ANSI C136.10-1996
(Revision of ANSI C136.10-1988)

American National Standard for Roadway Lighting Equipment—Locking-Type Photocontrol Devices and Mating Receptacle Physical and Electrical Interchangeability and Testing

Sponsor

Accredited Standards Committee on Roadway Lighting, C136

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American National Standards Institute

Secretariat

The Institute of Electrical and Electronics Engineers, Inc.

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Abstract: Equipment that may be physically and electrically interchanged to operate within established values is covered in this standard, such as locking-type photocontrol devices, locking-type mating receptacles, and shorting and nonshorting caps.
Keywords: lighting equipment, locking-type photocontrol devices, mating receptacle, photocontrol devices, roadway lighting equipment

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Introduction

(This introduction is not a part of ANSI C136.10-1996, American National Standard for Roadway Lighting Equipment—Locking-Type Photocontrol Devices and Mating Receptacle Physical and Electrical Interchangeability and Testing.)

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American National Standard for Roadway Lighting Equipment—Locking-Type Photocontrol Devices and Mating Receptacle Physical and Electrical Interchangeability and Testing

1. Scope

This standard covers the following equipment, which may be physically and electrically interchanged to operate within established values:

— Locking-type photocontrol, herein referred to as “photocontrol”
— Locking-type mating receptacle, herein referred to as “receptacle”
— Shorting and nonshorting caps

2. References

This standard shall be used in conjunction with the following publications. When the following standards are superseded by an approved revision, the revision shall apply.

ANSI C136.2-1985, American National Standard for Roadway Lighting—Luminaires—Voltage Classification.[1]

IEEE Std C62.1-1989 (Reaff 1994), IEEE Standard for Gapped Silicon Carbide Surge Arresters for AC Power Circuits (ANSI).[2]

IEEE Std C62.41-1991, IEEE Recommended Practice on Surge Voltages in Low-Voltage AC Power Circuits (ANSI).

UL 773-1987, The Standard for Plug-In, Locking Type Photocontrols for Use with Area Lighting.[3]

[1]ANSI C136 publications are available from the Institute of Electrical and Electronics Engineers, 445 Hoes Lane, P.O. Box 1331, Piscataway, NJ 08855-1331, USA.

[2]IEEE publications are available from the Institute of Electrical and Electronics Engineers, 445 Hoes Lane, P.O. Box 1331, Piscataway, NJ 08855-1331, USA.

[3]UL publications are available from Underwriters Laboratories, Inc., 333 Pfingsten Road, Northbrook, IL 60062-2096, USA.

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3. Definitions

3.1 fail-off photocontrol: A photocontrol that is designed so that the load remains off when the most likely failure occurs.

3.2 fail-on photocontrol: A photocontrol that is designed so that the load remains on when the most likely failure occurs.

3.3 follow current: The current from the connected power source that flows through an arrester during and following the passage of discharge or surge current.

3.4 horizontal footcandles (HFC): Illuminance measured in a horizontal plane.

3.5 inverse ratio photocontrol: A photocontrol with the turn-off at a lower value than turn-on.

3.6 maximum surge energy absorbed (for rating purposes only): The maximum allowable surge energy that the photocontrol can absorb without changing its operating characteristics. This is based on a single 10/1000 μs current waveform.

3.7 nonshorting cap: A device that provides an open circuit between line and load when a photocontrol is not used.

3.8 plug: A cluster of blades fixed to a photocontrol, shorting cap, or nonshorting cap to establish an electrical and mechanical connection when inserted into a mating receptacle.

3.9 plug-receptacle interface temperature: The temperature either at the top of the receptacle or at the bottom of the control base with the control mounted in the receptacle in an ambient temperature of 25 °C.

3.10 receptacle: An outlet that is intended to be equipped electrically and mechanically to receive the plug.

3.11 shorting cap: A device that provides a closed circuit between line and load when a photocontrol is not used.

3.12 surge current: The peak current in figure 13 of IEEE Std C62.41-1991, 8/20 μs discharge current waveform.

3.13 surge energy: The energy (in joules) contained in a surge. It can be calculated if the current and voltage wave shape are known:

$$E = \int_0^T V(t)I(t)dt$$

where

E is the energy
t is the time
I is the instantaneous current
V is the instantaneous voltage
T is the time duration of the pulse
$\int dt$ is the time integral

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3.14 surge voltage: The peak open-circuit voltage in figure 12 of IEEE Std C62.41-1991, for a 1.2/50 μs wave form.

