will be set up according to IEC 61000-4-5.

The DUT shall undergo the following tests:

|  |  |
| --- | --- |
| **Parameter** | **Test Level/ Configuration** |
| Short Circuit Current Peak (from table) | kA |
| Open Circuit Voltage Peak (from table) | kV |
| Source Impedance | 2Ω |
| Coupling | L1 to L2  L1 to PE  L2 to PE  L1 and L2 to PE |
| Polarity and Phase Angle | Positive at 90° and Negative at 270° |
| Number of Pulses | 5 for each setting (40 total) |
| Time Between Pulses | 1 minute |

The DUT shall be tested for all of the listed configurations in the test plan (different drivers and LED load configurations).

### Compliance

Criterion level B is required for this test. No unsafe operating conditions may occur during the test including smoke, flame and arcing.

LED Module shall pass the Low-current LED test (Section 4.2)

Luminaire or subassembly shall pass the Functional verification test (Section 4.1)

## Surge – 1.2/50 µs – 8/20 µs Combination Wave – Parameter Measurement

### Objective

This test will ensure that LED driver output parameters during surge would not exceed LED Module specifications.

### Applicable Standards

IEC 61000-4-5

### Device under Test

Luminaire  Subassembly  Electronic Component

### Test Levels and Limits

Lowest Nominal Line Voltage (LNLV)       (e.g.120VAC)

Highest Nominal Line Voltage (HNLV)       (e.g.277VAC)

### Equipment List

Surge Generator

Oscilloscope

Differential Voltage Probe

AC Current Probe

DC Current Probe

### Procedure

The test area will be set up according to IEC 61000-4-5.

The DUT shall undergo the following tests:

|  |  |
| --- | --- |
| **Parameter** | **Test Level/ Configuration** |
| Short Circuit Current Peak (from table) | Per Section 5.2 |
| Open Circuit Voltage Peak (from table) | Per Section 5.2 |
| Coupling | L1 to L2  L1 to PE  L2 to PE  L1 and L2 to PE |
| Polarity and Phase Angle | Positive at 90° and Negative at 270° |
| Number of Pulses | 1 for each setting at two line voltages (16 total) |
| Time Between Pulses | 1 minute minimum |

The DUT shall be tested for all of the listed configurations in the test plan (different drivers and LED load configurations).

The following measurements shall be taken once for each coupling and line voltage (16 sets of measurements total) for each luminaire configuration.

1. **LED Driver Output Measurements**

See Appendix 9.1 for the measurement and oscilloscope settings.

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **Coupling** | **Driver Output Measurements** | | | |
| **Current, Max (A)** | **Voltage (Differential Mode), Max (V)** | **Voltage (Common-Mode), Max (V)** | **Common-mode Voltage Slew Rate (V/s)** |
| L1 to L2 | x | x | x | x |
| L1 to PE | x | x | x | x |
| L2 to PE | x | x | x | x |
| L1, L2 to PE | x | x | x | x |

1. **LED Driver 0-10V Dimming Interface Measurements**

For the system using driver 0-10V dimming interface, see Appendix 9.2 for the measurement and oscilloscope settings.

The measurements shall be taken in two 0-10V interface configurations:

* 0-10V interface wires - open circuit (Dimming Module is not connected)
* 0-10V interface wires with Dimming Module connected

|  |  |  |
| --- | --- | --- |
| **Coupling** | **Driver 0-10V Interface Measurements** | |
| **Dimming Interface Voltage - Open Circuit, Max (V)** | **Dimming Interface Voltage – with Dimming Module, Max (V)** |
| L1 to L2 | x | x |
| L1 to PE | x | x |
| L2 to PE | x | x |
| L1, L2 to PE | x | x |

### Compliance

Measured parameters on the driver output shall not exceed LED Module component specifications.

Measured parameter on the 0-10V dimming interface shall not exceed Dimming Module specifications.

## Surge – 0.5 µs – 100 kHz Ring Wave

### Objective

This test will demonstrate the ability for an electronic product to survive surge transients in typical operating environments.

### Applicable Standards

ANSI/IEEE C62.41.1

ANSI/IEEE C62.41.2

IEC 61000-4-5

### Device under Test

Luminaire  Subassembly  Electronic Component

### Test Levels and Limits

ANSI/IEEE C61.42.2

Select the surge levels by selecting use and location check boxes.

* **Luminaire and Subassembly:**

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| **Category** | | **Sub-Category** | | **Voltage, kV** | **Impedance, Ω** | **Current, kA** |
| Residential |  | Indoor |  | 2.5 | 30 | 0.083 |
| Exterior Building -Mounted |  | 2.5 | 30 | 0.083 |
| Outdoor |  | 6 | 12 | 0.5 |
| Commercial |  | Indoor |  | 2.5 | 30 | 0.083 |
| Exterior Building-Mounted |  | 2.5 | 30 | 0.083 |
| Outdoor |  | 6 | 12 | 0.5 |
| Highbay |  | 2.5 | 30 | 0.083 |
| Industrial |  | Indoor |  | 6 | 12 | 0.5 |
| Exterior Building-Mounted (non-roadway) |  | 6 | 12 | 0.5 |
| Highbay |  | 6 | 12 | 0.5 |
| Sport Arenas & Convention Centers |  |  | | 6 | 12 | 0.5 |
| Roadway |  |  | | 6 | 12 | 0.5 |
| Stage & Studio |  |  | | 2.5 | 12 | 0.208 |

* **Electronic Component:**

Maximum surge level per component specification

Operating Voltage: Lowest Nominal Line Voltage (LNLV)       (e.g.120VAC)

Highest Nominal Line Voltage (HNLV)       (e.g.277VAC)

### Equipment List

Surge Generator

### Procedure

The test area will be set up according to IEC 61000-4-5.

The DUT shall undergo the following tests:

|  |  |
| --- | --- |
| **Parameter** | **Test Level/Configuration** |
| Short Circuit Current Peak (CP from table) | kA |
| Open Circuit Voltage Peak (PV from table) | kV |
| Coupling | L1 to L2  L1 to PE  L2 to PE  L1 and L2 to PE |
| Polarity and Phase Angles | Positive at 90° and Negative at 270° |
| Number of Pulses | 5 for each setting (40 total) |
| Time between Pulses | 1 minute |

The DUT shall be tested for all of the listed configurations in the test plan (different drivers and LED load configurations).

### Compliance

Criterion level B is required for this test. No unsafe operating conditions may occur during the test including smoke, flame and arcing.

LED Module shall pass the Low-current LED test (Section 4.2)

Luminaire or subassembly shall pass the Functional verification test (Section 4.1)

## Surge – 0.5 µs – 100 kHz Ring Wave – Parameter Measurement

### Objective

This test will ensure that LED driver output parameters during surge would not exceed LED Module or Control Modules specifications.

### Applicable Standards

IEC 61000-4-5

### Device under Test

Luminaire  Subassembly  Electronic Component

### Test Levels and Limits

Lowest Nominal Line Voltage (LNLV)       (e.g.120VAC)

Highest Nominal Line Voltage (HNLV)       (e.g.277VAC)

### Equipment List

Surge Generator

Oscilloscope

Differential Voltage Probe

AC Current Probe

DC Current Probe

### Procedure

The test area will be set up according to IEC 61000-4-5.

The DUT shall undergo the following tests:

|  |  |
| --- | --- |
| **Parameter** | **Test Level/ Configuration** |
| Short Circuit Current Peak (from table) | Per Section 5.4 |
| Open Circuit Voltage Peak (from table) | Per Section 5.4 |
| Coupling | L1 to L2  L1 to PE  L2 to PE  L1 and L2 to PE |
| Polarity and Phase Angle | Positive at 90° and Negative at 270° |
| Number of Pulses | 1 for each setting at two line voltages (16 total) |
| Time Between Pulses | 1 minute minimum |

The DUT shall be tested for all of the listed configurations (different drivers and LED load configurations).

The following measurements shall be taken once for each coupling and line voltage (16 sets of measurements total) for each luminaire configuration.

1. **LED Driver Output Measurements**

See Appendix 9.1 for the measurement and oscilloscope settings.

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **Coupling** | **Driver Output Measurements** | | | |
| **Current, Max (A)** | **Voltage (Differential Mode), Max (V)** | **Voltage (Common-Mode), Max (V)** | **Common-mode Voltage Slew Rate (V/s)** |
| L1 to L2 | x | x | x | x |
| L1 to PE | x | x | x | x |
| L2 to PE | x | x | x | x |
| L1, L2 to PE | x | x | x | x |

1. **LED Driver 0-10V Dimming Interface Measurements**

For the system using driver 0-10V dimming interface, see Appendix 9.2 for the measurement and oscilloscope settings.

The measurements shall be taken in two 0-10V interface configurations:

* 0-10V interface wires - open circuit (Dimming Module is not connected)
* 0-10V interface wires with Dimming Module connected

|  |  |  |
| --- | --- | --- |
| **Coupling** | **Driver 0-10V Interface Measurements** | |
| **Dimming Interface Voltage - Open Circuit, Max (V)** | **Dimming Interface Voltage – with Dimming Module, Max (V)** |
| L1 to L2 | x | x |
| L1 to PE | x | x |
| L2 to PE | x | x |
| L1, L2 to PE | x | x |

### Compliance

Measured parameters on the driver output shall not exceed LED Module component specifications.

Measured parameter on the 0-10V dimming interface shall not exceed Dimming Module specifications.

## Electrical Fast Transient (EFT)

### Objective

The EFT test simulates a low energy, high transition rate interference that can be caused by various conditions on the power line. These conditions might include equipment switching, faulty equipment, and other man-made interference.

### Applicable Standards

ANSI/IEEE C62.41.1

ANSI/IEEE C62.41.2

IEC 61000-4-4

### Device under Test

Luminaire  Subassembly  Electronic Component

### Test Levels and Limits

|  |  |
| --- | --- |
| **Parameter** | **Test Level/ Configuration** |
| Peak Voltage ( PV)(Open Circuit) | 2kV (Direct Coupling) |
| Burst Repetition Rate (BRR) | 5kHz |
| Polarity | Positive and Negative |
| Burst Duration | 15 mS |
| Burst Period | 300 mS |
| Coupling | L1, L2, PE, L1:L2, L1:PE, L2:PE, L1:L2:PE |
| Test Duration for Each Coupling and Polarity | 1 Minute (14 minutes of testing) |

### Equipment List

Surge Generator

Oscilloscope

### Procedure

The test set-up and procedure shall be conducted in accordance with IEC 61000-4-4.

### Compliance

Criterion level A is required for this test.

LED Module shall pass the Low-current LED test (Section 4.2)

Luminaire or subassembly shall pass the Functional verification test (Section 4.1)

## 5.7 Electrostatic Discharge (ESD)

### Objective

The intent of this test is to subject the DUT to ESD conditions expected in manufacturing, installation, operation or maintenance. Direct discharges occur when personnel physically touch the enclosure or exposed electronics, or when the DUT comes into contact with objects that are electro-statically charged. Indirect discharges simulate events such as a collapsing electric field created by nearby ESD radiated emission or by relays making or breaking a load.

The ESD test includes points and surfaces that are accessible to users during normal use and includes points inside the assembly that are accessed during normal customer maintenance. Typical customer maintenance does not include troubleshooting or replacing components.

### Applicable Standards

IEC 61000-4-2

### Device under Test

Luminaire  Subassembly  Electronic Component

### Test Levels and Limits

|  |  |  |
| --- | --- | --- |
| **Parameter** | **Direct Discharge** | |
| **Contact** | **Air** |
| ESD Peak Voltage (PV) (IEC 61000-4-2,)      ) |  |  |
| ESD Polarity | Positive and Negative | |
| DUT Operating Voltage | Lowest Nominal Line Voltage (e.g.120VAC)  Highest Nominal Line Voltage (e.g.277VAC) | |

### Equipment List

ESD Simulator

The test area shall be setup in accordance with IEC 61000-4-2

Adjustable AC Voltage Source

### Procedure

The test shall be conducted per IEC 61000-4-2 procedure

1. Direct Contact Discharge

The tip of the ESD simulator probe must always be in contact with the DUT before the discharge switch is operated.

* 1. Ten discharges (5 in each polarity) shall be made at each point as shown in the Figure 5.7.1. The DUT shall be in its normal operating state during the test. The test shall be repeated for each operating voltage.
  2. Ten discharges (5 in each polarity) shall be made at each point as shown in the Figure 5.7.2. The DUT shall be de-energized during the test.

Any anomalies and DUT failures during the test shall be recorded.

The test shall be followed by a functional demonstration (refer to Section 4.1 of this document).

1. Direct Air Discharge

The tip of the ESD simulator probe shall be moved as fast as possible (without causing mechanical damage) toward the DUT with the discharge switch held active. The ESD simulator tip shall be held perpendicular to the surface of the DUT during the approach. After each discharge, the ESD simulator shall be moved away from the DUT and reset for a new discharge.

1. Ten discharges (5 in each polarity) shall be made at each point as shown in the Figure 5.7.1. The DUT shall be in its normal operating state during the test. The test shall be repeated for each operating voltage.
2. Ten discharges (5 in each polarity) shall be made at each point as shown in the Figure 5.7.2. The DUT shall be de-energized during the test.

Any anomalies and DUT failures during the test shall be recorded.

The test shall be followed by a functional demonstration (refer to Section 4.1 of this document).

**Insert Figure Here**

**Figure 5.7.1. ESD discharge points, external**

**Insert Figure Here**

**Figure 5.7.2. ESD discharge points, wiring compartment**

### Compliance

Criterion level A is required for this test.

LED Module shall pass the Low-current LED test (Section 4.2)

Luminaire or subassembly shall pass the Functional verification test (Section 4.1)

## 5.8 Radiated, radio-frequency electromagnetic field immunity

### Objective

This test is applicable to the immunity requirements of electrical and electronic equipment to radiated electromagnetic energy. The object is to develop a common reference for evaluating the immunity of electrical and electronic equipment when subjected to radiated, radio-frequency electromagnetic fields.

Electromagnetic radiation is frequently generated by hand-held radio transceivers, fixed station radio and television transmitters, vehicle radio transmitters, and various industrial electromagnetic sources. There has been a significant increase in radio telephones along with other RF emitting devices in recent years. These devices operate between 800MHz to 6GHz and use a variety of modulation techniques. The tests for protection against RF devices are normally performed from 800MHz to 960MHz and from 1.4GHz to 6GHz. Products that operate above 3GHz are generally lower power devices which are less likely to present a significant problem.

### Applicable Standards

IEC 61547

IEC 61000-4-3

### Device under Test

Luminaire  Subassembly  Electronic Component

### Test Levels and Limits

**DUT Input Voltage**

Lowest Nominal Line Voltage (LNLV)       (e.g.120VAC)

Highest Nominal Line Voltage (HNLV)       (e.g.277VAC)

**Field Strength**

The levels for the unmodulated carrier field strength are in Table 5.8.1. For testing of equipment, the carrier signal is 80% amplitude modulated with a 1 kHz sine wave to simulate actual threats.

Commercial applications are Class 2, use level 2 in Table 5.8.1

Industrial applications are Class 3, use level 3 in Table 5.8.1



Table 5.8.1 Test levels related to general purpose, digital radio telephones and other RF devices

**Test Frequency Range**

Test levels related to general purpose: 80 MHz to 1,000 MHz

Test levels related to protection against RF emissions from digital radio telephones and other RF emitting devices: 800 MHz to 960 MHz and 1.4 GHz to 6GHz

The frequencies or frequency bands selected for the test are limited to those where mobile radio telephones and other intentional RF emitting devices actually operate.

### Procedure

A test report, provided by the testing laboratory, shall include the test setup, test conditions, test procedure, and test results.

### Compliance

Criterion level B is required for the tests. No unsafe operating conditions may occur during the test including smoke, flame and arcing to the enclosure.

## 5.9 Immunity to conducted disturbances, induced by radio-frequency fields

### Objective

The test deals with conducted immunity requirements of electrical and electronic equipment to electromagnetic disturbances coming from intended radio frequency transmitters in the frequency range of 150 kHz to 80 MHz. The test subjects the DUT to a source of an EM RF field (electric and magnetic) which simulates those coming from intentional RF transmitters. The disturbance is applied to the mains, communication lines and interface cables with coupling-decoupling devices (CDNs).

### Applicable Standards

IEC 61547

IEC 61000-4-6

### Device under Test

Luminaire  Subassembly  Electronic Component

### Test Levels and Limits

**DUT Input Voltage**

Lowest Nominal Line Voltage (LNLV)       (e.g.120VAC)

Highest Nominal Line Voltage (HNLV)       (e.g.277VAC)

**Open Circuit e.m.f.** (expressed in r.m.s.)

The levels for the unmodulated disturbing signal are in Table 5.9.1. For testing of equipment, the signal is 80% amplitude modulated with a 1 kHz sine wave to simulate actual threats. The test levels are set at the DUT port of the coupling devices. The DUT ports include signal, control, input mains and output mains.

Commercial applications are Class 2, use level 2 in Table 5.9.1 (moderate EM radiation environment)

Industrial applications are Class 3, use level 3 in Table 5.9.1 (severe EM radiation environment)



Table 5.9.1 Test levels

**Test Frequency Range**

The test frequency range is from 150 kHz to 80 MHz

### Procedure

A test report, provided by the testing laboratory, shall include the test setup, test conditions, test procedure, and test results.

### Compliance

Criterion level B is required for the tests. No unsafe operating conditions may occur during the test including smoke, flame and arcing to the enclosure.

## 5.10 Power frequency magnetic field immunity

### Objective

The test relates to the immunity requirements of equipment, only under operational conditions, to magnetic disturbances at power frequencies, 50 Hz and 60 Hz. The test is intended to demonstrate the immunity of equipment to power frequency magnetic fields related to the specific location and installation condition of the equipment. The magnetic field is generated by power frequency current in conductors in the proximity of the equipment.

This test is for equipment located in the proximity of high magnetic fields: power stations, railway locomotives, and near MRI scanners. This test should be considered for those locations/applications, but not for general lighting applications.

### Applicable Standards

IEC 61547

IEC 61000-4-8

### Device under Test

Luminaire  Subassembly  Electronic Component

### Test Levels and Limits

**DUT Input Voltage**

Lowest Nominal Line Voltage (LNLV)       (e.g.120VAC)

Highest Nominal Line Voltage (HNLV)       (e.g.277VAC)

**Magnetic Field Strength**

The magnetic field strength for continuous and short duration application of the magnetic field, applicable to distribution networks at 50 Hz and 60 Hz, is given in Table 5.10.1 and 5.10.2.