3.15 turn-off and/or turn-on response time: The time between a rapid change in light level and the switching of the load. Turn-off delay may be different than turn-on delay. The response time is measured at 25 °C and rated voltage.

Table 1—Time delay classification

Control category	Response time
Instant acting (no delay)	< 0.5 s
Fast acting (short delay)	0.5–5 s
Slow acting (long delay)	> 5 s

3.16 turn-off/turn-on ratio: The turn-off light level divided by the turn-on light level.

3.17 vertical footcandles (VFC): Illuminance measured in a vertical plane.

4. Mechanical requirements

4.1 Plug type

The plug used in the photocontrol, shorting cap, or nonshorting cap shall be a three-pole locking type. Its configuration, blades, and limiting dimensions shall be in accordance with figure 1.

4.2 Receptacle type

The receptacle shall be a three-pole, three-wire locking type. Its configuration, contacts, and limiting dimensions shall be in accordance with figure 2.

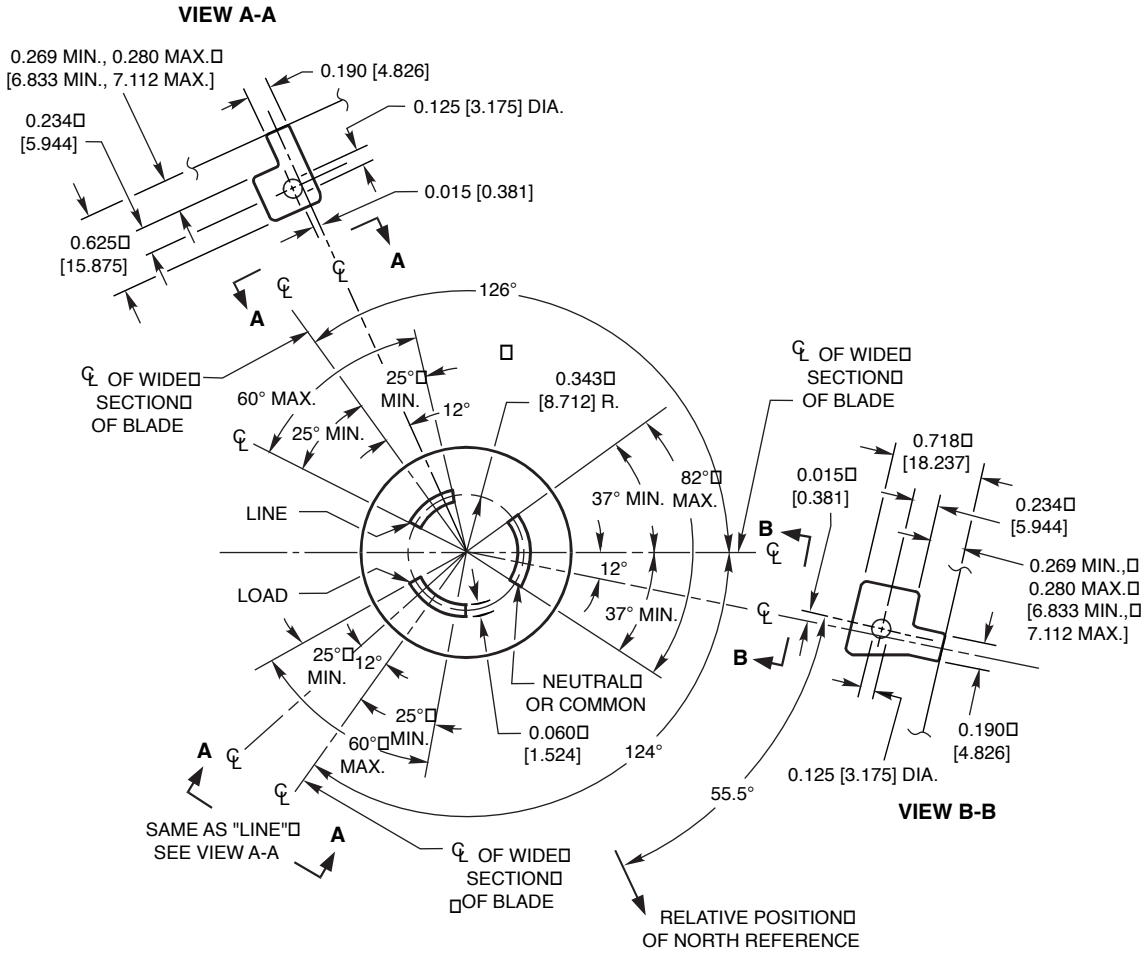
4.3 Sealing

A sealing means shall be provided as part of the photocontrol, shorting cap, or nonshorting cap to form a raintight seal on the “required seat” of the receptacle. The “required seat” of the receptacle shown in figure 3b shall be a smooth, flat surface. With the photocontrol, shorting cap, or nonshorting cap installed in its locking position, the sealing means shall not encroach on the area within the limiting profile of the mounting shown in figure 3b. No obstructions or projections other than the electrical contacts and sealing means shall project below the limiting profile shown in figure 3a. The configuration and limiting dimensions of the device shall be in accordance with figure 3a.

4.4 Receptacle dimensions

The receptacle shall be so designed that, when installed on a luminaire or other equipment, its configuration and limiting dimensions will be in accordance with figure 3b.

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NOTES

1—Dimensions: Dimensions not in brackets are in inches, and dimensions in brackets [ ] are in millimeters.

2—Tolerances: Unless otherwise noted, all dimensions are ± 0.005 in. All metric dimensions are ± 0.127 mm.

3—Angles: Unless otherwise noted, all angles are ± 0.5°.

Figure 1—Locking type, three-pole, three-wire plug for photocontrols, shorting caps, and nonshorting caps