The magnetic field strength is expressed in A/m; 1 A/m corresponds to a free space magnetic flux density of 1.26uT.

Commercial applications are Class 2 or 3, use level 2 in Table 5.10.1 and 5.10.2

Industrial applications are Class 3 or 4, use level 3 in Table 5.10.1 and 5.10.2

Refer to Annex C and D of IEC 61000-4-8 for selection of the level.



Table 5.10.1 Test Levels for continuous field



Table 5.10.2 Test Levels for short duration: 1 to 3 s

### Procedure

A test report, provided by the testing laboratory, shall include the test setup, test conditions, test procedure, and test results.

### Compliance

Criterion level B is required for the tests. No unsafe operating conditions may occur during the test including smoke, flame and arcing to the enclosure.

## 5.11 Immunity to conducted common-mode disturbances

### Objective

This test relates to immunity requirements of electrical and electronic equipment to conducted, common mode disturbances from DC to 150 kHz. The conducted common mode disturbances originate from power line currents and return leakage currents in the grounding or earthing system. The tests cover continuous mode and short term mode at DC, mains (50 or 60 Hz), and 15 Hz to 150 kHz swept mode.

### Applicable Standards

IEC 61000-4-16

### Device under Test

Luminaire  Subassembly  Electronic Component

### Test Levels and Limits

Lowest Nominal Line Voltage (LNLV)       (e.g.120VAC)

Highest Nominal Line Voltage (HNLV)       (e.g.277VAC)

The levels in the tables 5.11.1 and 5.11.2 apply to test voltage d.c. and mains frequencies of 162/3 Hz, 50 Hz and 60 Hz.

The levels in table 5.11.3 are for the frequency range of 15 Hz to 150 kHz.

The test voltage is applied in common mode to power supply, input and output, and communication ports.

Refer to Annex B of IEC 61000-4-16 for selection of the level.



Table 5.11.1 Levels for continuous disturbance



Table 5.11.2 Levels for short duration disturbance



Table 5.11.1 Test levels in the frequency range 15 Hz-150 kHz

### Procedure

A test report, provided by the testing laboratory, shall include the test setup, test conditions, test procedure, and test results.

### Compliance

Criterion level B is required for the tests. No unsafe operating conditions may occur during the test including smoke, flame and arcing to the enclosure.

# Electrical Tests

## 6.2 Power Interrupt on Start-up

### Objective

To determine the DUT’s sensitivity to short voltage interrupt during start-up conditions.

### Applicable Standards

N/A

### Device under Test

Luminaire  Subassembly  Electronic Component

### Test Levels and Limits

Operating voltage: Highest Nominal Line Voltage (HNLV)       (e.g.277VAC)

### Equipment List

Programmable AC Power Supply

Oscilloscope

### Procedure

|  |  |  |  |
| --- | --- | --- | --- |
| **Step #** | **Supply Voltage, VAC** | **Phase Angle** | **Dwell Time** |
| 1 | 0 | - | - |
| 2 | HNLV | 90 | 2 line cycles |
| 3 | 0 | - | 10 line cycles |
| 4 | HNLV |  | 2 seconds |
| 5 | 0 | - | 10 seconds |
| 6 | HNLV | 90 | 3 line cycles |
| 7 | 0 | - | 10 line cycles |
| 8 | HNLV |  | 2 seconds |
| 9 | 0 | - |  |

The following parameters shall be monitored and documented:

|  |  |  |
| --- | --- | --- |
| **Driver Output Voltage, Max**  **(V)** | **Driver Output Current, Max**  **(A)** | **Driver Output Current Pulse Duration (s)** |
| x | x | x |

### Compliance

Criterion level B is required for this test.

Maximum allowed driver output current shall not exceed LED Module current specification.

## Line Fluctuations – Voltage Variation and Interrupts

### Objective

This test simulates common voltage variation and interrupts that occur on utility power lines.

### Applicable Standards

IEC61000-4-11 (pre-compliance)

### Device under Test

Luminaire  Subassembly  Electronic Component

### Test Levels and Limits

Nominal voltage: Lowest Nominal Line Voltage (LNLV)       (e.g.120VAC)

Highest Nominal Line Voltage (HNLV)       (e.g.277VAC)

Under-voltage: (80% of nominal voltage)

(70% of nominal voltage)

(40% of nominal voltage)

### Equipment List

Programmable AC Power Supply

Step-up transformer

Oscilloscope

### Procedure

The DUT shall be supplied with nominal operating voltage. The power supply shall be programmed to set the required voltage test level instantaneously. The interval between each test shall be no less than 10 seconds.

The tests shall be repeated for each specified nominal voltage.

The data shall be recorded for all variations (models) of the product.

The report shall include a scope reading from each test levels in the table below.

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| **Test Voltage** | **Phase Angle** | **Duration** | **Test Criteria** | **Driver Output Voltage, Max (V)** | **Driver Output Current, Max (A)** | **Driver Output Current Pulse Duration, Max (s)** |
| 80% | 0 | 300 line cycles | Criterion A | x | x | x |
| 70% | 0 | 30 line cycles | x | x | x |
| 40% | 0 | 12 line cycles | x | x | x |
| 0 | 0, 45, 90, 135, 180, 225, 270, 315 | 1 line cycle | x | x | x |
| 0 | 0, 45, 90, 135, 180, 225, 270, 315 | 12 line cycles | Criterion B | x | x | x |
| 0 | 0, 45, 90, 135, 180, 225, 270, 315 | 300 line cycles | x | x | x |

### Compliance

Criteria levels A or B are required for this test.

Maximum allowed driver output current shall not exceed LED Module current specification.

## Ramp Input Voltage

### Objective

To determine the DUT’s sensitivity to “brown-out” conditions.

### Applicable Standards

UL 991 – Section 13 (Voltage Variation Test)

### Device under Test

Luminaire  Subassembly  Electronic Component

### Test Levels and Limits

Operating voltage: Lowest Nominal Line Voltage (LNLV)       (e.g.120VAC)

40% of Lowest Nominal Line Voltage (LNLV40))       (e.g.48VAC)

### Equipment List

Programmable AC Power Supply

Oscilloscope

### Procedure

Test procedure per UL 991 with the following voltage assignments:

1. Set the supply voltage to DUT at LNLV and verify that the DUT operates as intended.
2. Ramp the supply voltage down to LNLV40. Ramp time - 2 seconds (+/- 0.4 sec).
3. Maintain the supply voltage at LNLV40 for 1 second.
4. Ramp the supply voltage up to LNLV. Ramp time – 2 seconds (+/- 0.4 sec).
5. Maintain the supply voltage at LNLV for 1 second.
6. Ramp the supply voltage down to zero. Ramp time – 2 seconds (+/- 0.4 sec).
7. Maintain the supply voltage at zero for 1 second.
8. Ramp the supply voltage up to LNLV. Ramp time – 2 seconds (+/- 0.4 sec).
9. Repeat the test cycle three times with 10-seconds intervals between each test cycle.



Ramp Input Voltage Test Cycle

|  |  |  |
| --- | --- | --- |
| **Driver Output Voltage, Max (V)** | **Driver Output Current, Max (A)** | **Driver Output Current Pulse Duration, Max (s)** |
| x | x | x |

### Compliance

Criterion level B is required for this test.

Maximum allowed driver output current shall not exceed LED Module current specification.

## Leakage Current

### Objective

This test verifies that the DUT does not have an unsafe amount of leakage current to ground.

### Applicable Standards

UL1029 – Section 19 (Leakage Current Tests)

### Device under Test

Luminaire  Subassembly  Electronic Component

### Test Levels and Limits

Line Voltage: Highest Nominal Line Voltage (HNLV)       (e.g.277VAC)

Leakage Current Limit: 0.75 mA

### Equipment List

Leakage Current Test Fixture

### Procedure

The test shall be conducted per UL 1029 procedure.

### Compliance

The leakage current shall be documented in a test report.

## Steady State Characteristics

### Objective

Nominal operating measurements are required for product labeling, agency requirements, specification approval, and general product comparison.

### Applicable Standards

ANSI C82.77

IEEE 519

### Device under Test

Luminaire  Subassembly

### Test Levels and Limits

Operating Voltage: Lowest Nominal Line Voltage (LNLV)       and -10%

Other Intermediate Nominal Line Voltages (INLV1)     , (INLV2)     , (INLV3)     , Etc.

Highest Nominal Line Voltage (HNLV)       and +10%

### Equipment List

Adjustable AC Voltage Source

Power Analyzer

Oscilloscope

### Procedure

Measure the following DUT characteristics for the specified input voltage conditions.

Measurements shall be taken after DUT reaches thermal stability (three hours minimum after power-up).

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
| Measurement | Parameter | Operating Voltage (V AC) | | | | | |
| LNLV-10% | LNLV | INLV1 | INLV2 | HNLV | HNLV+10% |
| DUT Input | I | X | X | X | X | X | X |
| W | X | X | X | X | X | X |
| PF | X | X | X | X | X | X |
| % I THD |  | X | X | X | X |  |
| LED Driver Output | V | X | X | X | X | X | X |
| I | X | X | X | X | X | X |
| W | X | X | X | X | X | X |
| Pk-Pk (120Hz) \* | X | X | X | X | X | X |
| % Ripple (120Hz) \* | X | X | X | X | X | X |
| Pk-Pk (HF) \* | X | X | X | X | X | X |
| % Ripple (HF) \* | X | X | X | X | X | X |
| Waveform # \* | X | X | X | X | X | X |
| Efficiency | η % | X | X | X | X | X | X |

\* Only for Subassembly test

All measured parameters must be documented as test data. In addition, measured parameters for nominal operating voltages (LNLV, INLVs, and HNLV VAC) shall be presented in a table format.