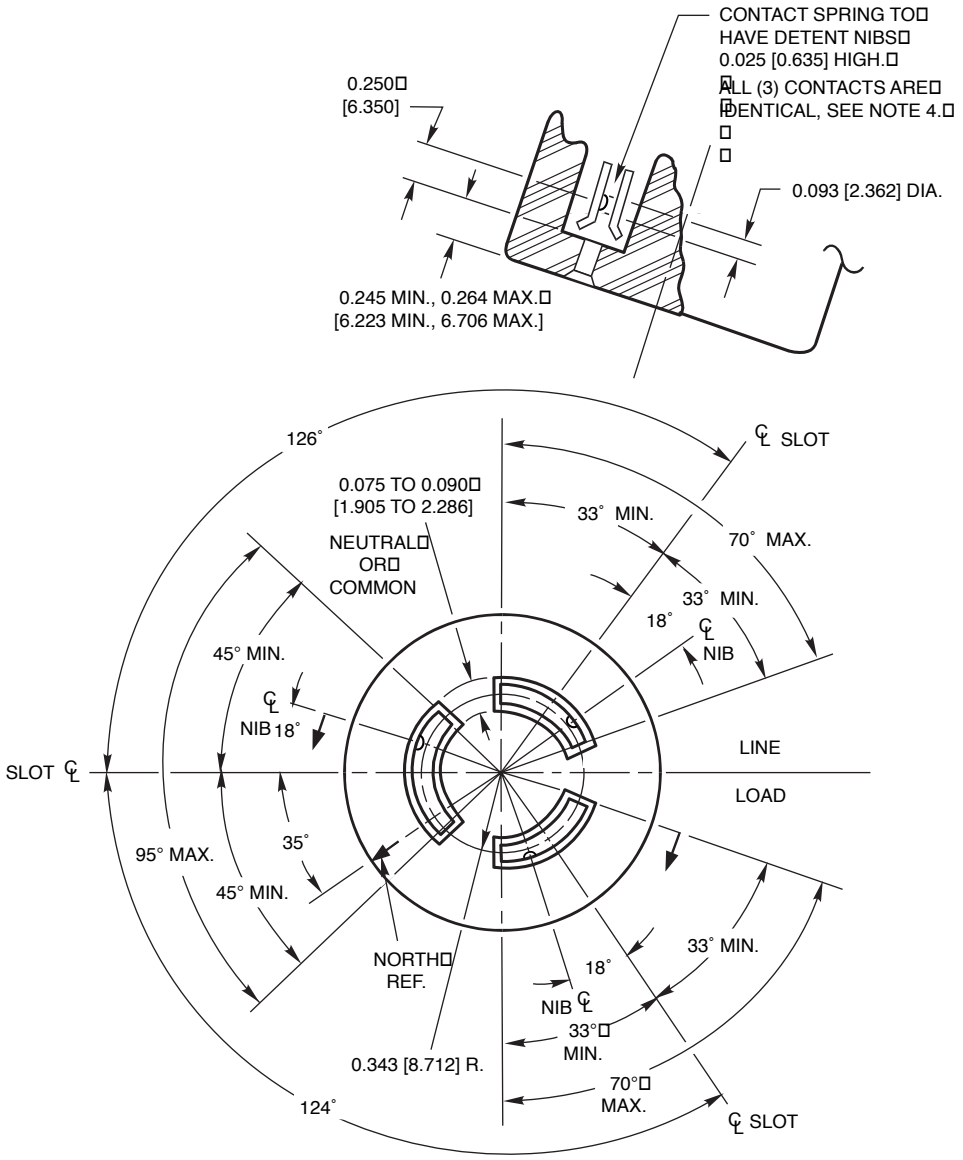
4.4.1 Mounting

When mounted on a luminaire, the receptacle shall be designed and mounted so that it can be turned 350°, but no more than 360°, and securely positioned at an angular adjustment within ± 15°. The means for adjusting orientation shall be externally accessible.

4.4.2 Marking

The receptacle or adjustment assembly shall be permanently marked with a north reference mark indicated by an arrow, “N,” or “NORTH” in the position as shown in figure 2.

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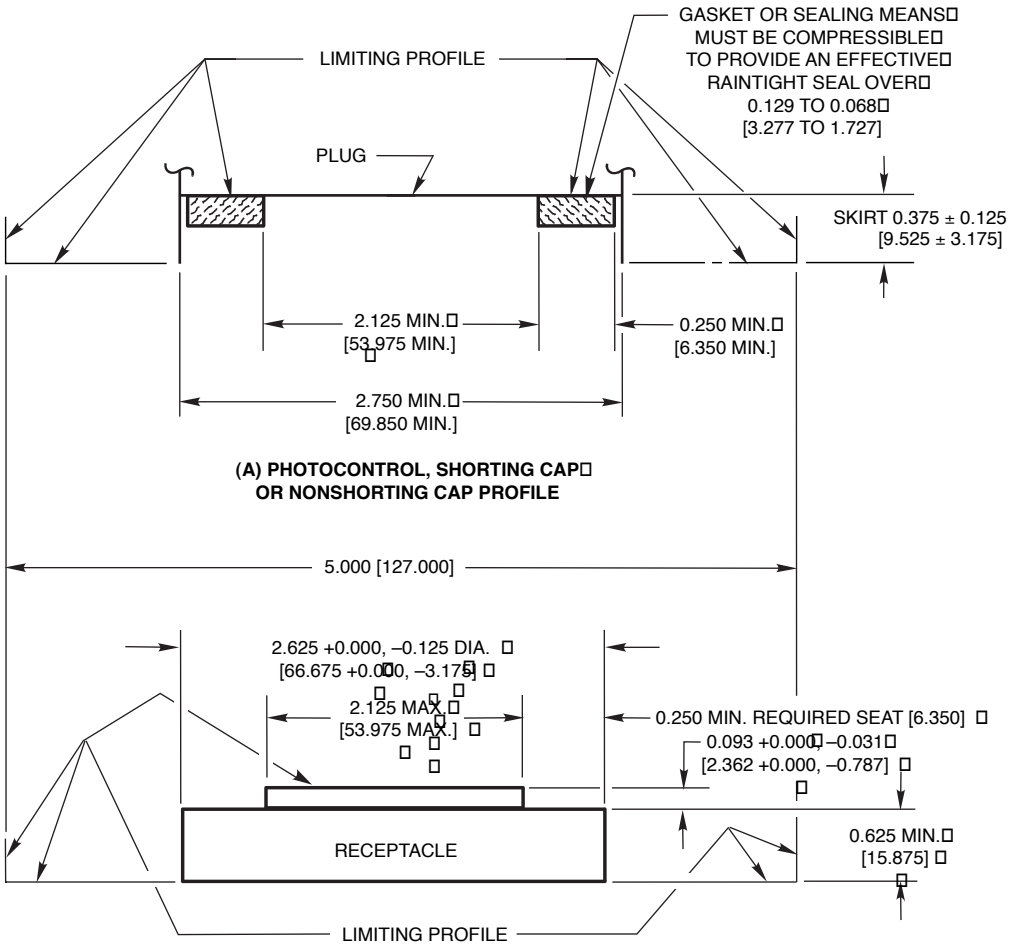
4—The configuration and alignment of the receptacle contacts shall mate with the plug blades (0.060 [1.524] thickness) and provide a positive mechanical and electrical connection.