The data shall be recorded for all variations (models) of the product in the test plan.

### Compliance

All measure characteristics must comply with Product Specifications.

## Inrush Current

### Objective

The test will measure the inrush current of the DUT during startup and compare the result to the product specification. The inrush characteristics are essential to lighting system design. A large inrush current can cause the electrical system to fail.

### Applicable Standards

NEMA 410

### Device under Test

Luminaire  Subassembly  Electronic Component

### Test Levels and Limits

Operating Voltage: Lowest Nominal Line Voltage (LNLV)       (e.g.120VAC)

Highest Nominal Line Voltage (HNLV)       (e.g.480VAC)

### Equipment List

Adjustable AC Voltage Source

Current Probe

Oscilloscope

### Procedure

For the Luminaire designed to use a photocontrol, the test should be done with shorting cap in place of photo control.

Insure the total line impedance provided to the DUT is approximately 450 mOhms and 100 uH

Apply power to DUT at the worst case phase angle (90, 270,) and measure inrush current, including waveforms.

A minimum of five measurements shall be taken at 5 minute intervals.

Record the maximum inrush current and phase angle.

### Compliance

The inrush current measurement must comply with NEMA 410, Table B-2.

## Immunity to harmonic disturbances

**Objective**

This test will demonstrate the ability of an electronic device to operate without performance degradation in the presence of harmonic disturbances in power line. Harmonic disturbances in power lines are typically generated by switching or rapid variation of industrial and residential loads such as motor starting, etc.

**Applicable Standards**

IEC 61000-4-13

### Device under Test

Luminaire  Subassembly  Electronic Component

**Test Levels and Limits**

Harmonics levels are defined by IEC 61000-4-13 for Class 3 environment

Operating Voltage: Lowest Nominal Line Voltage (LNLV)       (e.g.120VAC)

Highest Nominal Line Voltage (HNLV)       (e.g.480VAC)

**Equipment List**

Programmable AC Power Supply

Oscilloscope

Differential Voltage Probe

Current Probe

**Procedure**

The test shall be conducted per IEC 61000-4-13 procedure for Class 3 environment (industrial environment or presence of disturbing loads).

The following data shall be recorded for all variations (models) of the product:

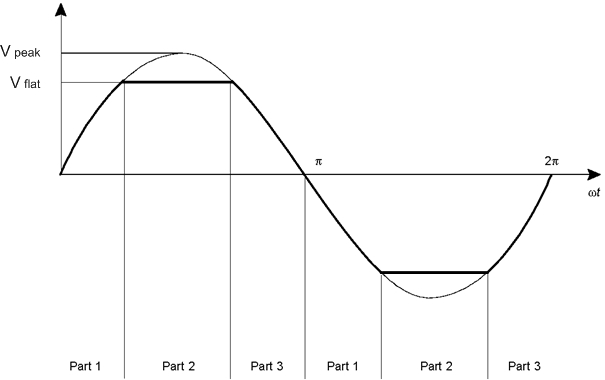
|  |  |  |  |
| --- | --- | --- | --- |
| **Measurement** | **Parameter** | **Operating Voltage (V AC)** | |
| **LNLV** | **HNLV** |
| LED Driver Output | IMAX | X | X |
| VMAX | X | X |
| Waveform # | X | X |

The tests for Class 3 Environment shall be performed in the following order:

**6.8.1. Harmonic Combination – Flat Curve**

The voltage follows a time related function in which each half-wave consists of three parts:

* + - * Part 1 starts from zero, follows a pure sine function up to 80% of peak voltage value
      * Part 2 is a constant voltage
      * Part 3 is following a pure sine function from 80% of peak voltage value to zero



*Figure 6.8.1 Flat Curve Waveform*

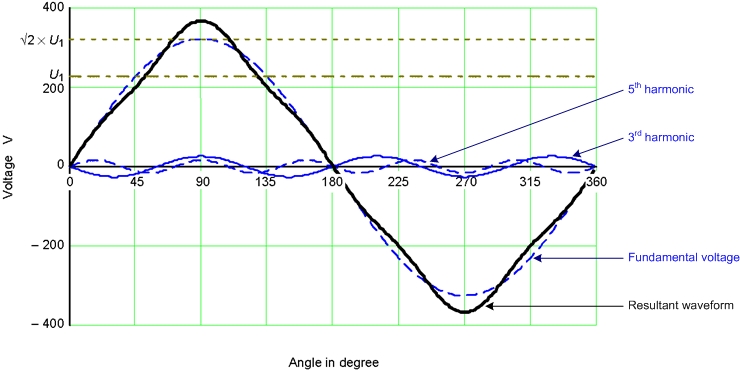
|  |  |  |
| --- | --- | --- |
| **Operating Voltage** | **Parameter** | **Test Level/Configuration** |
| 120 VAC | V peak | 188.66 V |
| V flat | 150.93 V |
| Duration | 2 minutes |
| 277 VAC | V peak | 435.49V |
| V flat | 348.4 V |
| Duration | 2 minutes |

**6.8.2. Harmonic Combination – Over Swing**

Over swing is generated by adding a discrete value of both the 3rd harmonic and the 5th harmonic with a corresponding percentage values and phase relationship in the table below.

It is essential that the rms voltage of the resultant waveform remain at the nominal value during the test by adjusting fundamental and harmonics according to percentage indicated in the table

|  |  |  |
| --- | --- | --- |
| **Operating Voltage** | **Parameter** | **Test Level/Configuration** |
| 120 VAC | Fundamental Voltage (V1) | 119.47 VAC |
| 3rd Harmonic (V3), % of V1 | 8% |
| 3rd Harmonic Phase in relation to V1 | 180° |
| 5th Harmonic (V5), % of V1 | 5% |
| 5th Harmonic Phase in relation to V1 | 0° |
| Test Duration | 2 minutes |
| 277 VAC | Fundamental Voltage (V1) | 275.78 VAC |
| 3rd Harmonic (V3), % of V1 | 8% |
| 3rd Harmonic Phase in relation to V1 | 180° |
| 5th Harmonic (V5), % of V1 | 5% |
| 5th Harmonic Phase in relation to V1 | 0° |
| Test Duration | 2 minutes |

****

*Figure 6.8.2 Over swing Waveform*

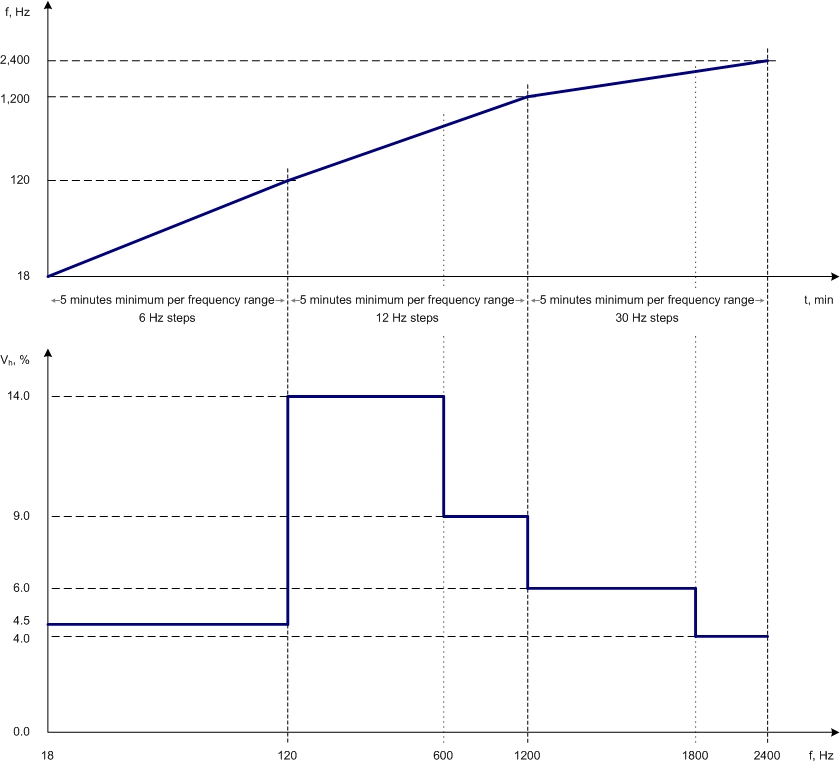
**6.7.3. Sweep In Frequencies**

During this test, the sweep (analog) or step rate (digital) should be such that the time taken per a frequency range is no less than 5 minutes (see Figure 6.7.3).

The amplitude of the applied test levels has to follow the values given in the table below.

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **Fundamental Voltage (V1)** | **Frequency Range** | **Frequency (f)** | **Frequency Step (∆f)** | **Test Level (Vh), % of V1** |
| 120 VAC | 1 | 18 Hz to 120 Hz | 6 Hz | 4.5 % |
| 2 | 120 Hz to 600 Hz | 12 Hz | 14% |
| 600 Hz to 1.2 kHz | 9% |
| 3 | 1.2 kHz to 1.8 kHz | 30 Hz | 6% |
| 1.8 kHz to 2.4 kHz | 4% |
| 277 VAC | 1 | 18 Hz to 120 Hz | 6 Hz | 4.5 % |
| 2 | 120 Hz to 600 Hz | 12 Hz | 14% |
| 600 Hz to 1.2 kHz | 9% |
| 3 | 1.2 kHz to 1.8 kHz | 30 Hz | 6% |
| 1.8 kHz to 2.4 kHz | 4% |

If a performance anomaly detected during the sweep in test, the frequency sweep will dwell at frequencies where the anomaly is detected. The dwell time should be at least 120 seconds.



*Figure 6.7.3 Sweep In Frequencies test levels*

**Compliance**

Criterion level B is required for the tests. No unsafe operating conditions may occur during the test including smoke, flame and arcing to the enclosure.

## Steady State Characteristics – Min/Max Load

### Objective

Nominal operating measurements are required for specification approval, and general comparison of LED drivers and power supply modules.

### Applicable Standards

ANSI C82.77

IEEE 519

### Device under Test

Subassembly  Electronic Component

### Test Levels and Limits

Operating Voltage: Lowest Nominal Line Voltage (LNLV)       and -10%

Other Intermediate Nominal Line Voltages (INLV1)     , (INLV2)     , (INLV3)     , Etc.

Highest Nominal Line Voltage (HNLV)       and +10%

### Equipment List

Adjustable AC Voltage Source

Power Analyzer

Oscilloscope

Adjustable LED Load

### Procedure

1. **Test with a minimum load**

Measure the following DUT characteristics for the specified input voltage conditions.

Measurements shall be taken after DUT reaches thermal stability (1.5 hours minimum after power-up).

The test shall be performed with minimum load (minimum LED voltage) specified in the driver (power supply) data sheet.

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
| **Measurement** | **Parameter** | **Operating Voltage (V AC)** | | | | | |
| **LNLV**  **-10%** | **LNLV** | **INLV1** | **INLV2** | **HNLV** | **HNLV**  **+10%** |
| DUT Input | I | X | X | X | X | X | X |
| W | X | X | X | X | X | X |
| PF | X | X | X | X | X | X |
| % I THD |  | X | X | X | X |  |
| LED Driver (Power Supply) Output | V | X | X | X | X | X | X |
| I | X | X | X | X | X | X |
| W | X | X | X | X | X | X |
| Pk-Pk (120Hz) | X | X | X | X | X | X |
| % Ripple (120Hz) | X | X | X | X | X | X |
| Pk-Pk (HF) | X | X | X | X | X | X |
| % Ripple (HF) | X | X | X | X | X | X |
| Waveform # | X | X | X | X | X | X |
| Efficiency | η % | X | X | X | X | X | X |

1. **Test with a maximum load**

Measure the following DUT characteristics for the specified input voltage conditions.

Measurements shall be taken after DUT reaches thermal stability (1.5 hours minimum after power-up).

The test shall be performed with maximum load (maximum LED voltage) specified in the driver (power supply) data sheet.

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
| **Measurement** | **Parameter** | **Operating Voltage (V AC)** | | | | | |
| **LNLV**  **-10%** | **LNLV** | **INLV1** | **INLV2** | **HNLV** | **HNLV**  **+10%** |
| DUT Input | I | X | X | X | X | X | X |
| W | X | X | X | X | X | X |
| PF | X | X | X | X | X | X |
| % I THD |  | X | X | X | X |  |
| LED Driver (Power Supply) Output | V | X | X | X | X | X | X |
| I | X | X | X | X | X | X |
| W | X | X | X | X | X | X |
| Pk-Pk (120Hz) | X | X | X | X | X | X |
| % Ripple (120Hz) | X | X | X | X | X | X |
| Pk-Pk (HF) | X | X | X | X | X | X |
| % Ripple (HF) | X | X | X | X | X | X |
| Waveform # | X | X | X | X | X | X |
| Efficiency | η % | X | X | X | X | X | X |

All measured parameters and waveforms must be documented as test data.

### Compliance

All measured characteristics must comply with component specifications.

PF > 0.9

THD < 20%

## Steady State Characteristics – Dimming

### Objective

Nominal operating measurements are required for a component specification approval, and general product comparison.

### Applicable Standards

N/A

### Device under Test

Subassembly  Electronic Component

### Test Levels and Limits

Operating Voltage: Lowest Nominal Line Voltage (LNLV)

Highest Nominal Line Voltage (HNLV)

### Equipment List

Adjustable AC Voltage Source

Power Analyzer

Oscilloscope

Adjustable LED Load

### Procedure

Measure the following DUT characteristics for the specified input voltage conditions.

Measurements shall be taken after DUT reaches thermal stability (1.5 hours minimum after power-up).

Dimming voltage shall be set using a potentiometer connected to dimming interface of the driver.

1. **Test with a minimum load**

The test shall be performed with minimum load (minimum LED voltage) specified in the driver (power supply) data sheet.

|  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **Measurement** | **Parameter** | **VDIM** | | | | | | | | | | |
| **0** | **1** | **2** | **3** | **4** | **5** | **6** | **7** | **8** | **9** | **10** |
| DUT Input | I | X | X | X | X | X | X | X | X | X | X | X |
| W | X | X | X | X | X | X | X | X | X | X | X |
| PF | X | X | X | X | X | X | X | X | X | X | X |
| % ITHD | X | X | X | X | X | X | X | X | X | X | X |
| LED Driver Output | V | X | X | X | X | X | X | X | X | X | X | X |
| I | X | X | X | X | X | X | X | X | X | X | X |
| W | X | X | X | X | X | X | X | X | X | X | X |
| Pk-Pk Ripple | X | X | X | X | X | X | X | X | X | X | X |
| % Ripple | X | X | X | X | X | X | X | X | X | X | X |
| FRIPPLE | X | X | X | X | X | X | X | X | X | X | X |
| FDIM  (if PWM dimming) | X | X | X | X | X | X | X | X | X | X | X |
| Duty Cycle  (if PWM dimming) | X | X | X | X | X | X | X | X | X | X | X |
| Waveform # | X | X | X | X | X | X | X | X | X | X | X |
| Efficiency | η % | X | X | X | X | X | X | X | X | X | X | X |
| 0-10V Dimming Interface | IDIM | X | X | X | X | X | X | X | X | X | X | X |

All measured parameters and waveforms must be documented as test data.

1. **Test with a maximum load**

The test shall be performed with maximum load (maximum LED voltage) specified in the driver (power supply) data sheet.

|  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **Measurement** | **Parameter** | **VDIM** | | | | | | | | | | |
| **0** | **1** | **2** | **3** | **4** | **5** | **6** | **7** | **8** | **9** | **10** |
| DUT Input | I | X | X | X | X | X | X | X | X | X | X | X |
| W | X | X | X | X | X | X | X | X | X | X | X |
| PF | X | X | X | X | X | X | X | X | X | X | X |
| % ITHD | X | X | X | X | X | X | X | X | X | X | X |
| LED Driver Output | V | X | X | X | X | X | X | X | X | X | X | X |
| I | X | X | X | X | X | X | X | X | X | X | X |
| W | X | X | X | X | X | X | X | X | X | X | X |
| Pk-Pk Ripple | X | X | X | X | X | X | X | X | X | X | X |
| % Ripple | X | X | X | X | X | X | X | X | X | X | X |
| FRIPPLE | X | X | X | X | X | X | X | X | X | X | X |
| FDIM  (if PWM dimming) | X | X | X | X | X | X | X | X | X | X | X |
| Duty Cycle  (if PWM dimming) | X | X | X | X | X | X | X | X | X | X | X |
| Waveform # | X | X | X | X | X | X | X | X | X | X | X |
| Efficiency | η % | X | X | X | X | X | X | X | X | X | X | X |
| 0-10V Dimming Interface | IDIM | X | X | X | X | X | X | X | X | X | X | X |

All measured parameters and waveforms must be documented as test data.

### Compliance

All measured characteristics must comply with component specifications.

PF > 0.9

THD < 20%

## LED Driver Overload

### Objective

The test will verify the LED Driver behavior at temporary over load conditions (such as luminaire power-up at -40˚C, when LED string voltage is approximately 11% higher than typical operating voltage).

### Applicable Standards

N/A

### Device under Test

Subassembly  Electronic Component

### Test Levels and Limits

Operating Voltage: Lowest Nominal Line Voltage (LNLV)

Highest Nominal Line Voltage (HNLV)

### Equipment List

Adjustable AC Voltage Source

Power Analyzer

Oscilloscope

Adjustable LED Load

### Procedure

Measure the following DUT characteristics for the specified input voltage conditions.

The test shall start with maximum load (maximum LED voltage) specified in the driver data sheet.

The load will be increased in 5% and 10% steps (calculated steps in LED string voltage). The load increase can be achieved by adjustable LED load.

The DUT shall be de-energized during load step change.

The load should be increased to 150% or until the driver output shutdown. All parameters and waveforms must be documented as test data.

|  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **Measurement** | **Parameter** | **LED Load** | | | | | | | |
| **100%** | **105%** | **110%** | **115%** | **120%** | **130%** | **140%** | **150%** |
| DUT Input | I | X | X | X | X | X | X | X | X |
| W | X | X | X | X | X | X | X | X |
| PF | X | X | X | X | X | X | X | X |
| % I THD | X | X | X | X | X | X | X | X |
| LED Driver Output | V | X | X | X | X | X | X | X | X |
| I | X | X | X | X | X | X | X | X |
| W | X | X | X | X | X | X | X | X |
| Pk-Pk (120Hz) | X | X | X | X | X | X | X | X |
| % Ripple (120Hz) | X | X | X | X | X | X | X | X |
| Pk-Pk (HF) | X | X | X | X | X | X | X | X |
| % Ripple (HF) | X | X | X | X | X | X | X | X |
| I reg % | X | X | X | X | X | X | X | X |
| Waveform # | X | X | X | X | X | X | X | X |

### Compliance

All measured characteristics must be documented in a test report.