Figure 2—Locking type, three-pole, three-wire receptacle for photocontrols, shorting caps, and nonshorting caps

4.4.3 Seal

The seal of the receptacle shall be mounted as close to horizontal as possible. If it deviates more than 30° from horizontal, the integrity of the seal may be affected.

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2—Tolerances: Unless otherwise noted, all dimensions are ± 0.005 in. All metric dimensions are ± 0.127 mm.

3—For mechanical requirements, see clause 4.

Figure 3—Limiting dimensions and configuration for photocontrol, shorting cap, non-shorting cap, and mounting receptacle

5. Electrical requirements

5.1 Photocontrol

The voltage rating, operating voltage range, failure mode, and corresponding color coding of photocontrols shall be in accordance with table 2. The enclosure of the photocontrol shall be permanently marked with the color coding, which shall be visible 360° around the photocontrol.

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5.2 Receptacle and plug

The receptacle and plug shall be rated 600 V, as defined in ANSI C136.2-1985.

5.3 Heat-cycle test

The receptacle shall be capable of withstanding a heat-cycle test, described in 11.1, allowing a maximum temperature rise of 30 °C on either line or load contact.

Table 2—Photocontrol electrical requirements—voltage rating, operating voltage

Rated volts (60 Hz)	Range (V)	Failure mode	Color coding
120	105–130	Fail-on	Gray or clear
120	105–130	Fail-off	Orange
240[a]	185–305	Fail-on	Maroon
240[a]	185–305	Fail-off	Green
120/240[b]	105–285	Fail-on	Blue
120/208/240/277	105–305	Fail-on	Blue
480	420–530	Fail-on	Yellow
CAUTION—Care should be taken to match photocontrol voltage to luminaire operating voltage, especially at 480 V, because mechanical damage or electrical hazard may occur.			

[a]These photocontrols can also be used on 208 V or 277 V systems.
[b]Not recommended for 277 V systems that may exceed 285 V.

6. Environmental requirements

a) Photocontrols, shorting caps, or nonshorting caps and receptacles shall operate over the ambient temperature range of –40 °C to 65 °C. The photocontrol, shorting cap, or nonshorting cap shall operate, without damage to components, when the maximum plug-receptacle interface temperature is 90 °C.

b) The photocontrol, shorting cap, or nonshorting cap, when properly installed in its receptacle mounting, shall pass the environmental tests described in 11.2 and 11.3.

7. Dielectric performance requirements

7.1 Grounding

Provision shall be made for grounding metallic enclosures.

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7.2 Dielectric withstand

Electrical insulation between current-carrying components and any metallic portion of the photocontrol, shorting cap, or nonshorting cap enclosure or the receptacle with its mounting shall meet the dielectric withstand test requirements given for the 600 V class in ANSI C136.2-1985. Photocontrols, shorting caps, or nonshorting caps utilizing polymeric enclosures shall be tested with all accessible parts (as installed) wrapped in metallic foil. The dielectric withstand voltage shall be applied between the current-carrying components and the metal foil.

7.3 Surges

When surge protection is provided, the photocontrol shall withstand surges as outlined in 11.4.3 and 11.4.4. If user specified, the photocontrol may be tested to higher level surges as outlined in 11.4.5. Damage that results in the photocontrol from not meeting the test requirements specified in 10.1 and 11.3 shall indicate a failure of the device.

8. Marking, materials, and finishes

8.1 Marking

The photocontrol enclosure shall be color-coded in accordance with 5.1 and shall be clearly and permanently marked with its voltage rating, load rating, north orientation, direction of installation and removal, the name of the manufacturer, and the model number. The color of the photocontrol enclosure shall be permanent for the life of the control.