## LED Driver Start-Up Characteristics

### Objective

The test will verify the LED Driver output behavior during start-up.

### Applicable Standards

N/A

### Device under Test

Subassembly  Electronic Component

### Test Levels and Limits

Operating Voltage: Lowest Nominal Line Voltage (LNLV)

Highest Nominal Line Voltage (HNLV)

### Equipment List

Adjustable AC Voltage Source

Power Analyzer

Oscilloscope

Adjustable LED load

### Procedure

Measure the following DUT characteristics for the specified input voltage conditions on power-up.

1. **Test with a minimum load**

The test shall be performed with minimum load (minimum LED voltage) specified in the driver (power supply) data sheet.

|  |  |  |  |
| --- | --- | --- | --- |
| **Measurement** | **Parameter** | **Operating Voltage (V AC)** | |
| **LNLV** | **HNLV** |
| LED Driver Output | IMAX | X | X |
| VMAX | X | X |
| Time from energizing to current regulation | X | X |
| Waveform # | X | X |

1. **Test with a maximum load**

The test shall be performed with maximum load (maximum LED voltage) specified in the driver (power supply) data sheet.

|  |  |  |  |
| --- | --- | --- | --- |
| **Measurement** | **Parameter** | **Operating Voltage (V AC)** | |
| **LNLV** | **HNLV** |
| LED Driver Output | IMAX | X | X |
| VMAX | X | X |
| Time from energizing to current regulation | X | X |
| Waveform # | X | X |

### Compliance

### All measured characteristics and waveforms must be documented in a test report.

## LED Driver Open Circuit

### Objective

The test will verify the LED Driver behavior at no load condition.

### Applicable Standards

N/A

### Device under Test

Subassembly  Electronic Component

### Test Levels and Limits

Operating Voltage: Lowest Nominal Line Voltage (LNLV)

Highest Nominal Line Voltage (HNLV)

### Equipment List

Adjustable AC Voltage Source

Power Analyzer

Oscilloscope

### Procedure

Measure the following DUT characteristics for the specified input voltage conditions.

No LED load will be connected to DUT output.

|  |  |  |  |
| --- | --- | --- | --- |
| **Measurement** | **Parameter** | **Operating Voltage (V AC)** | |
| **LNLV** | **HNLV** |
| DUT Input | I | X | X |
| W | X | X |
| PF | X | X |
| LED Driver Output | V | X | X |
| VPK-PK | X | X |
| Re-try Period | X | X |
| Duration | X | X |
| Frequency | X | X |
| Waveform # | X | X |

### Compliance

All measured characteristics and waveforms must be documented in a test report.

## LED Driver Output Short Circuit

### Objective

The test will verify that the LED Driver can withstand an output short circuit without damage.

### Applicable Standards

N/A

### Device under Test

Subassembly  Electronic Component

### Test Levels and Limits

Operating Voltage: Lowest Nominal Line Voltage (LNLV)

Highest Nominal Line Voltage (HNLV)

### Equipment List

Adjustable AC Voltage Source

Power Analyzer

Oscilloscope

Switching System

### Procedure

Switching system shall be set-up to apply a short circuit on the driver output under power.

Nominal LED load shall be used.

Measure the following DUT characteristics under the short circuit for the specified input voltage conditions.

* Apply power to DUT. Dwell for 2 minutes.
* Apply the short circuit to the DUT output. Dwell for 2 minutes.
* Remove the short circuit. Dwell for 2 minutes.
* Remove power from DUT

|  |  |  |  |
| --- | --- | --- | --- |
| **Measurement** | **Parameter** | **Operating Voltage (V AC)** | |
| **LNLV** | **HNLV** |
| DUT Input | I | X | X |
| W | X | X |
| PF | X | X |
| LED Driver Output | IMAX | X | X |
| IPK-PK | X | X |
| Re-try Period | X | X |
| Duration | X | X |
| Frequency | X | X |
| Waveform # | X | X |

### All measured characteristics and waveforms must be documented in a test report.

### Compliance

### The driver shall operate per specification after the short circuit is removed

## LED Driver Output Load Step

### Objective

The test will verify the LED Driver output behavior during load step under power.

### Applicable Standards

N/A

### Device under Test

Subassembly  Electronic Component

### Test Levels and Limits

Operating Voltage: Lowest Nominal Line Voltage (LNLV)

Highest Nominal Line Voltage (HNLV)

### Equipment List

Adjustable AC Voltage Source

Power Analyzer

Oscilloscope

Adjustable LED load

Switching System

### Procedure

Switching system shall be set-up to change and disconnect LED load from the driver output under power.

* Set-up DUT with minimum load
* Apply power to DUT
* Switch the load to maximum. Dwell for 10-20 seconds.
* Switch the load out (open circuit). Dwell for 10-20 seconds.
* Switch the load to minimum. Dwell for 10-20 seconds.

Measure the following DUT characteristics for all specified load conditions

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| **Measurement** | **Parameter** | **Load Transient Conditions** | | | |
| **MIN to MAX** | **MAX to OC** | **OC to MAX** | **MAX to MIN** |
| LED Driver Output | IMAX | X | X | X | X |
| Pulse Duration | X | X | X | X |
| VMAX | X | X | X | X |
| Waveform # | X | X | X | X |

### All measured characteristics and waveforms must be documented in a test report.

### Compliance

### The driver shall operate per specification after the test

## LED Driver Low Line Voltage Response

### Objective

The test will determine the LED Driver response to low voltage input conditions.

### Applicable Standards

N/A

### Device under Test

Subassembly  Electronic Component

### Test Levels and Limits

Operating Voltage: Lowest Nominal Line Voltage (LNLV)

### Equipment List

Adjustable AC Voltage Source

Power Analyzer

Oscilloscope

Adjustable LED Load

### Procedure

Measure the following DUT characteristics for the specified input voltage conditions.

* Power-up the DUT. Dwell 10-20 seconds.
* Gradually reduce the input voltage until the output current is out of regulation. Document the minimum input voltage to regulate the current
* Keep gradually reducing the voltage until the DUT output shuts down. Document the minimum input voltage before shutdown.
* Turn the power off. Dwell 2 minutes.
* Turn the power on.
* Gradually increase the input voltage until the DUT output turns on. Document the minimum power-up input voltage

1. **Test with a minimum load**

The test shall be performed with minimum load (minimum LED voltage) specified in the driver (power supply) data sheet.

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **Measurement** | **Parameter** | **Operating Voltage (V AC)** | | |
| **VMIN for output regulation** | **VMIN before shutdown** | **VMIN to start-up** |
| DUT Input | I | X | X | X |
| V | X | X | X |
| LED Driver Output | V | X | X | X |
| I | X | X | X |
| Waveform # | X | X | X |

1. **Test with a maximum load**

The test shall be performed with maximum load (maximum LED voltage) specified in the driver (power supply) data sheet.

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **Measurement** | **Parameter** | **Operating Voltage (V AC)** | | |
| **VMIN for output regulation** | **VMIN before shutdown** | **VMIN to start-up** |
| DUT Input | I | X | X | X |
| V | X | X | X |
| LED Driver Output | V | X | X | X |
| I | X | X | X |
| Waveform # | X | X | X |

### Compliance

All measured characteristics and waveforms must be documented in a test report.

## LED Driver High Potential Test

### Objective

The test will quantify dielectric isolation of the LED driver.

### Applicable Standards

N/A

### Device under Test

Electronic Component

### Test Levels and Limits

Hipot voltage: 3000Vac/4242Vdc – input to output

500Vac/700Vdc – output to dimming interface

1500Vac/2121Vdc – primary to case

### Equipment List

Hipot tester

### Procedure

Dielectric withstand of DUT should be tested at the following conditions:

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| **Test** | **Hipot Connections** | | **Voltage Test Level** | **Test Current Limit** | **Pass / Fail** | **Fail Voltage Level** |
| **Positive** | **Negative** |
| Input to Output | Driver Inputs (Line and Neutral) connected together | Driver Outputs (Positive and Negative) connected together | 3000 Vac  or  4242 Vdc | 5 mA | X | X |
| Input to Dimming Interface | Driver Inputs (Line and Neutral) connected together | Driver Dimming Interface (Positive and Negative) connected together | 3000 Vac  or  4242 Vdc | 5 mA | X | X |
| Input to Case | Driver Inputs (Line and Neutral) connected together | Driver Case | 1500 Vac  or  2121 Vdc | 5 mA | X | X |
| Output to Dimming Interface | Driver Outputs (Positive and Negative) connected together | Driver Dimming Interface (Positive and Negative) connected together | 500 Vac  or  700 Vdc | 5 mA | X | X |

### Compliance

All measured characteristics and waveforms must be documented in a test report.

## 6.18 Immunity to Frequency Variations

### Objective

The object of this test is to establish a reference for evaluating the immunity of electric and electronic equipment when subjected to variations of the power frequency.

### Applicable Standards

IEC 61000-4-28

### Device under Test

Luminaire  Subassembly  Electronic Component

### Test Levels and Limits

Frequency variation levels are defined by IEC 61000-4-28 for Class 3 environment

Operating Voltage: Lowest Nominal Line Voltage (LNLV)       (e.g.120VAC)

Highest Nominal Line Voltage (HNLV)       (e.g.480VAC)

### Equipment List

Programmable AC Power Supply

Oscilloscope

Differential Voltage Probe

Current Probe

### Procedure

The test shall be conducted per IEC 61000-4-28 procedure for Class 3 environment (industrial environment or presence of disturbing loads).

The following data shall be recorded for all variations (models) of the product:

|  |  |  |  |
| --- | --- | --- | --- |
| **Measurement** | **Parameter** | **Operating Voltage (V AC)** | |
| **LNLV** | **HNLV** |
| LED Driver Input | Vac | X | X |
| LED Driver Output | IMAX | X | X |
| VMAX | X | X |
| Waveform # | X | X |

The DUT should be tested at the following conditions:

The DUT is initially operated at a mains frequency f1 and is then subjected to the frequency variation sequence according to figure 6.18.1.

During the transitional period, tp, (figure 6.18.2), the maximum change in frequency per cycle shall be less than .5% of f1.

* ∆f1/f1 is specified as a percentage of nominal frequency f1.
* Test level 3:
  + - Frequency variation (∆f1/f1): +4%, -6%
    - Transitional period (tp): 10s



Figure 6.18.1 Frequency Variation Sequence



Figure 6.18.2 Example of transitional period tp

**Compliance**

Criterion level B is required for the tests. No unsafe operating conditions may occur during the test including smoke, flame and arcing to the enclosure.

# 7. Environmental Tests

## 7.1. Temperature/Voltage Cycle

### Objective

To verify DUT’s ability to operate at the minimum and maximum specified environmental parameters.

### Applicable Standards

NA

### Device under Test

Luminaire  Subassembly  Electronic Component

### Test Levels and Limits

|  |  |
| --- | --- |
| Operating Voltage: | Lowest Nominal Line Voltage-10%(LNLV90)       (e.g.120VAC)  Highest Nominal Line Voltage+10% (HNLV110)       (e.g.277VAC) |
| Operating Temperature: | Low Temperature Test Point (LTTP)°C,  Operating High Temperature Test Point (OHTTP)°C,  Non-Operating High Temperature Test Point (NHTTP)°C   |  |  |  |  | | --- | --- | --- | --- | |  | LTTP | OHTTP | NHTTP | | Indoor | 0 | 40 | 55 | | Outdoor | -40 | 40 | 55 | | Roadway | -40 | 40 | 55 | |

### Equipment List

Temperature Chamber

Data Acquisition Equipment

Adjustable AC Voltage Source

Switching Control system

### Procedure

The DUT shall be set inside the temperature chamber for the duration of this test. The chamber, the adjustable AC power source and the switching control system shall be set-up to follow the steps below:

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **Step** | **Voltage (Vac)** | **Temperature (°C)** | **Duration (hrs)** | **DUT Operation** |
| 1 | 0 | NHTTP | 10 | - |
| 2 | 0 | Ramp down from NHTTP to LTTP | 2 | - |
| 3 | 0 | LTTP | 12 | - |
| 4 | LNLV90 | LTTP | 18 | Power cycling - 4 hrs on, 2 hrs off |
| 5 | LNLV90 | Ramp up from LTTP to OHTTP | 2 | Power - off |
| 6 | LNLV90 | OHTTP | 18 | Power cycling - 4 hrs on, 2 hrs off |
| 7 | LNLV90 | Ramp down from OHTTP to LTTP | 2 | Power - off |
| 8 | HNLV110 | LTTP | 18 | Power cycling - 4 hrs on, 2 hrs off |
| 9 | HNLV110 | Ramp up from LTTP to OHTTP | 2 | Power - off |
| 10 | HNLV110 | OHTTP | 18 | Power cycling - 4 hrs on, 2 hrs off |
| 11 | 0 | Ramp down from OHTTP to 20˚C | 2 | Power - off |

The data acquisition system shall monitor and record the following parameters:

* Chamber temperature
* Temperature at Tc point of LED driver
* Luminaire input voltage (AC rms)
* LED driver output voltage (DC)
* Luminaire input current
* LED driver output current

All recorded data shall be included in the report as a graph. Any anomalies found during the test shall be noted.

The test shall be followed by a functional demonstration (refer to Section 4.1 of this document).

The test shall be repeated for all variations (models) of the product in the test plan

### Compliance

Criterion level A is required for this test.

## 7.2. Thermal Shock – Sub assembly - Operating

### Objective

The purpose of this test is to ensure that the DUT will withstand being subjected to rapid temperature variations that may be encountered in operating conditions.

### Applicable Standards

IEC 60068-2-14, Test Nb: Change of Temperature

### Device under Test

Subassembly  Electronic Component

### Test Levels and Limits

|  |  |
| --- | --- |
| Operating Voltage: (OV) | VAC |
| Low Temperature: (LT) | °C |
| High Temperature: (HT) | °C |
| Exposure Time at Each Temperature: | 15 min |
| Temperature Change Rate: | 3°C/minute |
| Number of Cycles: | 5 |

### Equipment List

Temperature Chamber

Data Acquisition Equipment

### Procedure

The test shall be conducted per IEC 60068-2-14 procedure. The DUT shall be set inside the temperature chamber for the duration of this test. The DUT shall be powered during the test.

The data acquisition system shall monitor and record the following parameters:

* Chamber temperature
* Temperature at Tc point of LED driver
* Luminaire input voltage (AC rms)
* LED driver output voltage (DC)
* Luminaire input current
* LED driver output current

All recorded data shall be included in the report as a graph. Any anomalies found during the test shall be recorded, following by engineering evaluation.

The test shall be followed by a functional demonstration (refer to Section 4.1 of this document).

### Compliance

Criterion level A is required for this test. The DUT shall pass a functional demonstration after the test is complete.

## Condensing Humidity

### Objective

To verify the DUT’s ability to operate in a condensing environment it may be subjected to during storage, shipping or use.

### Applicable Standards

NA

### Device under Test

Luminaire  Subassembly

### Test Levels and Limits

Temperature: Low Temperature Test Point (LTTP)°C

High Temperature Test Point (HTTP)°C

Supply Voltage: Lowest Nominal Line Voltage-10% (LNLV90)       (e.g.120VAC)

Highest Nominal Line Voltage+10% (HNLV110)       (e.g.277VAC)

Power cycle period: 20 minutes (15 minutes ON, 5 minutes OFF)

|  |  |  |
| --- | --- | --- |
|  | LTTP | HTTP |
| Indoor | 0 | 40 |
| Outdoor | -20 | 40 |
| Roadway | -20 | 40 |

### Equipment List

Environmental Chamber

Adjustable AC Voltage Source

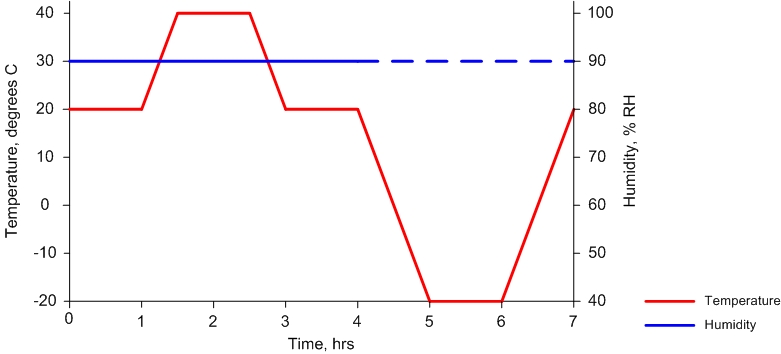
Switching Control system

Data Acquisition System

### Procedure

The DUT shall be set inside the temperature chamber for the duration of this test. The chamber, the adjustable AC voltage source and the switching control system shall be set-up to follow the profile below:

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **Step** | **Temperature** | **Duration** | **Humidity** | **DUT Operation** |
| 1 | 20°C | 1 hr | 90% RH | Power cycling – 15 min ON, 5 min OFF |
| 2 | Ramp up to HTTP°C | 0.5 hrs | 90% RH | OFF |
| 3 | HTTP°C | 1 hr | 90% RH | OFF |
| 4 | Ramp down to 20°C | 0.5 hrs | 90% RH | Power cycling – 15 min ON, 5 min OFF |
| 5 | 20°C | 0.5 hrs | 90% RH |
| 6 | Ramp down to -LTTP°C | 1 hr | Uncontrolled |
| 7 | -LTTP°C | 1 hr | Uncontrolled |
| 8 | Ramp up to 20°C | 1 hr | Uncontrolled | OFF |



The profile must be repeated a total of 8 times: 4 times at HNLV110 VAC input voltage, and 4 times at LNLV90 VAC input voltage.

The data acquisition system shall monitor and record the following parameters:

* Chamber temperature
* Luminaire input voltage (AC rms)
* Luminaire input current

All recorded data shall be included in the report as a graph. Any anomalies found during the test shall be recorded, following by engineering evaluation.

The test shall be followed by a functional demonstration (refer to Section 4.1 of this document).

### Compliance

Criterion level A is required for this test. The DUT shall pass a functional demonstration after the test is complete.

## Dust Ingress

### Objective

This test ensures that the DUT’s enclosure prevents the dust ingress into electronic chamber.