8.2 Low temperature impact

A polymeric enclosure of a photocontrol, shorting cap, or nonshorting cap shall be capable of withstanding exposure to low temperature. This capability is tested by exposing a complete device to an ambient temperature of -29 °C for 72 h. Within 10 s of removal from the cold chamber, the device is to be mounted into a receptacle and subjected to an impact of 1 ft·lb (1.36 N·m) by means of a solid, smooth, steel sphere, weighing 1.2 lb (0.54 kg), 2 in (50.8 mm) in diameter, dropped from 10 in (0.254 m) and applied to external surfaces, *excluding the window.* The photocontrol, shorting cap, or nonshorting cap shall meet the requirements of 11.3 (the rain test) after being subjected to the impact test.

8.3 Atmospheric conditions

Materials and protective coatings used in the construction of the photocontrol, shorting cap, nonshorting cap, receptacle, and related components shall individually and as a system be resistant to atmospheric conditions, including the corrosive and erosive action of conditions of service encountered in industrial and seaboard areas.

8.4 Temperature rise

When the photocontrol, shorting cap, or nonshorting cap is operated at its rated load, voltage, and frequency, within its ambient temperature range and subjected to a wind of 2 m/h (3.2 km/h), the temperature rise of any component shall not injure or render inoperative any material or component part.

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9. Ratings

9.1 Load ratings

The photocontrol shall have a minimum load rating of both 1000 W incandescent lamp load and 1800 VA high-intensity-discharge (HID) load. Voltampere load may be at a power factor as low as 0.4 inductive. Ballast losses are included in the load rating.

9.2 Surge protection rating

Photocontrols designated for luminaire system protection shall limit the maximum surge voltage to below 5000 V_{PEAK} when tested with the standard surge described in 11.4.1 or the high-level surge described in 11.4.5.

10. Operating requirements

10.1 Photocontrol

The photocontrol shall turn on within the limits of +100% and –50% of its calibrated light level setting at rated voltage and frequency:

a) Over a range of input voltages as indicated in 5.1 and an ambient temperature of 25 °C ± 5 °C. Photocontrols designed to operate over several voltages shall operate within the above limits when calibrated and operated at 240 V.
b) Over a range of ambient temperatures from –40 °C to 65 °C with relative humidity up through 96% when operated at nominal voltage. Photocontrols designed to operate at 120/240 V, 208/240/277 V, and 120/208/240/277 V shall operate within the above limits when calibrated and operated at 240 V.

10.2 Light levels

Measurements and calibration for operating light levels shall be in accordance with the following subclauses.

10.2.1 Mounting

All measurements of operating light levels shall be based on the performance of photocontrols mounted fully exposed to the sky to within 5° of true horizon and shielded from artificial light. Photocontrols requiring north orientation shall be oriented to within 15° of true north. Operating light levels are defined in footcandles of daylight illumination as determined by measurements with a conventional color-corrected photometer held in a vertical plane, facing within 15° of true north and within 5° of true horizon, and located within 1 ft (0.305 m) vertically and 15 ft (4.572 m) laterally of the photocontrol under test. All measurements shall be made to a precision of ±15%. Instrument accuracy shall be maintained by proper calibration against filament lamp candlepower standards, traceable to the National Institute of Standards and Technology (NIST).

10.2.2 Measurements

The nominal or rated operating light levels shall be determined by the average of measurements taken in accordance with 10.2.1 on at least three clear, cloudless days. The photocontrol shall be operated at rated voltage and frequency.

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10.2.3 Artificial illumination

Measurement and/or adjustment of the photocontrol operating light levels under artificial illumination shall be correlated to average performance under daylight illumination in accordance with 10.2.1 and 10.2.2.

10.3 Specifications

Photocontrol manufacturers should recommend the necessary equipment and procedure for measurement and adjustment and include correlation data in accordance with 10.2.3 for their photocontrols when used with the recommended equipment and procedure. If not, the user should specify whether

a) The photocontrol is to be adjusted to turn on at 1.5 fc ± 0.5 fc (16 lx ± 6 lx) and a maximum turn-off at 6 fc (65 lx), as measured in accordance with 10.2.3; or

b) The photocontrol is to be adjusted to operate at any operating point.

11. Qualification test procedures

11.1 Receptacle heating test

a) The temperature on the line or load receptacle contact shall be measured by means of a thermocouple attached to the outside surface of the inner blade opposite the detente of the receptacle contact. The receptacle shall be securely mounted in a horizontal position on an aluminum plate that is 6 in^2, 1/8 in thick. The test shall be performed at an ambient temperature of 25 °C.

b) A shorting cap with brass blades shall be inserted, locked, and removed five times before starting the test.

c) The same shorting cap that was used in item b) shall be inserted and locked into the test receptacle. A current of 15 A shall be applied to the line and load contacts of the test receptacle. The current shall be applied for 15 cycles, each consisting of a 20-h on period and a 4-h off period.

d) The receptacle shall be considered to have failed if the temperature rise on the receptacle contact, at the end of a 20 h period, is greater than 30 °C.

11.2 Humidity test

The assembly of the photocontrol, shorting cap, or nonshorting cap and receptacle shall be exposed to 96% relative humidity at 50 °C for 168 h when operating at rated voltage and load. The photocontrol shall be illuminated for 12 h at 100 fc (1075 lx) and 12 h below 0.1 fc (1.075 lx) for 7 cycles. Within 1 min of its removal from the humidity chamber, the assembly shall be subjected to the dielectric voltage-withstand requirements described in 7.2. Within 10 min after the removal from the humidity chamber, the photocontrol shall meet the light level requirements of 10.1.

11.3 Rain test

The assembly of the photocontrol, shorting cap or nonshorting cap, and receptacle shall be subjected to the rain tightness test described in UL 773-1987. Within 5 min after completion of the rain test, the device shall be tested and shall meet the voltage-withstand requirements of 7.2.

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11.4 Surge test

11.4.1 Standard surge

The open-circuit surge voltage shall have a 6000 V peak amplitude and a 1.2 × 50 μs wave shape. The voltage wave shall be synchronized with the ac power line and shall be initiated 30° to 60° or 255° to 285° after the instantaneous 60 Hz voltage has changed from negative to positive polarity. Positive voltage polarity is defined to be the same polarity as the surge voltage. The short-circuit surge current shall have a 3000 A peak amplitude and an 8 × 20 μs wave shape. The minimum available follow current shall be 1000 A rms and have a minimum duration of 1 cycle.

11.4.2 Test equipment calibration

During calibration, the photocontrol shall be removed from the test receptacle. All test points shall be less than 6 in from the test receptacle. The follow current shall be measured by shorting the line and neutral test points. The back filter shall be connected when determining follow current. The open-circuit surge voltage shall be measured between the line and neutral test points with the back filter and ac power line connected. The short-circuit surge current shall be determined by shorting the line and neutral test points. The ac power lines and back filter shall not be connected for the short-circuit surge current measurement.

11.4.3 Test procedure (standard surge; 6000 V)

The test procedure shall be performed after the test equipment has been calibrated according to 11.4.2 to give the value specified in 11.4.1. The photocontrol shall be inserted into the test fixture and shall be placed in darkness. Two surges as specified in 11.4.1 with a phase angle of 30° to 60° shall be applied to the photocontrol, followed by one surge with a phase angle of 255° to 285°. These three surges shall be repeated with the photocontrol illuminated to a minimum of 30 fc (322 lx). The minimum time between surges shall be 15 min.

11.4.4 Test procedure (low voltage)

The procedure outlined in 11.4.3 shall be repeated using a new photocontrol, except that the surge voltage shall have a peak value equal to the sum of 350 V plus the rated root-mean-square (rms) voltage of the photocontrol. The surge current will be proportionally lower.

11.4.5 Test procedure (high-level surge; 10 000 V)

For products rated for high-level surges (10 000 V), the procedure outlined in 11.4.3 shall be used, except that the open-circuit surge voltage shall be 10 000 V, the short-circuit surge current shall be 6 500 A, and the minimum available follow current shall be 3 000 A.

11.5 Load test

Prior to the load test, the photocontrol shall carry a continuous current of 15 A for 4 h at an ambient temperature of 25 °C.

11.5.1 Load and supply

The photocontrol shall be connected to a single 1000 W mogul-base tungsten-filament lamp at 120 V, 60 Hz. The test setup shall be capable of supplying an instantaneous inrush current at the lamp of a minimum of 95 A peak.

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11.5.2 Test cycle

The photocontrol shall be cycled at a rate no faster than 1 cycle in 6 min as described, with the following time period: dark for 1.5 min, gradually illuminated to 20 fc (215 lx) over 1 min, then maintained at 20 fc (215 lx) minimum for 2.5 min, then gradually decreasing the illumination from 20 fc (215 lx) to dark over 1 min.

11.5.3 Test duration

The photocontrol shall be capable of completing 3650 cycles of operation with no more than five failures to transfer the load.

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