### Applicable Standards

IEC 60529, Section 13 – Test for protection against solid foreign objects indicated by the first character numeral

### Device under Test

Luminaire  Subassembly  Electronic Component

### Test Levels and Limits

The limits are defined in IEC 60529 for enclosures or IEC 60598 for Luminaires for IP     X rating

### Equipment List

Dust Chamber

### Procedure

This test shall be performed in accordance with IEC 60529 for IP     X rating and Acuity Brands test procedure for Singleton Dust Chamber. A test report shall include the test setup, test conditions, test procedure, and test results.

### Compliance

The acceptance conditions for IP     X rating are defined in IEC 60529.

The DUT shall pass a functional demonstration after the test is complete.

## Moisture Ingress

**Objective**

This test ensures that the DUT’s enclosure limits moisture ingress to a quantity that does not interfere with DUT’s operation.

### Applicable Standards

IEC 60529, Section 14 – Test for protection against water indicated by the second characteristic numeral

### Device under Test

Luminaire  Subassembly  Electronic Component

### Test Levels and Limits

The limits are defined in IEC 60529 for enclosures or IEC 60598 for Luminaires for IP X      rating

### Equipment List

Water Spray System

### Procedure

This test shall be performed in accordance with IEC 60529 for IP X      rating and Acuity Brands Test Procedure for ED&D Water System. A test report shall include the test setup, test conditions, test procedure, and test results.

### Compliance

The acceptance conditions for IP X      rating are defined in IEC 60529.

The DUT shall pass a functional demonstration after the test is complete.

## Corrosion

### Objective

This test ensures that the DUT maintains an operational integrity in corrosive environments.

### Applicable Standards

ASTM B 117

### Device under Test

Luminaire  Subassembly  Electronic Component

### Test Levels and Limits

ASTM B 117

Salt Spray Resistance – 1,000 hours

5% Neutral Salt Spray

### Equipment List

Salt Spray Chamber

### Procedure

This test shall be performed in accordance with ASTM B 117 at an outside test facility. A test report, provided by the testing laboratory, shall include the test setup, test conditions, test procedure, and test results.

### Compliance

Thru Film Corrosion/Blistering and Creep shall be evaluated per ASTM D1654 and D714.

The DUT shall pass a functional demonstration after the test is complete.

# Mechanical Tests

## 8.1. Vibration 1 – Sub Assembly

### Objective

The purpose of this test is to ensure the immunity of the DUT to mechanical vibration that can be encountered during operation or shipment.

### Applicable Standards

IEC 60068-2-6, Test Fc and guidance: Vibration

### Device under Test

Subassembly  Electronic Component

### Test Levels and Limits

|  |  |
| --- | --- |
| Acceleration (Sweep): | 5 Hz ≥ ƒ ≤ 500 Hz at 1.0 g |
| Acceleration (Dwell): | 3.0 g |
| Sweep Rate: | 1 Octave / Minute (± 10%) |
| Dwell Time: | 10 Minutes |
| Motion: | Sinusoidal |
| Duration: | 10 sweep cycles per axis on each of three mutually perpendicular axes |
| Operating Voltage | Lowest Nominal Line Voltage (e.g.120VAC) |

### Equipment List

Single Axis Vibration System

Accelerometer Monitoring System

### Procedure

The DUT must be mounted securely to the vibration generator for the duration of this test. The DUT shall be powered during the test.

The monitoring accelerometers shall be placed in locations on the electronics, near massive electronic components, near high flex areas on a PCB or a mechanical mount.

The DUT shall be tested in each of the three principal axes.

During the 5 to 500 Hz sweep any reference with a gain greater than 2 shall be noted. After the 10 sweeps are complete the DUT shall dwell at each resonant frequency at 3 g acceleration for 10 minutes.

All recorded data shall be included in the report. Any anomalies found during the test shall be recorded, following by engineering evaluation.

The test shall be followed by a functional demonstration (refer to Section 4.1 of this document).

### Compliance

Criterion level A is required for this test. The DUT shall pass a functional demonstration after the test is complete.

## 8.2. Vibration 2

### Objective

The purpose of this test is to ensure the immunity of the DUT to mechanical vibration that can be encountered during operation.

### Applicable Standards

ANSI C136.31-2001

### Device under Test

Luminaire  Subassembly  Electronic Component

.

### Test Levels and Limits

|  |  |
| --- | --- |
| ANSI C136.31-2001 |  |
| Acceleration (Dwell): | 1.5g  or 3g, other |
| Duration: | 100,000 cycles per axis on each of three mutually perpendicular axes |

### Equipment List

Single Axis Vibration System

Accelerometer Monitoring System

### Procedure

This test shall be performed in accordance with ANSI C136.31-2001. The DUT shall be un-powered during the test.

All recorded data shall be included in the report. Any anomalies found during the test shall be recorded, following by engineering evaluation.

The test shall be followed by a functional demonstration (refer to Section 4.1 of this document).

### Compliance

Criterion level A is required for this test. The DUT shall pass a functional demonstration after the test is complete.

## Mechanical Shock

### Objective

The purpose of this test is to ensure the immunity of the DUT to mechanical vibration that can be encountered before or during an installation.

### Applicable Standards

IEC 60068-2-27, Test Ea and guidance: Shock

### Device under Test

Luminaire  Subassembly  Electronic Component

### Test Levels and Limits

|  |  |
| --- | --- |
| Severity: | 30 g peak |
| Duration: | 11 ms |
| Application: | 3 shocks in each direction on three mutually perpendicular axes (18 shocks total) |
| Motion: | Half sine wave |

### Equipment List

Single Axis Vibration System

### Procedure

This test shall be performed in accordance with IEC 60068-2-27.

The DUT shall be un-powered at the time of the shock.

### Compliance

Criterion level A is required for this test. The DUT shall pass a functional demonstration after the test is complete.

## Drop Test

### Objective

This test is intended to evaluate capability of a shipping container/packaging to protect the DUT from the mechanical stress that can be encountered during shipping and handling.

### Applicable Standards

ASTM D 5276

### Device under Test

Luminaire  Subassembly  Electronic Component

### Test Levels and Limits

ASTM D 5276

### Equipment List

Free-Fall Drop Test Set-up conforming to ASTM D 5276 requirements

### Procedure

This test shall be performed in accordance with ASTM D 5276 at an outside test facility. A test report, provided by the testing laboratory, shall include the test setup, test conditions, test procedure, and test results.

### Compliance

The package/container performance shall be evaluated per ASTM 5276.

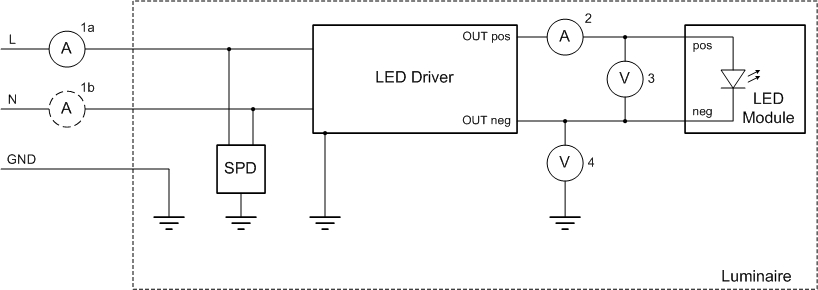
The DUT shall pass a functional demonstration after the test is complete.

# Appendix

## 9.1. Surge Test Measurement Set-up – Driver Output

### Measurement Set-up

Voltage and current probes shall be connected to the luminaire system at the following test points:

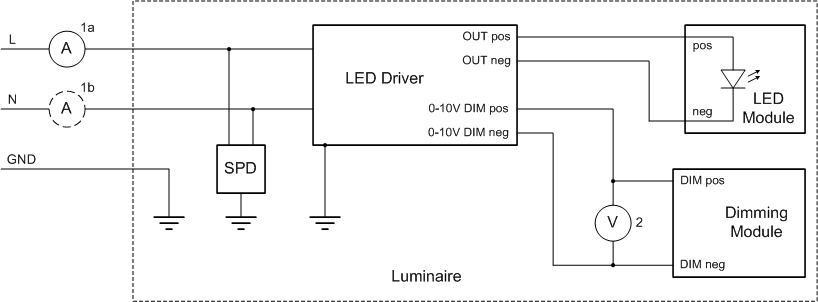


|  |  |  |
| --- | --- | --- |
| **Test Point** | **Equipment** | **Description** |
| 1 | AC Current Probe | Luminaire Input current (used for triggering on a surge pulse):  1a – the probe is on L input for L1-L2, L1-PE, L1,L2-PE couplings  1b – the probe is on N for L2-PE coupling |
| 2 | DC Current Probe | Driver Output Current |
| 3 | Differential Voltage Probe | Driver Output Voltage (Differential-mode) |
| 4 | Differential Voltage Probe | Driver Output Voltage (Common-mode) |

## 9.2. Surge Test Measurement Set-up – 0-10V Dimming Interface

### Measurement Set-up

Voltage and current probes shall be connected to the luminaire system at the following test points:



|  |  |  |
| --- | --- | --- |
| **Test Point** | **Equipment** | **Description** |
| 1 | AC Current Probe | Luminaire Input current (used for triggering on a surge pulse):  1a – the probe is on L input for L1-L2, L1-PE, L1,L2-PE couplings  1b – the probe is on N for L2-PE coupling |
| 2 | Differential Voltage Probe | Driver 0-10 Dimming Interface Voltage |